Progressive Rehabilitation and Closure Plan

Blair Athol Coal Mine

TerraCom Limited

Prepared for Orion Mining Pty Ltd | September 2025



Orion Mining Pty Ltd

E jschoeman@terracom.au

W www.terracomresources.com

A Blair Athol Mine Access Road
Clermont QLD 4721

P PO Box 131
Clermont QLD 4721

TerraCom

SGMenvironmental

This page is intentionally blank

Progressive Rehabilitation and Closure Plan

Blair Athol Coal Mine

TerraCom Limited

Prepared for Orion Mining Pty Ltd | 30 September 2025

Orion Mining Pty Ltd

E jschoeman@terracom.au

W www.terracomresources.com

A Blair Athol Mine Access Road

Clermont QLD 4721

P PO Box 131

Blair Athol Coal Mine | Progressive Rehabilitation and Closure Plan

Date of submission: 30 September 2025

Document number: 21B031-001

Holder: Orion Mining Pty Ltd

Tenure: ML1804

Project number:	21B031
Document title:	Progressive Rehabilitation and Closure Plan | Blair Athol Coal Mine
Revision:	V2-5
Date:	30 September 2025
Client:	Orion Mining Pty Ltd

Project manager:	M Forbes
Author:	D Borombovits, G Greening, L Purdy, C Brownbill, T Kelly

Legal Name:	SGM Environmental Pty Limited		
Address:	PO Box 5622, Stafford Heights, Qld 4053		
ACN:	621 989 866	ABN:	65 621 989 866
Representative:	Timothy Rohde	Phone:	+61 7 3148 6288
Email:	trohde@sgmenvironmental.com		



Honest | Trust | Innovation | Safety

This Report is provided to you the abovenamed Client (Client, you or your) in respect of the above Project and following our Standard Terms. Capitalised terms that are not specifically defined in this Report have the meanings given to them in our Standard Terms.

© Copyright 2022 SGM Environmental Pty Limited. The concepts and information contained in this document are the property of SGM Environmental Pty Limited. Use or copying of this document in whole or in part without the written permission of SGM Environmental Pty Limited constitutes an infringement of copyright.

Data / confidentiality: This report contains information and data that is confidential and / or subject to restrictions in respect of Intellectual Property Rights (IP). Readers agree to be bound by confidentiality and IP provisions contained in our Standard Terms and the obligation not to cause any damage or hardship to SGM Environmental Pty Limited or the Client.

Document history and status

Revision	Date	Description	By	Review	Approved
V0-1	23/08/22	Draft	G Greening	T Rohde	T Rohde
V0-2	05/06/23	Draft	L Purdy	D Borombovits	T Rohde
V1-3	17/08/23	Draft	D Borombovits	TCL	T Rohde
V1-4	07/05/24	Final draft	D Borombovits	T Rohde	T Rohde
V2-4	17/05/24	Final	D Borombovits	A Koerber	D McCarthy

Revision	Date	Description	By	Review	Approved
V2-5	31/05/24	Final	C Brownbill, T Kelly	M Forbes	T Rohde

Table of contents

Executive summary xi

3.0 Rehabilitation planning part 1

3.1 Project planning 1

3.1.1 Baseline information 1

3.1.2 Project description 30

3.1.3 Design for closure 35

3.1.4 Rehabilitation and improvement planning 35

3.2 Community consultation 38

3.2.1 Community consultation register 38

3.2.2 Community consultation plan 38

3.3 Post mining land use 41

3.3.1 Transitional provisions 41

3.3.2 Nominated post-mining land uses 41

3.3.3 Community consultation 44

3.3.4 Land use planning 44

3.4 Non-use management area 45

3.4.1 Transitional provisions 45

3.4.2 Nominated non-use management areas 45

3.4.3 Community consultation 47

3.4.4 Land use planning 47

3.5 Rehabilitation and management methodology 48

3.5.1 General rehabilitation practices 48

3.5.2 Co-disposal areas 86

3.5.3 Final void 87

3.5.4 Underground mining 91

3.5.5 Built infrastructure 93

3.5.6 Summary of key rehabilitation and management activities 93

3.6 Risk assessment 102

3.6.1 Rehabilitation trials 103

3.7 Monitoring and maintenance 104

3.7.1 Vegetation and final landform 104

3.7.2 Diversion monitoring 108

3.7.3 Water quality 109

3.7.4 Administration 122

References 123

Appendix A PRC plan schedule 127

Appendix B Environmental management plan 137

Appendix C Groundwater investigation 193

Appendix D Final void hydrology 256
Appendix E Soil and capping material assessment 274
Appendix F Disposal plan 293
Appendix G Spontaneous combustion management plan 345
Appendix H Landform report 363
Appendix I Geotechnical stability assessment 384
Appendix J WEPP erosion model 398
Appendix K Water management plan 438
Appendix L Erosion and sediment control management plan 472
Appendix M Water balance model report 487
Appendix N Revegetation plan 521
Appendix O Rehabilitation management plan 572
Appendix P Residual void management plan 666
Appendix Q Numerical groundwater modelling 870
Appendix R Risk assessment 988
Appendix S PMLU options analysis 993
Appendix T Geotechnical clarification memo 1001
Appendix U Growth Media – Mitigation & Management Strategy 1012
Appendix V Flood assessment 1036
Appendix W Mine closure management plan 1071
Appendix X Western Waterway Diversion monitoring design 1126
Appendix Y Eastern Waterway Diversion monitoring design 1143

Figure

Figure 1 Location 2
Figure 2 Topography 3
Figure 3 Bushfire prone areas 7
Figure 4 Geology 9
Figure 5 Hydrology and fluvial networks 11
Figure 6 Mapped soil units 19
Figure 7 State-mapped regional ecosystems 25
Figure 8 Threatened ecological communities 26
Figure 9 Mining tenements 31
Figure 10 Primary mine features and infrastructure 33
Figure 11 Existing rehabilitation 37
Figure 12 Blair Athol water chemistry plot 49
Figure 13 Pre-mining conceptual groundwater model 52
Figure 14 Waste coal stockpile locations 64
Figure 15 Final landform design 67
Figure 16 Cut and fill areas 68

Figure 17 Final landform elevation 69
Figure 18 Water flow pathways schematic 76
Figure 19 Post-mining conceptual groundwater model 89
Figure 20 Final void long-term predicted salinity concentration and load 90
Figure 21 Void design plan 91
Figure 22 Underground workings 92
Figure 23 Risk management process 102
Figure 24 Rehabilitation monitoring locations 106
Figure 25 Final site design 130
Figure 26 Rehabilitation areas 131

Table

Table 1 Mean monthly and annual rainfall 5
Table 2 Mean daily evaporation 5
Table 3 Mean maximum and minimum monthly and annual temperature 5
Table 4 2030-2070 Projected climate 5
Table 5 Water quality objectives 12
Table 6 Groundwater levels 13
Table 7 Groundwater properties 15
Table 8 Mapped soil units 18
Table 9 Protected matters report identified MNES 21
Table 10 Matters of state environmental significance 22
Table 11 Environmentally sensitive areas 23
Table 12 Regional ecosystems 24
Table 13 Fauna presence 27
Table 14 Neighbouring properties 29
Table 15 Tenure 30
Table 16 Ancillary environmentally relevant activities 30
Table 17 Rehabilitation areas 35
Table 18 Community consultation register 39
Table 19 Community consultation plan 40
Table 20 Identified community members 40
Table 21 Nominated post-mining land use 41
Table 22 PMLU completion criteria 43
Table 23 NUMA completion criteria 46
Table 24 Soil nutrient ranges for rehabilitation 54
Table 25 Soil sample results 55
Table 26 Soil stockpiles 57

Table 27	Additional soil volumes	57
Table 28	Soil accounting	58
Table 29	Spoil sample results	61
Table 30	Sources of coal in waste coal stockpiles	63
Table 31	Waste coal stockpile management	65
Table 32	Source, pathway and fate of contaminants	75
Table 33	Water storage infrastructure	77
Table 34	Recommended soil ameliorants	81
Table 35	Growth media quantities needed for rehabilitation	83
Table 36	Reject disposal requirements of the environmental authority	86
Table 37	Lake storm event modelling results	89
Table 38	Rehabilitation milestones and strategies	95
Table 39	Management milestones and strategies	100
Table 40	Laboratory parameters for surface water quality	111
Table 41	Laboratory parameters for sediment quality	113
Table 42	Parameters for macroinvertebrate assessments	114
Table 43	Summary of Table C2 of the EA	116
Table 44	Summary of Table C3 of the EA	116
Table 45	Groundwater monitoring locations and frequencies (Table I1 of EA)	119
Table 46	Groundwater quality limits (Table I2 of EA)	119
Table 47	Rehabilitation milestones and milestone criteria	132
Table 48	Management milestones and milestone criteria	136

Important note about your report

This Report is provided for the exclusive use of the Client pursuant to the Scope of Works 25 August 2021, which requires us to provide Services relating to Progressive Rehabilitation and Closure Plan (PRC plan).

This Report is provided to the Client on the terms and conditions set out in the Standard Terms of SGM Environmental Pty Limited (SGME, we, us or our).

We derive data in this Report from information (or confirmation of the absence thereof) sourced from the Client and their subconsultants, designated laboratories and / or information that has been made available in the public domain at the time or times outlined in this Report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the PRC plan and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this Report.

SGME has prepared this Report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to any applicable standards, guidelines, procedures and practices outlined in the Scope of Works as at the date of issue of this Report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this Report, to the extent permitted by law.

This Report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by SGME for use of any part of this Report in any other context.

Reporting of the PRC plan are based on a desktop assessment of data that has been measured by the Client and their subconsultants and other third parties.

SGME does not accept any Liability whatsoever for, or in respect of, any use of, or reliance upon this Report by any person contrary to the above or our Standard Terms.

Executive summary

Blair Athol Coal Mine

Blair Athol Coal Mine (the Mine) is an open cut coal mining operation owned and operated by TerraCom Limited (TCL). It is authorised under environmental authority (EA) EPML00876713 and mining lease (ML) 1804.

Transition notice

Under the *Environmental Protection Act 1994* (EP Act), a three-year period between 1 November 2019 and 1 November 2022 was given within which the administering authority could issue a transition notice to site-specific EA holders. The EA holder must prepare and submit a proposed progressive rehabilitation and closure plan (PRC plan) by the date specified within the transition notice. TCL was issued a transition notice for EA EPML00876713 on 18 November 2021 which required the original submission of the proposed PRC plan by 17 November 2023. This time period has been amended. The EA holders must now submit the proposed PRC plan to the administering authority by 17 May 2024.

Transitional PRC plan

A transitional PRC plan has been prepared comprising two parts:

- part A — the rehabilitation planning part; and
- part B — the PRC plan schedule (Appendix A).

The PRC plan schedule and reports and plans have been attached as appendices.

3.0 Rehabilitation planning part

3.1 Project planning

Blair Athol Coal Mine (the Mine) is owned and operated by TerraCom Limited (TCL). It was previously operated by Blair Athol Coal Pty Limited, a subsidiary of Rio Tinto Coal Australia Pty Limited (Rio Tinto), from 1982 until 2012 when it was put into care and maintenance. Small scale mining has occurred on the land since the 1890s.

TCL via its subsidiary bought the Mine grant of title transfer from the Queensland Government in 2017. The acquisition means that TCL can efficiently reshape and restore one of Queensland's oldest coal mines while effectively retrieving remnant resources.

Acquisition of the Mine has the following benefits:

- progressive rehabilitation of one of Queensland's oldest coal mines;
- resumption of coal mining and sales which enhance local, state and federal economies through increased economic activity, employment, royalties and taxation; and
- positive cash flow through a low overhead structure and operational efficiencies.

3.1.1 Baseline information

3.1.1.1 Location

The Mine is approximately (~) 240 kilometres (km) south-west of Mackay and ~17 km north-west of Clermont township in central Queensland (Figure 1). It is located in the Isaac Regional Council local government area (LGA). Blair Athol State Forest adjoins west of the Mine tenure, with Apsley State Forest located to the south-east.

The closest sensitive receptor is Blair Athol Station, which includes the Blair Athol Homestead and Old Blair Athol Homestead ~3 km to the north. The nearest township is Clermont ~15 km to the south.

The closest mining operation is Clermont Coal Mine, which is ~10 km south-east and ~12 km from Clermont, and produces high quality thermal coal for export.

Access is via Peak Downs Highway then onto Gregory Development Road. From Gregory Development Road, access is via Blair Athol Connection Road and Blair Athol Mine Road.

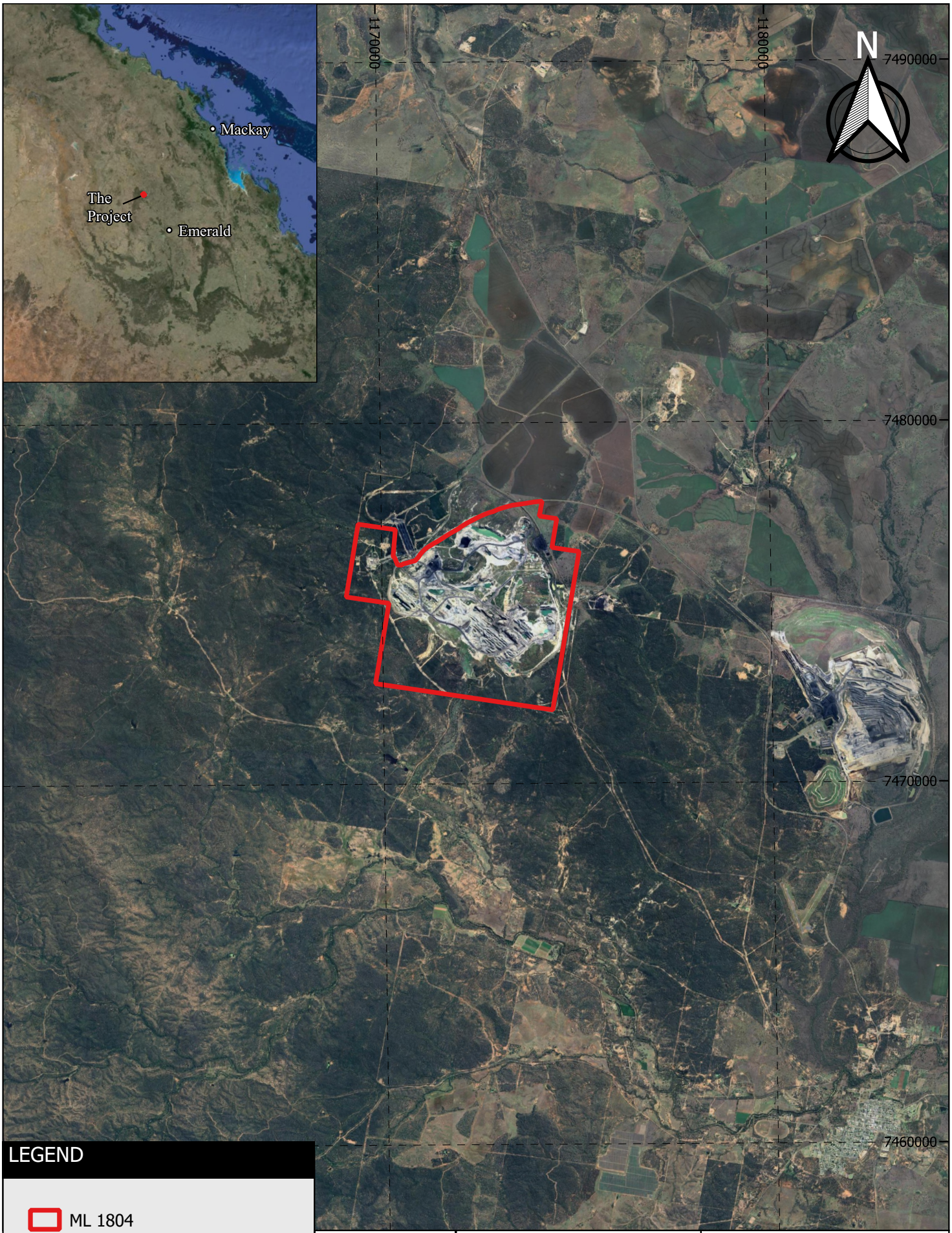
3.1.1.2 Topography

a Local

Topography in the ML ranges from ~260-340 metres (m) Australia Height Datum (AHD). There is an 80 m difference between the lowest point near the centre and the highest point in the north-east (Figure 2).

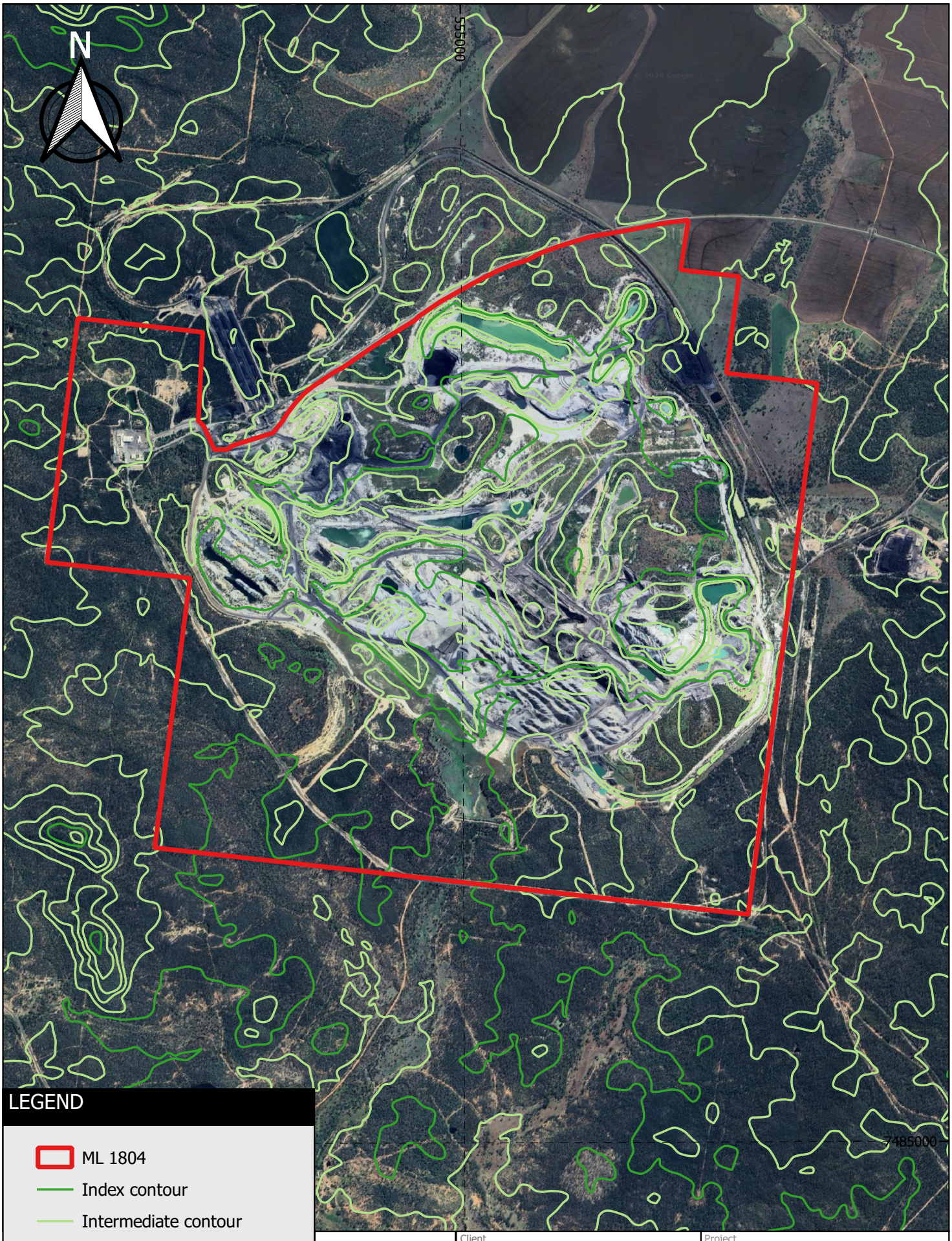
b Regional

The Mine is located on the eastern flank of the Drummond Range. Drummond range rises to a maximum height of 340 m AHD.



SGM environmental	Client: TerraCom Limited	Project: Progressive rehabilitation and closure plan
	Design: SGM Environmental Pty Ltd 16.05.2024 Scale: 1 : 50,000 CRS: GDA 2020	Title: Location Figure: 1

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.



LEGEND

- ML 1804
- Index contour
- Intermediate contour

Scale 1 : 15 000

0 0.5 1 km

SGM environmental	Client: TerraCom Limited	Project: Progressive rehabilitation and closure plan	
	Design: SGM Environmental Pty Ltd 16.05.2024 Scale: 1 : 15,000 CRS: GDA 2020	Title: Topography	Figure: 2

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

3.1.1.3 Climate

The climate is classified as subtropical under the Bureau of Meteorology (BoM) modified Köppen classification system (BoM 2016). Subtropical regions typically experience a cool to mild winter and a hot summer with high humidity.

The closest weather stations are:

- Clermont Post Office (site number 035019) — located ~12 km south-east; and
- Clermont Airport (site number 035124) — located ~18 km south-east.

Clermont Post Office weather station started recording data in 1870 and closed 18 Oct 2018. Clermont Airport weather station is currently operational and started recording data in 2010.

a Rainfall

The region has a distinct wet season occurring between December-March, during which ~60 % of total annual rainfall is received. The dry season typically occurs from April-September, during which the region normally receives less than (<) 25 millimetres (mm) of rain. Mean monthly and annual rainfall for both weather stations are in Table 1.

b Evaporation

Gridded Scientific Information for Land Owners (SILO) data was used to determine evaporation statistics for the Mine. SILO datasets provide spatially and temporally complete datasets and are based on observational records provided by BoM.

Mean annual potential evaporation is ~2,117 mm which is ~ three times higher than mean annual rainfall. Highest evaporation rates typically occur between October-January. Mean monthly and annual evaporation at Clermont Post Office weather station is in Table 2.

c Temperature

Highest mean maximum temperature at Clermont Post Office weather station is 34.8 degrees Celsius (°C) and occurs in December. Lowest mean minimum temperature is 6.7 °C and occurs in July. Mean maximum, mean minimum and annual temperatures for both weather stations are in Table 3.

d Long-term climate projections

According to the Queensland Government (2022a) and CSIRO & BoM (2020), the following changes in climatic conditions are expected as a result of climate change:

- lower median annual rainfall;
- higher frequency and intensity of heavy rainfall;
- higher frequency and intensity of droughts;
- increased median annual evaporation;
- increased maximum, minimum and mean temperatures; and
- higher frequency of hot days.

The *Regional Climate Projections Report* provides historical and projected climate information for 2030, 2050 and 2070 based on SILO climate data and the Queensland Government's *Consistent Climate Scenarios* projection data. This is based on climate modelling for the Intergovernmental Panel on Climate Change (IPCC) *Fifth Assessment Report* (AR5). Projected rainfall, evaporation and minimum and maximum temperatures for the Mine are in Table 4.

Table 1 Mean monthly and annual rainfall

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean rainfall (mm) — Clermont Post Office[1]	117.8	114.4	74.6	38.2	33.9	33.2	25.1	18.6	20.0	35.2	57.0	91.5	659.5
Mean rainfall (mm) — Clermont Airport[2]	83.9	72.3	101.2	20.7	15.1	22.3	25.5	16.9	25.8	32.4	58.4	70.8	545.3

1. Mean rainfall from 1910-2011 (BoM 2022a)
2. Mean rainfall from 2010-2022 (BoM 2022b)

Table 2 Mean daily evaporation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean daily evaporation (mm) — Clermont Post Office	7.5	6.7	6.3	5.1	3.7	3.0	3.2	4.2	5.7	7.0	7.4	8.1	5.7

Mean evaporation from 1889-2021 (BoM 2022a)

Table 3 Mean maximum and minimum monthly and annual temperature

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean maximum temperature (°C) —Clermont Post Office[1]	34.3	33.0	32.0	29.5	26.1	23.1	23.1	25.3	28.8	31.9	33.9	34.8	29.7
Mean minimum temperature (°C) — Clermont Post Office[1]	21.6	21.1	19.4	15.7	11.4	8.1	6.7	8.3	12.1	16.3	19.0	20.8	15.0
Mean maximum temperature (°C) —Clermont Airport[2]	34.5	33.9	32.0	29.4	26.0	23.2	23.7	26.0	29.4	32.3	33.8	34.5	29.9
Mean minimum temperature (°C) — Clermont Airport[2]	21.6	21.2	20.0	15.4	10.3	7.5	6.3	7.0	11.6	15.6	18.9	20.9	14.7

1. Mean maximum and minimum temperatures from 1910-2011 (BoM 2022a)
2. Mean maximum and minimum temperatures from 2010-2022 (BoM 2022b)

Table 4 2030-2070 Projected climate

Climate variable — median annual	Historical (1960-2010)	Projection 2030	Projection 2050	Projection 2070
Rainfall (mm)	574.8	558.7	543.8	528.7
Evaporation (mm)	2,123.5	2,231.5	2,289.9	2,340.4
Mean temperature (°C)	22.2	23.3	23.9	24.4
Maximum temperature (°C)	29.3	30.4	31.0	31.5
Minimum temperature (°C)	15.2	16.2	16.8	17.3

Lot 2 on Plan USL43676 (Queensland Government 2022a)

e Climate extremes and natural hazards

The region is prone to extreme climatic events and natural hazards such as tropical cyclones, droughts and bushfires. Risks to rehabilitation from climate extremes are identified in the risk assessment (Section 3.6) and include:

- more frequent and intense droughts resulting in increased bushfire and erosion risks, a loss of trees and reduced surface cover;
- higher temperatures and humidity levels causing cattle heat stress and impacting pasture nitrogen (N) status; and
- higher intensity of storms causing decreased soil moisture levels, decreased pasture growth, increased runoff and increased soil erosion risks.

Tropical cyclones

Due to climate change, tropical cyclones are projected to become less frequent but more intense (CSIRO & BoM 2020). Cyclones are measured on a scale of 1-5 with category 1 being least destructive and category 5 being most destructive. Since 1969, there have been three tropical cyclones within 50 km of the Mine which were classified as category 2, 3 and 4 respectively (BoM 2022c). There is no record of a category 5 cyclone occurring within 50 km of the Mine (Bom 2022c).

Droughts

Droughts can impact soil and plant cover of natural and rehabilitated land. Two relevant historical droughts are the millennium drought which occurred between 1997 and 2009 in southern and eastern areas of Australia and the drought which occurred between 2017 and 2019 in numerous locations across the country (BoM 2022d). The Mine is in the Isaac region which contains areas with drought declarations (Queensland Government 2022b).

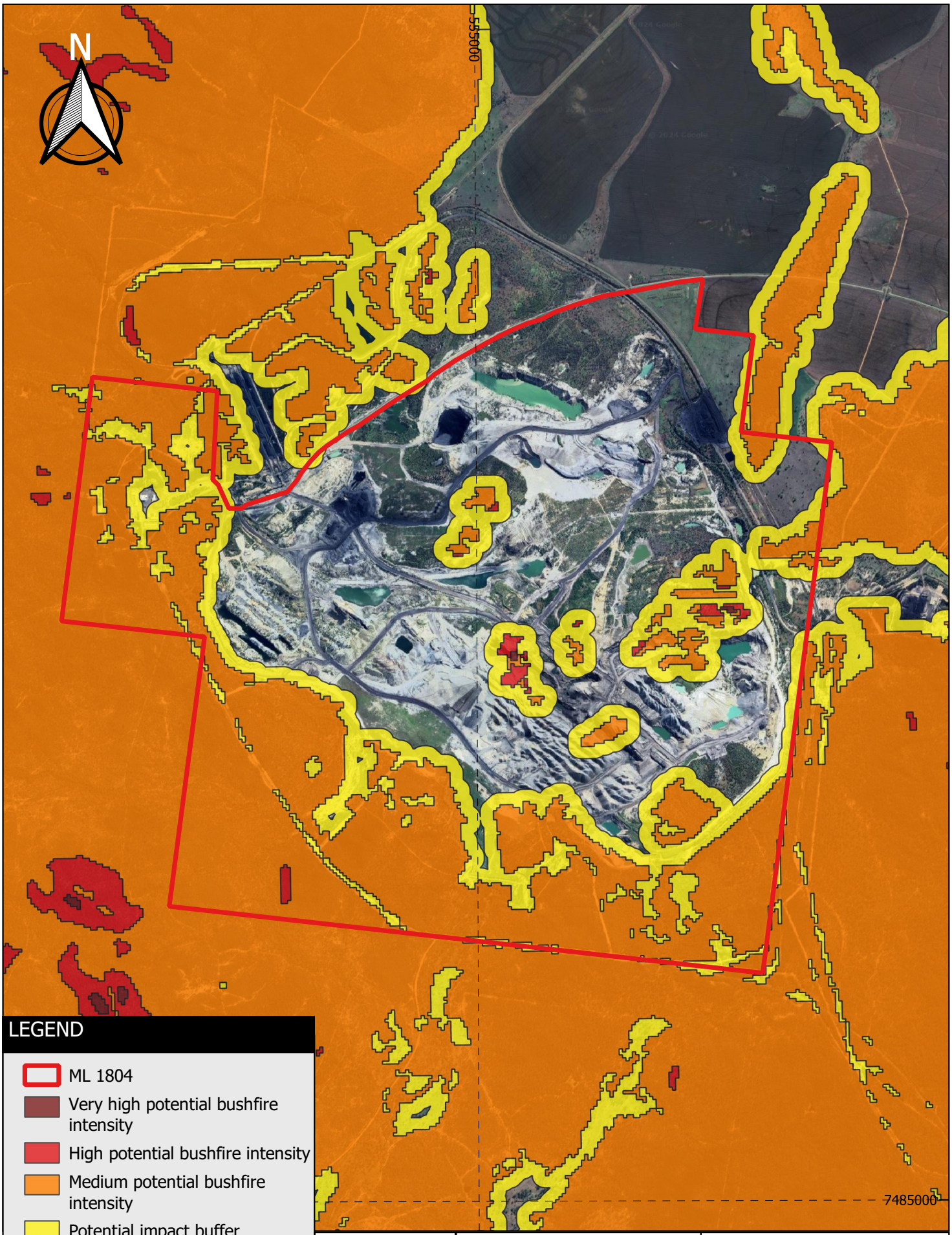
Bushfires

Bushfires pose a threat to human health, infrastructure and the environment. They can prolong successful rehabilitation of an area by damaging or destroying mature plants, juvenile plants and seed banks. Implementing fire breaks, conducting hazard reduction burns, removing potential fuel and sourcing updated information can mitigate the aforementioned risks to rehabilitation. These control measures can also increase suitability of land for the proposed post mining land use (PMLU).

There has been an increase in annual frequency of dangerous fire weather days across Australia, particularly during the dry season, which can be attributed to climate change (CSIRO & BoM 2020). The Commonwealth Scientific and Industrial Research Organisation (CSIRO) in conjunction with the Queensland Fire and Emergency Service has made state-wide bushfire hazard area mapping to support the bushfire hazard provisions of the *State Planning Policy* (SPP) (Leonard et al 2014). This classification system considers:

- potential fuel load volume calculated from vegetation type and quantity;
- fire weather severity rating based on the Forest Fire Danger Index; and
- fire line intensity which combines potential fuel load, maximum landscape slope and fire weather severity rating.

Under this classification system, there is a medium-high potential fuel load, a medium-high potential fire weather severity rating, a medium fire line intensity potential and a medium potential intensity rating as a bushfire prone area (Leonard et al 2014). Therefore, there is a medium-high bushfire risk (Figure 3).



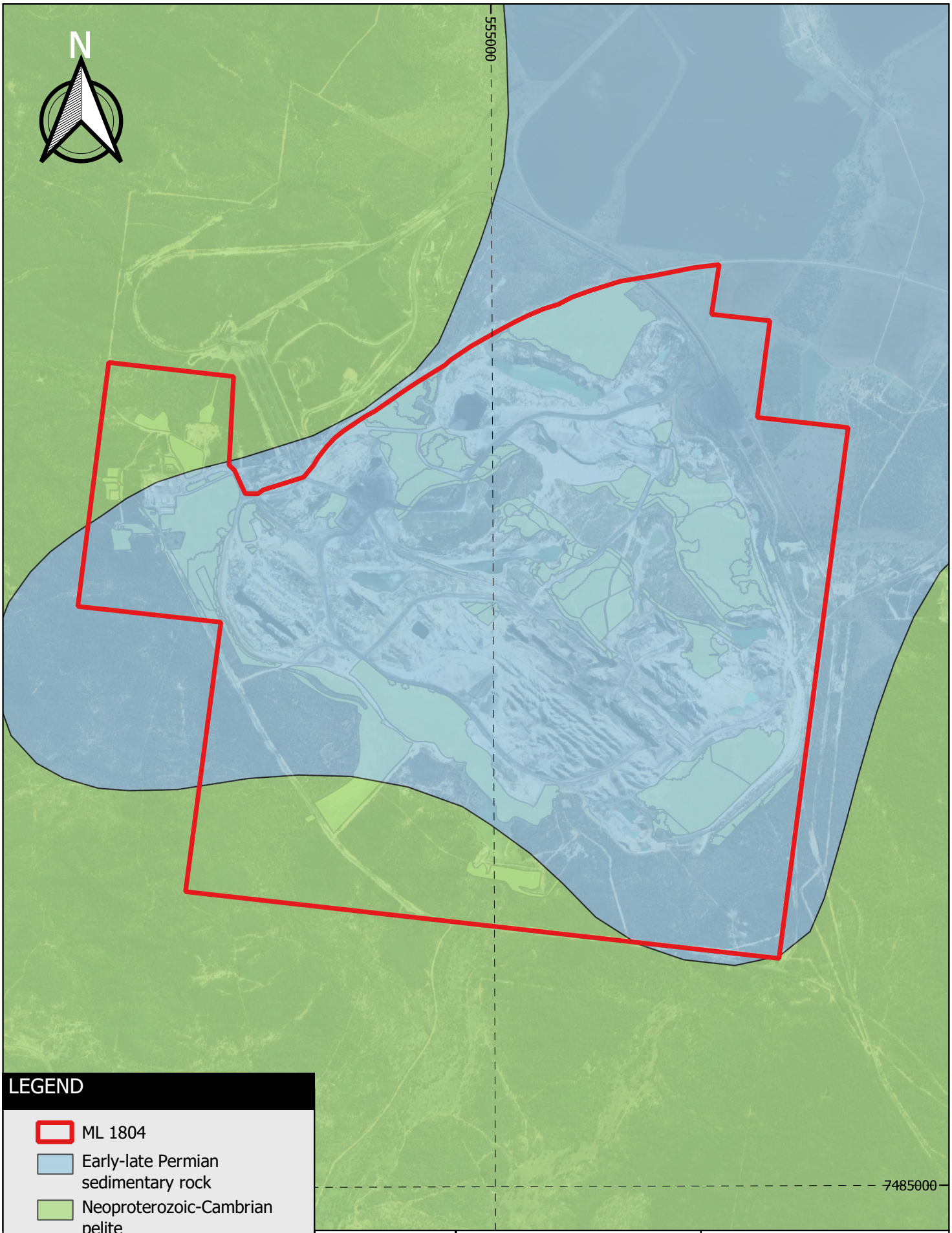
SGM environmental	Client: TerraCom Limited	Project: Progressive rehabilitation and closure plan	
	Design: SGM Environmental Pty Ltd 16.05.2024 Scale: 1 : 15,000 CRS: GDA 2020	Title: Bushfire hazard	Figure: 3

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

3.1.1.4 Geological setting

Blair Athol Basin is an isolated Permian basin, near the western edge of northern Bowen Basin on the northern extension of Dennison Trough (JBT 2012). The Mine has five lithological units which are listed below from oldest to youngest (Figure 4) (EES 2018):

- Proterozoic to Cambrian schist, phyllite and metabasalt of the Anakie Metamorphic Group;
- Early to Middle Devonian arenites occupying a small basement trough in the south of the basin;
- the Permian Blair Athol coal measures including:
  - lower coal measures consisting of basal conglomerate, sandstone, siltstone and mudstone with an estimated maximum thickness of 130-150 m; and
  - upper coal measures consisting of sandstone, siltstone, mudstone and conglomerate in addition to four main coal seams which are referred to as seams 1, 2, 3, and 4 respectively;
- Tertiary Basalt occurring in the north and east of the ML with an average thickness of 18-22 m; and
- Tertiary and Quaternary Alluvial deposits within ephemeral streams which act as drainage for the Mine and Bath and Washpool creeks.



SGM environmental	Client: TerraCom Limited	Project: Progressive rehabilitation and closure plan
	Design: SGM Environmental Pty Ltd 16.05.2024 Scale: 1 : 15,000 CRS: GDA 2020	Title: Geology Figure: 4

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

3.1.1.5 Hydrology and fluvial networks

a Receiving environment

For water management purposes, receiving environment is defined as waters of Bath Creek and connected or surrounding waterways within 12 km downstream. The receiving environment is influenced by historical and current land uses, in addition to the ephemeral and unpredictable nature of the waterways.

There is no approved release point; therefore, impact on the receiving environment is extremely low. Historical mine workings have created a depressed landform which causes the majority of disturbed area to drain internally.

b Drainage network

The site is located at the top of Bath Creek in foothills of Drummond Range. Bath Creek is a tributary of Sandy Creek which is a sub-catchment of Nogoa River in the north-west corner of Fitzroy Basin. Drummond Range, in the north-west forms a watershed between Burdekin drainage system in the north and Fitzroy system in the south.

Water from Bath Creek feeds Sandy Creek and Theresa Creek before entering the Nogoa River near Emerald. Nogoa River then feeds Fitzroy River which flows through to the Coral Sea. Local waterways and drainage networks are in Figure 5.

Diversions have been constructed in Bath Creek, Washpool Creek and Breaker Creek to avoid passing through the Mine. Washpool Creek is diverted along the Northern Boundary Drain along the Eastern Diversion which flows downstream into Bath Creek. Breaker Creek flows around the western perimeter and joins Bath Creek West downstream of the Western Diversion which flows into Bath Creek ~1.6 km downstream.

These diversions only facilitate flows during the wet season due to their ephemeral nature. The diversions are also considered part of the final landform and will remain post closure, and not temporary or artificial features.

c Downstream water users

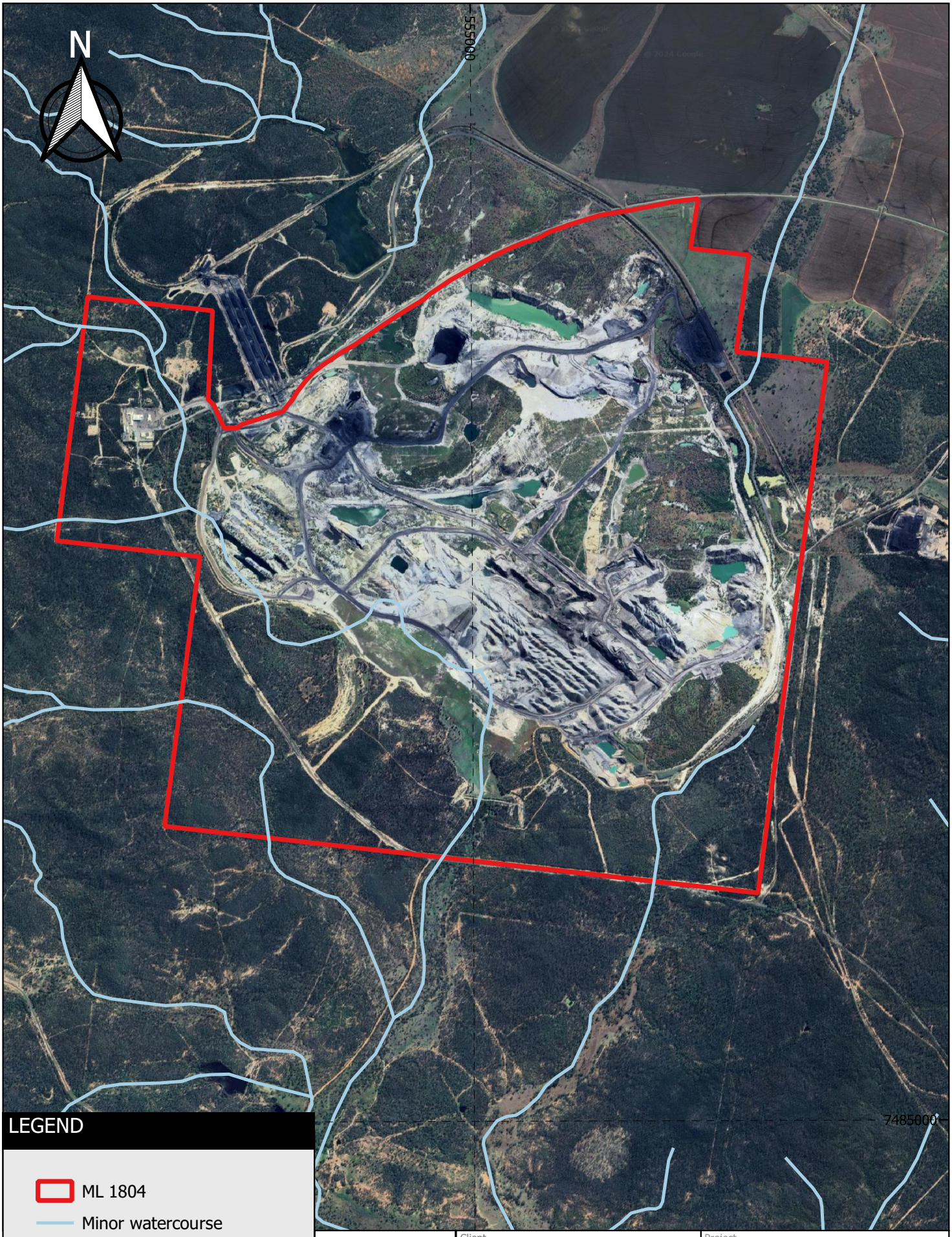
Water is used for stock watering and ecosystem function. Cattle and wildlife use water from several waterholes along Bath Creek during the dry season. The nearest downstream drinking water reservoir is ~200 km away in the township of Blackwater.

d Surface water environmental values

The *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP (Water)) establishes environmental values (EVs) for waterways in Queensland and provides a decision-making framework to identify water quality objectives (WQOs). The *Queensland Water Quality Guidelines 2009* (DEHP 2009) outline the conditions of specific waterways and make land use recommendations based on physical, chemical and biological factors of a catchment. EVs for Lower Nogoa River and Theresa Creek Sub-basin include:

- protection of aquatic ecosystems;
- suitability for irrigation;
- suitability for stock watering;
- suitability for aquaculture;
- suitability for human consumption;
- suitability for primary and secondary recreation;
- maintenance of visual amenity;
- suitability for industrial use; and
- protection of cultural and spiritual values.

WQOs for waters of the Lower Nogoa and Theresa Creek Sub-basin are in Table 5.



LEGEND

ML 1804

Minor watercourse

Scale 1 : 15 000

0 0.5 1 km

SGM environmental	Client: TerraCom Limited	Project: Progressive rehabilitation and closure plan	
	Design: SGM Environmental Pty Ltd 16.05.2024 Scale: 1 : 15,000 CRS: GDA 2020	Title: Hydrology	Figure: 5

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

Table 5 Water quality objectives

Parameter		Objective
N	Ammonia	Maintain at less than (<) 10 micrograms per litre (µg/L)
	Oxidised	Maintain at < 60 µg/L
	Organic	Maintain at < 420 µg/L
	Total	Maintain at < 500 µg/L
Phosphorous (P)	Filterable reactive	Maintain at < 20 µg/L
	Total	Maintain at < 50 µg/L
Chlorophyll a		Maintain at < 5.0 µg/L
Dissolved oxygen (O)		Maintain at 85-110 % saturation
Turbidity		Maintain at < 50 nephelometric turbidity unit (NTU)
Suspended solids		Maintain at < 10 milligrams per litre (mg/L)
pH		Maintain at 6.5-8.5
Electrical conductivity (EC)	Baseflow (Lower Nogoa)	Maintain at < 340 microsiemens per centimetre (µS/cm)
	Baseflow (Theresa Creek)	Maintain at < 720 µS/cm
	High flow	Maintain at < 250 µS/cm
Sulphate		Maintain at < 25 mg/L
Macroinvertebrates	Taxa richness (composite)	Maintain at 12-21
	Taxa richness (edge habitat)	Maintain at 23-33
	Plecoptera, *Ephemeroptera* and *Trichoptera* (PET) taxa richness (composite)	Maintain at 2-5
	PET taxa richness (edge habitat)	Maintain at 2-5
	Stream invertebrate grade number – average level (SIGNAL) index (composite)	Maintain at 3.33-3.85
	SIGNAL index (edge habitat)	Maintain at 3.31-4.2
	Tolerant taxa (composite) (%)	Maintain at 25-50 %
	Tolerant taxa (edge habitat) (%)	Maintain at 44-56 %

DEHP (2011)

3.1.1.6 Groundwater levels and properties

Three groundwater aquifers have been identified as passing through the ML (TerraCom 2107a). These are referred to as:

- coal measures;
- Basalt area in the north; and
- Alluvial, associated with the natural creek system.

Groundwater from the coal measures has considerable variability and is not a reliable source of water. The Basalt aquifer is largely undisturbed and it is assumed from water quality data to be predominantly recharged by rainfall (TerraCom 2017a). Most regional groundwater is sourced from either the Basalt or Alluvial aquifer.

Changes in groundwater levels and quality impact groundwater uses, groundwater dependent ecosystems (GDEs) and aquifer quality. There are two groundwater compliance bores which are monitored quarterly and eight additional bores which are comparison points to measure underlying groundwater properties (TerraCom 2020a).

a Groundwater levels

A drilling and pumping test program was done by Coffey (1980) to understand local groundwater systems. Six test bores and piezometers were constructed ~100 m south of Void 1 and a series of pumping tests were done. The program concluded that the static water levels in seams 3 and 4 were coincident and that pumping from Seam 3 caused drawdown in Seam 4.

Seam 3, Seam 4 and spoil were found to behave as an unconfined aquifer and there is direct hydraulic connection between the coal seams. The aquifer in Seam 3 is ~18 m thick and Seam 4 is ~5 m thick. Spoil (interburden) between seams 3 and 4 was 4-6 m thick. Relative levels (RLs) of the ground surface, top of casing and water level for each monitoring bore along with the date of observation are in Table 6.

Table 6 Groundwater levels

Bore	RL ground surface (m AHD)	RL top of casing (m AHD)	RL water level (m AHD)	Date
BH1 (Seam 3)	307.15	307.24	283.820	24/06/1980
			283.858	24/06/1980
			283.840	25/06/1980
			283.855	25/06/1980
			283.859	25/06/1980
			283.842	26/06/1980
			283.848	27/06/1980
			283.897	01/07/1980
			283.822	02/07/1980
			283.750	04/07/1980
			283.605	07/07/1980
BH2 (Seam 4)	307.095	307.23	284.115	24/06/1980

Bore	RL ground surface (m AHD)	RL top of casing (m AHD)	RL water level (m AHD)	Date
			284.145	24/06/1980
			284.126	25/06/1980
			284.14	25/06/1980
			284.147	25/06/1980
			284.112	26/06/1980
			284.113	27/06/1980
			284.145	01/07/1980
			284.040	02/07/1980
			284.068	04/07/1980
			283.915	07/07/1980
BH3 (Seam 4)	307.095	307.23	283.94	24/06/1980
			283.971	24/06/1980
			283.953	25/06/1980
			283.967	25/06/1980
			283.970	25/06/1980
			283.958	26/06/1980
			283.962	27/06/1980
			283.990	01/07/1980
			283.956	02/07/1980
			283.945	04/07/1980
			283.760	07/07/1980
BH4 (Seam 3)	307.090	307.34	283.955	24/06/1980
			283.973	24/06/1980
			283.952	25/06/1980
			283.967	25/06/1980
			283.970	25/06/1980
			283.951	26/06/1980
			283.955	27/06/1980
			283.987	01/07/1980
			283.880	02/07/1980

Bore	RL ground surface (m AHD)	RL top of casing (m AHD)	RL water level (m AHD)	Date
			283.940	04/07/1980
			283.765	07/07/1980
BH5 (Seam 3)	307.060	307.275	283.960	24/06/1980
			283.962	24/06/1980
			283.896	25/06/1980
			283.948	25/06/1980
			283.938	25/06/1980
			283.904	26/06/1980
			283.922	27/06/1980
			283.759	01/07/1980

Attachment A (Coffey 1980)

b Groundwater properties

Groundwater samples were taken from three monitoring bores and analysed by Australian Laboratory Services Pty Limited (ALS Environmental 2021) to determine the physicochemical properties of the groundwater. Samples were taken from two compliance bores named 'Curtis' and 'Mayes', and from a comparison point bore referred to as 'GW04B' (Table 7).

Table 7 Groundwater properties

Property		Curtis	Mayes	GW04B
pH		8.05	8.21	7.65
EC (µS/cm)		863	588	885
Total dissolved solids (TDS) (mg/L)		526	355	555
Suspended solids (mg/L)		< 5	<5	662
Total alkalinity (mg/L)		400	273	431
Sulphate (mg/L)		14	20	34
Chloride (mg/L)		43	20	40
Calcium (Ca) (mg/L)		62	35	71
Magnesium (Mg) (mg/L)		56	29	53
Sodium (Na) (mg/L)		56	59	58
Potassium (K) (mg/L)		1	1	1
Aluminium (Al)	Dissolved (mg/L)	< 0.01	< 0.01	< 0.01
	Total (mg/L)	< 0.01	< 0.01	2.28

Property		Curtis	Mayes	GW04B
Arsenic (As)	Dissolved (mg/L)	< 0.001	0.003	< 0.001
	Total (mg/L)	< 0.001	0.004	0.001
Boron (B)	Dissolved (mg/L)	0.07	0.06	0.06
	Total (mg/L)	0.06	0.06	0.06
Barium (Ba)	Dissolved (mg/L)	0.009	0.004	0.019
	Total (mg/L)	0.006	0.005	0.182
Beryllium (Be)	Dissolved (mg/L)	< 0.001	< 0.001	< 0.001
	Total (mg/L)	< 0.001	< 0.001	< 0.001
Cadmium (Cd)	Dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001
	Total (mg/L)	< 0.0001	< 0.0001	< 0.0001
Cobalt (Co)	Dissolved (mg/L)	< 0.001	< 0.001	< 0.001
	Total (mg/L)	< 0.001	< 0.001	< 0.001
Chromium (Cr)	Dissolved (mg/L)	< 0.001	< 0.001	< 0.001
	Total (mg/L)	< 0.001	< 0.001	0.002
Copper (Cu)	Dissolved (mg/L)	0.002	0.001	0.001
	Total (mg/L)	0.007	0.002	0.011
Manganese (Mn)	Dissolved (mg/L)	0.006	0.004	0.005
	Total (mg/L)	0.006	0.012	0.018
Nickel (Ni)	Dissolved (mg/L)	0.012	0.006	0.003
	Total (mg/L)	0.014	0.010	0.005
Lead (Pb)	Dissolved (mg/L)	< 0.001	< 0.001	< 0.001
	Total (mg/L)	< 0.001	< 0.001	0.002
Selenium (Se)	Dissolved (mg/L)	< 0.01	< 0.01	< 0.01
	Total (mg/L)	< 0.01	< 0.01	< 0.01
Vanadium (V)	Dissolved (mg/L)	0.02	< 0.01	0.01
	Total (mg/L)	0.02	< 0.01	0.02
Zinc (Zn)	Dissolved (mg/L)	< 0.005	< 0.005	0.015
	Total (mg/L)	0.012	0.006	0.068
Molybdenum (Mo)	Dissolved (mg/L)	< 0.001	0.001	0.005
	Total (mg/L)	< 0.001	< 0.001	0.005

Property		Curtis	Mayes	GW04B
Silver (Ag)	Dissolved (mg/L)	< 0.001	< 0.001	< 0.001
	Total (mg/L)	< 0.001	< 0.001	< 0.001
Uranium (U)	Dissolved (mg/L)	0.001	< 0.001	< 0.001
	Total (mg/L)	0.001	< 0.001	< 0.001
Iron (Fe)	Dissolved (mg/L)	< 0.05	< 0.05	< 0.05
	Total (mg/L)	< 0.05	0.17	0.7
Mercury (Hg) (mg/L)		< 0.0001	< 0.0001	< 0.0001
Fluoride (mg/L)		0.1	0.1	0.1
Total anions (milliequivalents per litre (meq/L))		9.5	6.44	10.4
Total cations (meq/L)		10.2	6.72	10.4
Ionic balance (meq/L)		3.4	2.2	0.03

ALS Environmental (2021)

3.1.1.7 Soil types, properties and productivity

a Soil types

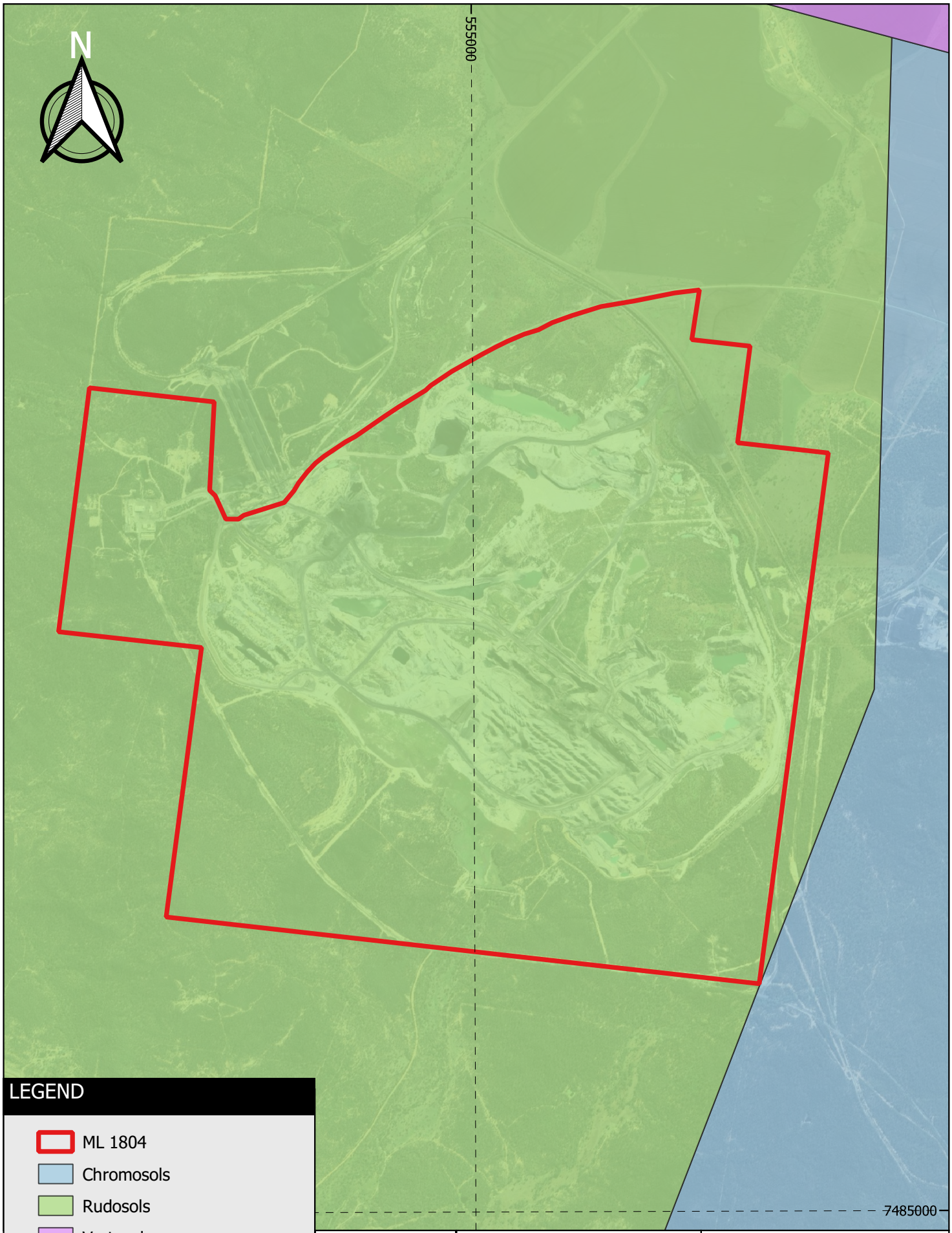
Mapped soil units

Mapped soil units in the *Atlas of Australian Soils* are soil landscapes which typically contain numerous soil types. Five mapped soil units were identified from the *Digital Atlas of Australian Soils* (ASRIS 2013) (Figure 6). There is low to extremely low probability of acid sulphate soils (ASS) at very low confidence (ASRIS 2013). Descriptions of each mapped soil unit and respective Australian Soil Classifications (ASCs) are in Table 8.

Table 8 Mapped soil units

Soil unit	Map code	Description[1]	ASC[2]
Ub79	2807	Gently to moderately undulating plains with sandy to loamy duplex soils and moderately deep A horizons. Dominant forms are Dy3.42 and Dy3.32. Similar Dy2 soils also common. Alkaline forms are less frequent. Small areas of other duplex soils such as Dr2.42, Dr2.12, Db1.32 and Db1.12 occur. Small areas of sandy red earths such as Gn2.12 may occur on higher landscapes. Small areas of dark clays such as Ug5.12 and Ug5.16 may be present.	Sodosol
Sl19	2498	Moderately to strongly undulating plains with extremely gravelly (quartz) loamy duplex soils including Dy2.43 and Dy2.33 with less frequent Dr2.43, Dr2.33, Db1.33, Db1.13 and Dy3.43. Shallow gravelly loams such as Um1.43 and Um4.1 occur on some higher ridges. Gravelly sands such as Uc2.12 are less frequent. Small areas of loamy red earths such as Gn2.12 are in the unit as mapped and some small areas of gravel-strewn moderately gilgaied grey clays such as Ug5.24 may occur on lower landscapes.	Sodosol
Ke19	1137	Gently to broadly undulating plains interrupted by some stony ridges, basalt flow scarps, broad low hill crests and occasional low conical hills. Shallow to moderately deep dark grey or dark brown cracking clays such as Ug5.12 are dominant, often with clays such as Ug5.13 and Ug5.14. Linear gilgai often occur on slopes. Dark red or red-brown clays including Ug5.37, Ug5.38, and Ug5.32 are on higher landscapes. Small level plains exist on lower elevations, often as narrow flood-plains adjacent to streams. The soils are deep dark clays such as Ug5.15 and Ug5.16 with smaller areas of Uf6.32 and Uf6.31. Shallow clay soils such as Uf6.31, Uf6.32 and Ug5.12 occur on higher stony ridges. There may be small local areas of highly calcareous clays such as Ug5.11.	Vertosol
Fz12	794	Low hilly or strongly undulating dissected lands with short slopes and a closed drainage pattern. Shallow extremely gravelly loams such as Um1.43 are dominant, while angular quartz gravel is prominent on the surface and throughout the solum. Other shallow stony loams such as Um4.1 and Um2.12 occur in addition to deeper less gravelly red duplex soils including Dr2.12, Dr2.13, Dr2.23, Dr2.33, Dr2.43, and Dy2.43. Comparatively stone-free areas of red clays and clay loams such as Uf6.31, Gn2.12 and Gn2.13 also occur locally. Small alluvial stream flood-plains within the unit mostly have loamy duplex soils such as Dy2.43 and Db1.33.	Rudosol
Ob18	2081	Undulating or strongly undulating plains with occasional low hilly areas. Fairly shallow red loamy duplex soils with extremely gravelly A horizons such as Dr2.23, Dr2.33 and Dr2.43 are dominant. Similar soils such as Dy2 are associated and small areas of gravelly red friable earths such as Gn3.13 and Gn3.12 occur locally. Extremely gravelly shallow loams such as Um1.43, Um4.1 and Um2.12 of unit Fz12 are on higher ridge crests and on low hills.	Chromosol

1. *Digital Atlas of Australian Soils* (ASRIS 2013)
2. Australian Soil Classification (Ashton and McKenzie 2001)



Client: TerraCom Limited	Project: Progressive rehabilitation and closure plan	
Design: SGM Environmental Pty Ltd 16.05.2024 Scale: 1 : 15,000 CRS: GDA 2020	Title: Soils	Figure: 6

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

Soil survey

b Soil properties

Dames and Moore (1983) identified six soil types within the ML including Soloth (soil type A), Alluvial (soil types B, C_1 and C_2), Solofic (soil type D), and Yellow Pozolic (soil type E) Great Soil Group (GSG) classifications. The survey also found:

- there were no significant elemental imbalances in surface soils (A_1 and A_2 horizons); however, subsoils (B horizon) of soil types A, D and E were sodic;
- there were no soil acidity issues, with pH concentrations consistently above 5.0;
- levels of exchangeable Ca in all A horizon soils were greater than twice the level of exchangeable Mg;
- N was within the normal range;
- P was relatively low; and
- there was a relatively low percentage of organic matter.

c Soil productivity

Land suitability

In Queensland, a five-class system is used to assess the pre-mining suitability of land for specific uses based on physical and chemical limiting factors. The five land suitability classes are:

- Class 1 — high quality land with negligible limitations;
- Class 2 — land with minor limitations;
- Class 3 — moderate limitations to sustaining the use;
- Class 4 — marginal land requiring major inputs to sustain the use; and
- Class 5 — unsuitable due to extreme limitations.

According to the *Environmental Management Plan* (TerraCom 2017a) (Appendix B), land suitability ranges from Class 3-4 for cattle grazing and is Class 5 for broadacre cropping. Limiting factors identified include:

- water availability;
- soil fertility;
- risk of local flooding along creek lines;
- presence of established rill and gully erosion; and
- steep hillsides.

3.1.1.8 Land stability

a Pre-existing land degradation and erosion

Mining began on a small scale in 1864 and fluctuated until establishment of the modern-day mine in 1984. Land degradation which existed prior to 1975 can be attributed (Rio Tinto 2010) to:

- land clearing;
- cultivation;
- dams;
- forests;
- mining;
- road and rail infrastructure; and
- the small township of Blair Athol which has since been demolished.

b Predisposition to ongoing stability issues

Dames & Moore (1983) found that soils would be highly susceptible to erosion if structural deterioration occurs during handling. This is due to high proportions of silt and fine sand. The slightly dispersive nature of the A_1 horizon of soil type C_2 (Alluvial GSG) indicates a risk of erosion if placed in drainage lines or slopes above 5 degrees (°).

3.1.1.9 Vegetation communities and ecological data

a Matters of environmental significance

Matters of national environmental significance

Matters of national environmental significance (MNES) are identified in the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) *Protected Matters Report* (Table 9).

Table 9 Protected matters report identified MNES

MNES	Relevance to the Mine
World Heritage properties	Not applicable.
National Heritage properties	Not applicable.
Wetlands of International Importance	Not applicable.
Great Barrier Reef (GBR) Marine Park (MP)	Not applicable.
Commonwealth marine area	Not applicable.
Listed Threatened Ecological Communities (TECs)	There are three endangered communities which are likely to occur.
Listed threatened species	There are two critically endangered species, nine endangered species and 11 vulnerable species which may occur.
Migratory species	There are eight migratory species which may occur, with one of these species being critically endangered.

EPBC Act Protected Matters Report (DAWE 2021)

Matters of state environmental significance

Matters of state environmental significance (MSES) are identified by the Queensland Government's *Environmental Reports Online Portal* (The State of Queensland 2023a). MSES within Lot 2 on Plan USL43676 (the ML) are in Table 10.

Table 10 Matters of state environmental significance

MSES	Relevance to the Mine
7a Threatened (endangered or vulnerable) wildlife	Threatened wildlife species occur on 37.48 ha.
7b Special least concern animals	Special least concern animals occur on 17.12 ha.
8c Regulated vegetation — Category R (GBR riverine growth)	Category R regulated vegetation communities of GBR riverine regrowth occur on 13.41 ha.
8e Regulated vegetation — intersecting a watercourse	Regulated vegetation communities which intersect a watercourse occur across 1.4 km.

The State of Queensland (2023a)

Matters of local environmental significance

Wangan and Jagalingou Peoples are the traditional owners of the land. Principles and values upheld by the Wangan and Jagalingou Peoples (Wangan & Jagalingou Family Council 2023) include:

- protecting land, water, people, history and totems;
- upholding connections with Country including trees, plants, shrubs, medicines, waterholes, animals, habitats and aquifers; and
- maintaining spiritual connections with ancestors.

The *Isaac Regional Planning Scheme* (the Planning Scheme) was released by Isaac Regional Council (IRC) (2021) to communicate plans for development to the Queensland Government and the public. Relevant sections of the Planning Scheme relating to desirable environmental outcomes for the region (IRC 2021) include:

- maintaining productive rural lands which:
  - are a major source of economic activity and local employment;
  - may be reconfigured if they can support long-term rural enterprise and will not impact farming activities, agricultural areas, infrastructure or services;
  - protect intensive animal industries, cropping, stock routes and other large-scale or high-impact activities provided they are situated in an appropriate location; and
  - do not significantly impact amenity of rural residential properties.
- appropriate management of extractive, mineral, gas and petroleum activities and resources which:
  - are protected from encroachment by sensitive land uses which may prevent or constrain current or future operations;
  - occur where compatible with assigned land use zoning;
  - have measures which mitigate impacts of operations, noise, dust, light, blasting and vibrations on visual amenity, the natural environment, MSES and water quality; and
  - are progressively rehabilitated where possible.
- protecting biodiversity, water quality and the natural environment by:
  - mitigating impacts on MNES, MSES and local biodiversity;
  - maintaining a connected network of habitat areas;
  - avoiding the introduction or spread of pest plant and animal species;
  - minimising disturbances to topography, waterways, vegetation and areas which may have ASS; and
  - protecting or enhancing the EVs and quality of waterways.

b Environmentally sensitive areas

Environmentally sensitive areas (ESAs) are described in the *Environmental Protection Regulation 2019* (EP Regulation). There are three ESAs near the Mine (Table 11).

Table 11 Environmentally sensitive areas

Name[1]	Description[1]	Location[2]
Blair Athol State Forest	Category C ESA	Adjoining western boundary
Aspley State Forest	Category C ESA	Adjoining eastern boundary
Endangered regional ecosystem (RE)	Category B ESA	~3 km north-east

1. Queensland Government (2023)
2. Relative to the Mine

Groundwater dependent ecosystems

GDEs are ecosystems which depend, completely or intermittently, on groundwater systems. DES (2015) identifies three major classes of GDEs:

- Class 1 — subterranean ecosystems including caves and aquifers;
- Class 2 — aquatic ecosystems which rely on surface expression of groundwater; and
- Class 3 — terrestrial ecosystems which rely on subsurface groundwater.

There are no known or derived subterranean GDEs near the Mine (DES 2023a).

c Regional ecosystems

REs are a Queensland-based tool to describe the bioregion, land zone and vegetation type of a particular area (DES 2023b). The Mine is in bioregion 11, defined as Brigalow Belt bioregion. There are numerous land zones and vegetation types which contribute to RE classifications.

Vegetation communities are classified within REs by conservation status by the *Vegetation Management Act 1999* (VM Act) and the *Environmental Protection Act 1994* (EP Act). REs near the Mine and their descriptions are in Table 12 along with their status under the VM Act and EP Act. Location of each RE is in Figure 7.

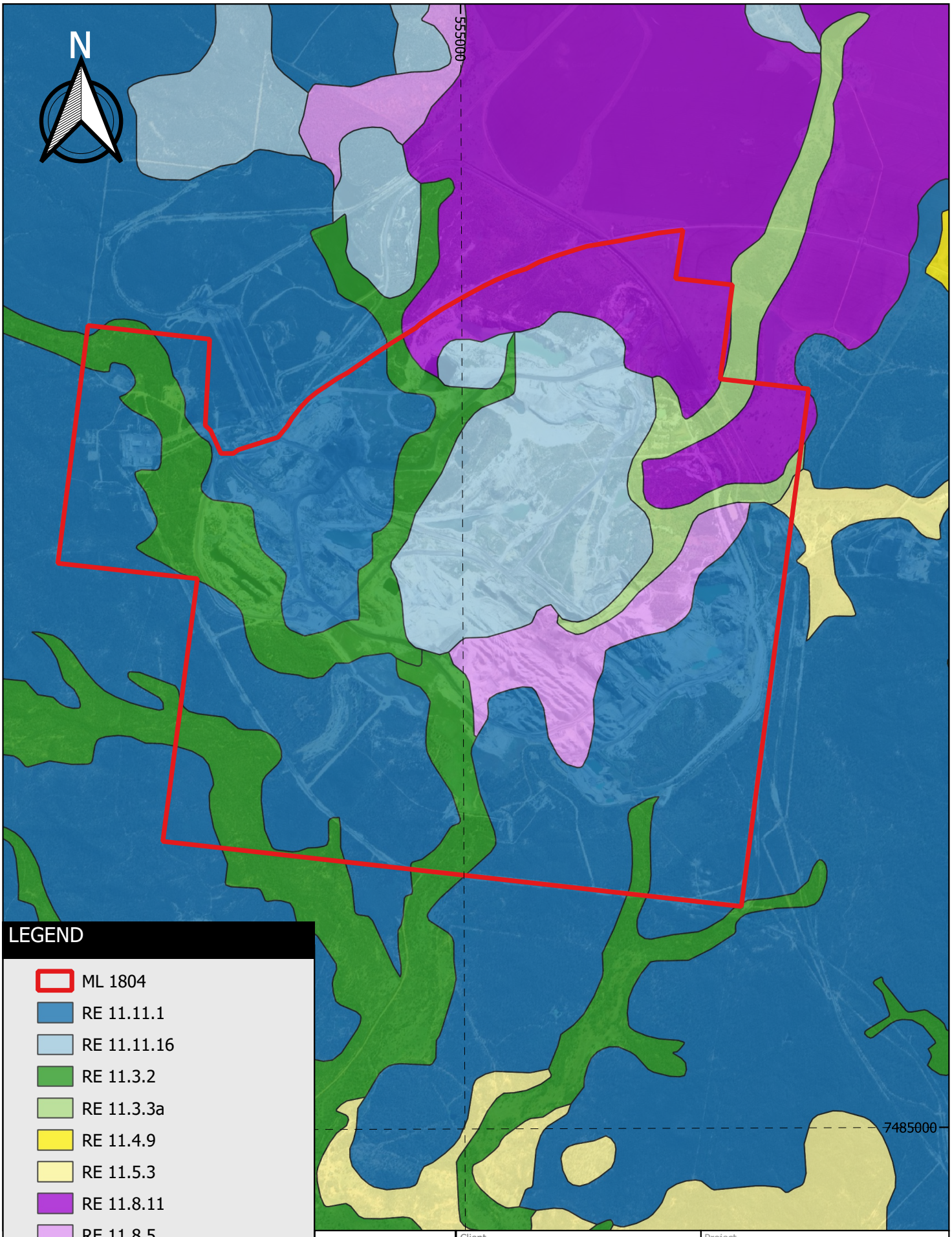
d Threatened ecological communities

There are numerous areas of dominant vegetation of concern near the Mine; however, there are no areas of endangered ecological communities (Figure 8).

Table 12 Regional ecosystems

RE[1]	Description[2]	VM Act status[3]	EP Act status[4]
11.3.2	*Eucalyptus populnea* (Poplar Box) woodland to open woodland on Cainozoic alluvial plains commonly with *Eucalyptus melanophloia* (Silver-leaved Ironbark) and *Eucalyptus crebra* (Narrow-leaved Ironbark). A secondary tree layer may occur with species including *Geijera parviflora* (Wilga), *Eremophila mitchellii* (False Sandalwood), *Acacia salicina* (Cooba), *Cassia brewsteri* (Brewster's Cassia) and *Acacia excelsa* (Ironwood). The ground layer is dominated by various tussock grasses such as *Chloris* spp. (Windmill Grasses), *Enteropogon* spp. and *Aristida* spp. (Wiregrasses). Palustrine wetlands may be present.	Of concern	Of concern
11.3.3a	*Melaleuca bracteata* (Black Tea Tree) woodland to open woodland on Cainozoic alluvial plains or levees. A secondary tree layer may occur with species including Poplar Box, *Eucalyptus coolabah* (Coolabah), *Acacia stenophylla* (Shoestring Acacia), *Alectryon oleifolius* (Boonaree), *Terminalia oblongata* (Yellow-wood) in the north, *Acacia pendula* (Weeping Myall), *Acacia cambagei* (Gidgee) and *Duma florulenta* (Tangled Lignum). The ground layer is dominated by seasonal grass and forb species.	Of concern	Of concern
11.3.4	*Eucalyptus tereticornis* (Forest Red Gum) and other *Eucalyptus* spp. on woodland to open forests on Cainozoic alluvial plains. Other species potentially present include *Eucalyptus camaldulensis* (River Red Gum), *Corymbia tessellaris* (Carbeen), *Corymbia clarksoniana* (Grey Bloodwood), Silver-leaved Ironbark, *Eucalyptus platyphylla* (Poplar Gum), *Angophora floribunda* (Rough-barked Apple), Narrow-leaved Ironbark and *Lophostemon suaveolens* (Swamp Mahogany). There is typically no shrub layer. The prominent ground layer is dominated by *Bothriochloa bladhii* (Forest Bluegrass), Wiregrasses, *Heteropogon controtus* (Black Speargrass), *Dichanthium* spp. (Bluegrasses) and *Themeda triandra* (Kangaroo Grass).	Of concern	Of concern
11.3.25	Forest Red Gum or River Red Gum woodland to open forest which fringes drainage lines on alluvial plains or levees and banks of major rivers. Other tree species may include *Casuarina cunninghamiana* (River She-oak), Coolabah, Black Tea Tree, *Melaleuca viminalis* (Weeping Bottlebrush), *Livistona* spp. in the north, *Melaleuca* spp. (Paperbarks) and Rough-barked Apple. A tall shrub layer of Cooba, Shoestring Acacia and *Lysiphyllum carronii* (Northern Bean Tree) may occur. There is an open to sparse ground layer dominated by perennial grasses, sedges or forbs.	Least concern	Of concern
11.5.3	Woodlands of Poplar Box, Silver-leaved Ironbark, Grey Bloodwood, *Corymbia dallachiana* (Dallachy's Gum), *Eucalyptus cambageana* (Dawson River Blackbutt) or *Eucalyptus brownii* (Brown's Box) on flat to gently undulating Cainozoic sand plains or remnant surfaces. Some areas are dominated by Silver-leaved Ironbark, Narrow-leaved Ironbark or other canopy species. The secondary tree layer typically includes False Sandalwood, Wilga, *Archidendropsis basaltica* (Eastern Dead Finish), *Erythroxylum australe* (Cocaine Tree), Brewster's Cassia, *Ventilago viminalis* (Supplejack), *Allocasuarina luehmannii* (Bull Oak) and *Callitris glaucophylla* (White Cypress). A low shrub layer commonly occurs consisting of *Carissa ovata* (Currant Bush) and *Capparis lasiantha* (Nipan).	Least concern	No concern
11.8.5	*Eucalyptus orgadophila* (Mountain Coolibah) open woodland on undulating plains, rises, low hills or flat tablelands on top of mountains of Cainozoic igneous rocks formed by basalt. Species which are sometimes present include *Corymbia erythrophloia* (Red Bloodwood), Silver-leaved Ironbark and Narrow-leaved Ironbark. The moderately dense to dense ground layer is dominated by *Aristida lazaridis*, *Aristida ramosa* (Purple Wiregrass), *Bothriochloa ewartiana* (Desert Bluegrass), *Dichanthium sericeum* (Queensland Bluegrass), *Chrysopogon fallax* (Golden Beard Grass), Black Speargrass, *Enneapogon gracilis* (Slender Nineawn), Kangaroo Grass, *Tragus australianus* (Burr Grass), *Brunoniella australis* (Blue Trumpet), *Evolvulus alsinoides* (Dwarf Morning-glory), *Galactia tenuiflora* (Snail Flower) and *Indigofera linnaei* (Birdsville Indigo).	Least concern	No concern
11.8.11	Queensland Bluegrass grassland on Cainozoic igneous rocks, particularly fresh basalt. Other dominant species include Wiregrasses, *Astrebla* spp. (Mitchell Grasses), *Panicum decompositum* (Native Panic), *Aristida lazaridis*, Purple Wiregrass, Desert Bluegrass, Golden Beard Grass, Black Speargrass, Slender Nineawn, Kangaroo Grass, Burr Grass, Blue Trumpet, Dwarf Morning-glory, Snail Flower and Birdsville Indigo. Some emergent trees may occur including Mountain Coolibah, Silver-leaved Ironbark, Red Bloodwood and Cooba.	Of concern	Of concern
11.11.1	Narrow-leaved Ironbark woodland commonly with *Acacia rhodoxylon* (Rosewood) on sub-coastal hills and ranges with old sedimentary rocks of varying degrees of folding and metamorphism. Other typical species include *Corymbia citriodora* (Lemon-scented Gum), *Corymbia leichhardtii* (Rustyjacket), Silver-leaved Ironbark, Red Bloodwood, Grey Bloodwood, *Eucalyptus fibrosa* (Red Ironbark), *Eucalyptus moluccana* (Grey Box), *Macrozamia* spp. (Burrawangs) and *Lophostemon grandifloras* (Northern Swamp Mahogany).	Least concern	No concern
11.11.2	*Acacia shirleyi* (Lancewood) or *Acacia catenulate* (Bendee) woodland to open forest on hills and ranges formed on old sedimentary rocks with varying degrees of folding and metamorphism. Other common species include Narrow-leaved Ironbark, *Eucalypt* spp. and Lemon-scented Gum.	Least concern	No concern
11.11.16	Dawson River Blackbutt and *Acacia harpophylla* (Brigalow) open forest to woodland on gently undulating plains and rises formed on old sedimentary rocks with varying degrees of folding and metamorphism.	Of concern	Of concern

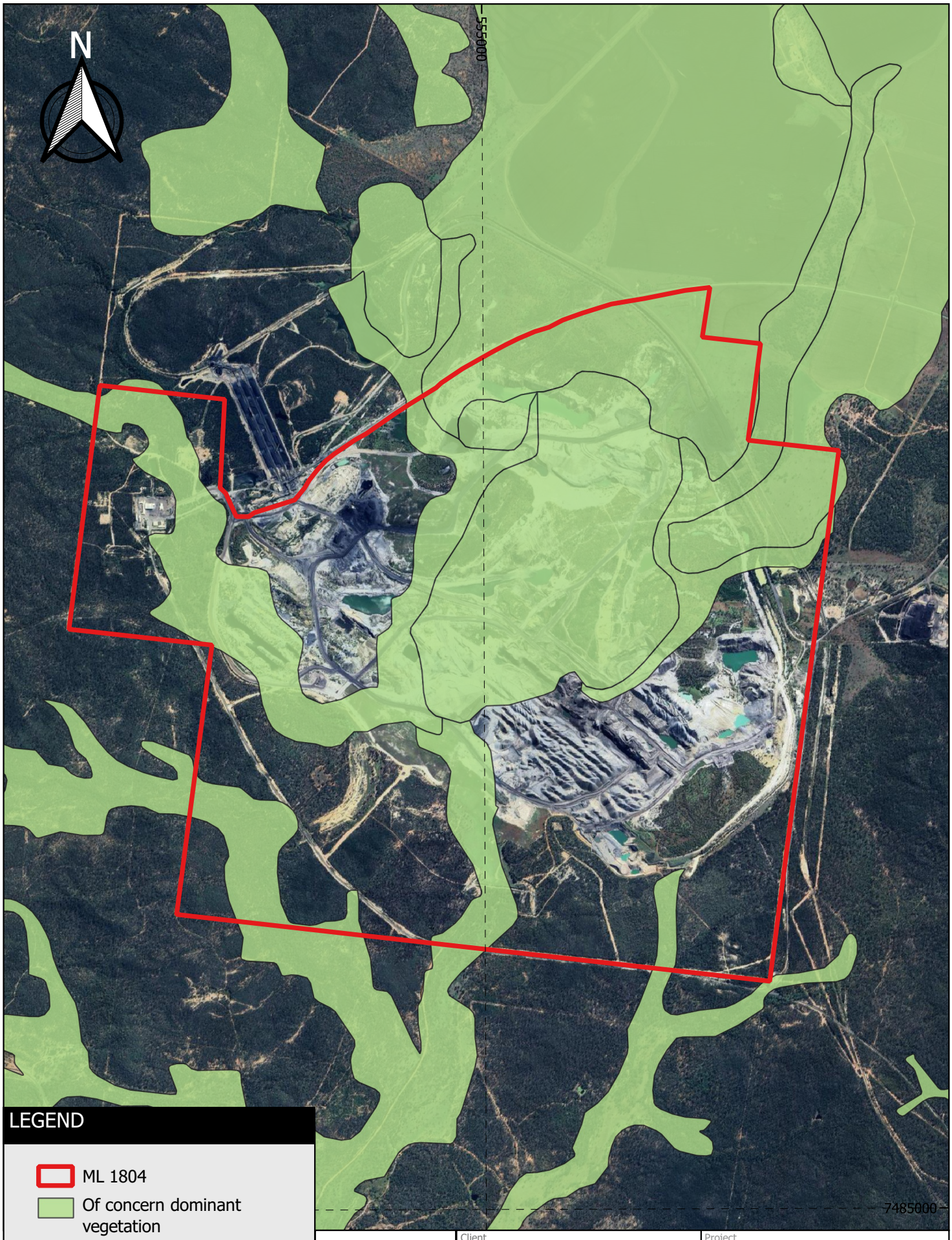
1. The State of Queensland (2023b)
2. DES (2021)
3. *Vegetation Management Act 1999* classification
4. *Environmental Protection Act 1994* classification



SGM environmental

Client: TerraCom Limited		Project: Progressive rehabilitation and closure plan	
Design: SGM Environmental Pty Ltd 16.05.2024 Scale: 1 : 15,000 CRS: GDA 2020		Title: Dominant regional ecosystems	Figure: 7

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.



SGM environmental	Client: TerraCom Limited	Project: Progressive rehabilitation and closure plan
	Design: SGM Environmental Pty Ltd 16.05.2024 Scale: 1 : 15,000 CRS: GDA 2020	Title: Threatened ecological communities Figure: 8

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

3.1.1.10 Fauna presence and populations

a Terrestrial fauna

An ecological survey by WSP (2019) recorded a total of 16 native fauna species. These species, along with their conservation status according to the *Nature Conservation Act 1992* (NC Act), are in Table 13.

Table 13 Fauna presence

Scientific name	Common name	NC Act status
Anas superciliosa	Pacific Black Duck	Least concern
Aquila audax	Wedge-tailed Eagle	Least concern
Ardea ibis	Cattle Egret	Least concern
Ardea intermedia	Intermediate Egret	Least concern
Corvus orru	Torresian Crow	Least concern
Cracticus tibicen	Australian Magpie	Least concern
Dacelo novaeguineae	Laughing Kookaburra	Least concern
Eolophus roseicapilla	Galah	Least concern
Granilla cyanoleuca	Magpie-lark	Least concern
Manorina melancephala	Noisy Miner	Least concern
Pardalotus striatus	Striated Pardalote	Least concern
Philemon corniculatus	Noisy Friarbird	Least concern
Rhipidura leucophrys	Willie Wagtail	Least concern
Todiramphus macleayii	Forest Kingfisher	Least concern
Macropus giganteus	Eastern Grey Kangaroo	Least concern

WSP (2019)

Although no observations were made during the ecological survey, WSP (2019) states that there have been numerous anecdotal sightings of *Phascolarctos cinereus* (Koala) in the area and that there is a moderate likelihood of *Petauroides* spp. (Greater Glider) occurring. The NC Act lists Koalas as endangered and Greater Glider species as either vulnerable or endangered.

b Vegetation communities

There are numerous areas of remnant vegetation in and around the Mine (the State of Queensland 2023c). Broad vegetation groups, from most to least abundant in the area (the State of Queensland 2023c) are:

- *Eucalypt* spp. woodlands to open forests;
- open forests dominated by *Acacia* spp. (Wattles) other than *Acacia aneura* (mulga);
- open woodlands of Paperbarks on depositional plains;
- tussock grasslands or forblands; and
- *Eucalypt* spp. dry woodlands on inland depositional plains.

3.1.1.11 Pre-mining land use

The Mine is located in the former Blair Athol township. Blair Athol township was a coal mining town with operations dating back to the 1860s. In the mid-1970s, Blair Athol township was closed to expand mining and residences were transferred to Clermont. The historic cemetery reserve for Blair Athol township remains as a sensitive area.

It is located on the Country of the Wangan and Jagalingou people who occupied and used the land prior to colonisation. Wangan and Jagalingou people are the Traditional Owners of a large area of land in the Galilee Basin in western Central Queensland.

Pre-mining land use was:

- historic Blair Athol township;
- historic open cut and underground coal mining;
- cropping and grazing;
- designated stock routes; and
- a cemetery reserves.

3.1.1.12 Underlying landholders

a Property descriptions

The Mine is predominately located on Unallocated State Land, but also includes State Forest, freehold, lands lease, railway and reserve land. These properties include:

- Rail corridor on:
  - Lot 1 of Plan CLM149;
  - Lot 151 of Plan CLM34;
  - Lot 2 of Plan CLM150;
  - Lot 25 of Plan CLM594; and
  - Lot 27 of Plan MPH40967;
- Freehold land on:
  - Lot 1 of Plan RP607100;
  - Lot 2 of Plan PR600709;
  - Lot 2 of Plan PR600710; and
  - Lot 2 of Plan PR607100;
- State Forest on Lot 117 of Plan FPY1615;
- State land on Lot 141 of Plan CLM34;
- Camping and water reserve on Lot 22 of Plan CLM687;
- Cemetery on Lot 5 of Plan CLM5207; and
- Unallocated state land on:
  - Lot 13 of Plan AP5081;
  - Lot 394 of Plan MPH247;
  - Lot 3 of Plan AP5081;
  - Lot 2 of Plan USL42676;
  - Lot 40 of Plan USL43703;
  - Lot 2 of Plan AP5081;
  - Lot 4 of Plan AP5081;
  - Lot 463 of Plan MPH257; and
  - Lot 5 of Plan USL43676.

b Stakeholders

There are numerous stakeholders external to TerraCom including:

- Department of Environment, Science and Innovation (DESI);
- Department of Natural Resources and Mines (DNRM);
- Commonwealth Department of the Environment and Energy;
- Isaac Regional Council;
- Wangan and Jagalingou Native Title Parties;
- Clermont Regional Landcare;
- Clermont Community Consultative Committee; and
- neighbouring property holders of Blair Athol Station.

c Neighbouring properties

Activities on the surrounding land include State Forests, grazing and limited cropping. The residential sensitive receptors are in Table 14.

Table 14 Neighbouring properties

Name	Description	Distance from Mine boundary
D. Mayes	New Blair Athol Homestead	2.5 km north
J. Burnett	Old Blair Athol Homestead	500 m east
Capricorn Bulk Handling	A domestic coal screening and crushing facility	800 m east

TerraCom (2017a)

d Native title

Wangan and Jagalingou Peoples are the traditional owners of the land; however, a determination was made in 2022 that Native Title does not exist. National Native Title Tribunal file number QC2004/06 (QUD25/2019) entitled the 'Clermont-Belyando Area Native Title Claim' was filed in 2004 and was registered until 2022 when the decision to overturn the determination was made.

Rio Tinto entered a *Cultural Heritage Investigation and Management Agreement* (CHIMA) with the Wangan and Jagalingou Peoples in 2004 (Rio Tinto 2010). The CHIMA describes assessment and management of Aboriginal cultural heritage (Rio Tinto 2010). A *Cultural Heritage Management Plan* (CHMP) was also approved by the Queensland Government in 2004 which addresses all statutory requirements under the *Aboriginal Cultural Heritage Act 2003* (ACH Act) (Rio Tinto 2010). The CHIMA and CHMP were both transferred to TCL on acquisition.

3.1.2 Project description

3.1.2.1 Mining tenements

The Mine operates under environmental authority (EA) EPML00876713 and ML 1804 (Table 15 and Figure 9). ML 1804 was granted on 16 November 1978 to Rio Tinto. Large-scale open cut production began in 1984. It was placed into care and maintenance by Rio Tinto in 2012. TCL acquired the Mine on 31 May 2017 and recommenced mining.

The adjacent ML 1881, which was originally part of ML 1804, was granted for mining infrastructure purposes (rail loop and train loadout (TLO) stockpiles). The TLO and associated infrastructure were sold and the boundaries of ML 1804 and ML 1881 were realigned in 2014 to facilitate this transaction.

The rail line and rail corridor easement are excluded from ML 1804. Historical Blair Athol Cemetery is also excluded from ML 1804 as per the boundary realignment that was done in 2014 and retention of the 50 m offset buffer.

Table 15 Tenure

EA number	Tenure type	Tenure number	Area (ha)
EPML00876713	ML	1804	2,361

a Ancillary environmentally relevant activities

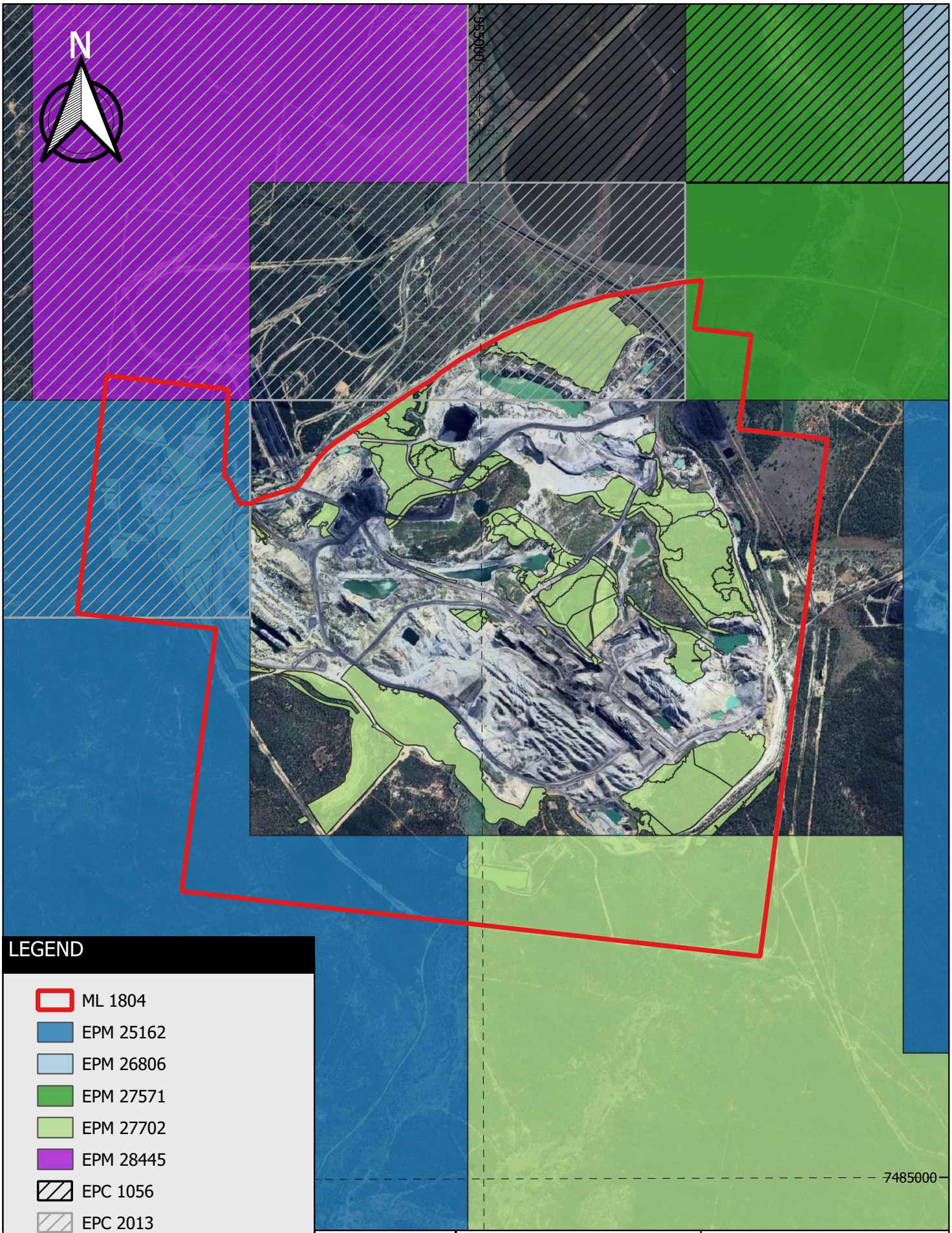
Activities that will, or have the potential to, release contaminants into the environment and cause environmental harm are defined as environmentally relevant activities (ERAs) under the EP Act. Ancillary ERAs authorised under the EA are in Table 16.

Table 16 Ancillary environmentally relevant activities

ERA(s)	Location
Ancillary 08 — Chemical Storage 1: Storing a total of 50 tonnes (t) or more of chemicals of dangerous goods class 1 or class 2, division 2.3 under subsection (1)(a).	ML 1804
Ancillary 31 — Mineral processing 2: Processing, in a year, the following quantities of mineral products, other than coke (b) more than 100,000 t.	ML 1804
Ancillary 63 — Sewage Treatment 1: Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of (b-i) more than 100 but not more than 1500EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme.	ML 1804
Schedule 2A 13: Mining black coal.	ML 1804

b Stock routes

Stock routes have no separate title or tenure from the underlying road reserve, and the same roads are used for walking or agisted stock and vehicular transport. Reserves for travelling stock include camping and water reserves, pasture reserves and trucking reserves. A reserve-type stock route overlaps ML 1804 and is classed as minor and unused. There are several surrounding road type stock routes which are classed as either minor and unused or secondary.



SGM environmental

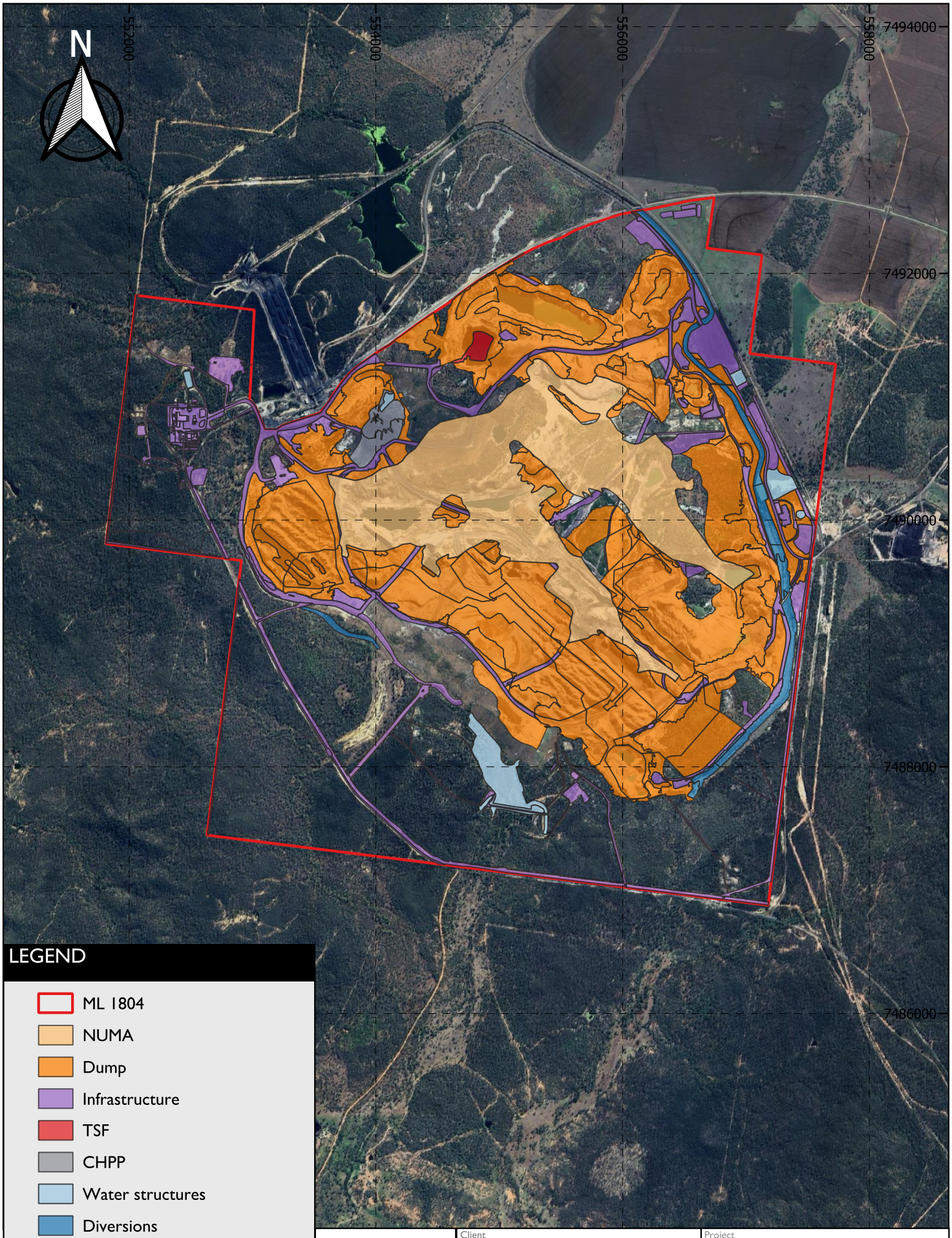
Client: TerraCom Limited	Project: Progressive rehabilitation and closure plan	
Design: SGM Environmental Pty Ltd 16.05.2024 Scale: 1 : 15,000 CRS: GDA 2020	Title: Tenements	Figure: 9

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

3.1.2.2 Primary mine features and infrastructure

Primary mine features and infrastructure within ML1804 are in Figure 10. These include:

- transport infrastructure such as:
  - access track and roads;
  - mobile lube truck operation;
  - fixed heavy equipment and light vehicle refuelling station;
  - heavy equipment workshop; and
  - heavy equipment and light vehicle wash down facility.
- port and rail infrastructure including:
  - TLO facility;
  - TLO pad; and
  - rail easement.
- resource sourcing such as:
  - mining industrial area (MIA); and
  - rock quarry.
- water management infrastructure including:
  - water treatment plant;
  - levees;
  - dams; and
  - diversions.
- product handling infrastructure including:
  - Coal Handling and Preparation Plant (CHPP);
  - Raw coal primary crushing plant;
  - Mobile crushing plant; and
  - conveyors.
- storage areas for:
  - diesel;
  - oil;
  - other hydrocarbons;
  - chemicals;
  - soil; and
  - laydown.
- voids including:
  - Far West Pit;
  - West Pit;
  - South Pit;
  - East Pit;
  - East Pit Endwall Extension; and
  - Ramp 3 Pit.
- historical exploration infrastructure including:
  - drill lines;
  - boreholes; and
  - sump pads.
- waste management including:
  - reject and run of mine (ROM); and
  - sewage treatment plant.



SGME	Client: TerraCom Limited	Project: Progressive rehabilitation and closure plan	
	Design: SGME Pty Limited 2.09.2025 Scale: 1 : 17,500 CRS: GDA2020	Title: Primary features	Figure: 10

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

3.1.2.3 Type of mining operation

a Mining method

The Mine is a conventional strip-mining open-cut operation which uses a single dragline, truck and excavator fleets and bulk push dozer methods to remove spoil and expose the coal seam. Mined coal is loaded and transported from the void via truck and excavator. All spoil removal and mining are performed continuously on a seven-day roster basis with blasting activities only occurring during the day. Mining does not occur on undisturbed areas and no more than 11 million tonnes of ROM coal are produced per annum as per the EA (TerraCom 2017a).

b Mining

The following process is used to extract coal which underlies previously mined areas:

- a mining strip 60-80 m wide is identified and cleared of vegetation via bulldozers and graders, with the vegetation being stockpiled for rehabilitation purposes;
- soil is stripped to a depth of 0.3 m via bulldozers and scrapers before being spread on rehabilitation areas or stockpiled for future use;
- spoil is drilled and blasted using a rotary drill rig and contractor bulk-explosive manufacturing trucks before being transported to spoil dumps, either inside or outside the void, via draglines, bulldozers, large excavators and trucks;
- the exposed coal seam is drilled and blasted then ripped by dozers and mined by a hydraulic excavator or front-end loader and loaded into haul trucks;
- raw coal is hauled to the CHPP for processing and to the bypass coal area for crushing and screening; and
- rehabilitation including profiling, soil placement and revegetation occurs.

c Coal processing and rejects

Approximately 50% of ROM coal meets specification requirements without washing; however, a modular wash plant which was constructed in 1999 is utilised to reduce ash and sulphur (S) content of product where necessary. Coal is processed at up to 300 tonnes per hour through the CHPP and up to 500 tonnes per hour through the crushing and screening plant. Coal is then transported to the TLO facility while coarse rejects are transported via truck and thickened fines are pumped via dedicated pipelines to existing voids before being covered with spoil.

3.1.2.4 Proposed duration of the operation

The life of mine (LOM) is governed by a range of factors including:

- coal reserves available;
- demand for coal product;
- operational factors including costs; and
- coal price.

Each of these factors can affect the LOM in isolation or combination. Subsequently, annual production rates will vary accordingly as will the LOM. This will result in variations in the rate of annual production, which in turn will vary the LOM. Ongoing exploration may identify additional coal resources that would potentially further extend the LOM, as will a reduction in annual mining rate. If the prevailing market should support a higher production rate, then duration of the operation may be shortened.

Based on current reserves, mining is anticipated to continue until 2033. Rehabilitation at closure will continue until 2043. Mining is staged and rehabilitation is done progressively (Section 3.1.4).

3.1.3 Design for closure

Transitional PRC plans are not needed to demonstrate the closure design for existing or approved disturbance. Design for closure of planned expansions and further development must be addressed. Given the lack of planned expansions and development, TCL is not needed to demonstrate closure design.

3.1.4 Rehabilitation and improvement planning

Rehabilitation must commence as soon as practicable after land becomes available to maximise the efficiency and probability of successful progressive rehabilitation. Under section 126D(5) of the EP Act, land is considered available for rehabilitation when:

- land is no longer being mined;
- land is no longer needed to operate infrastructure or machinery for mining including dams or water storage facilities;
- land is not needed for mining of a probable or proved ore reserve; and / or
- land contains permanent infrastructure which remains for a PMLU.

3.1.4.1 Relevant activities and progressive rehabilitation

The relevant activities (RAs) which require rehabilitation are in Table 17 along with the predicted duration, size and availability for progressive rehabilitation. All rehabilitation is anticipated to be finished by December 2055.

Table 17 Rehabilitation areas

Rehabilitation area	Relevant activity	Predicted duration	Size (ha)	Availability for progressive rehabilitation
IA1	Residual void	2033-2043	291.6	Active mining area will become available for rehabilitation once the resource has been extracted and processing has ended.
RA1	Dump	2033-2048	735.75	Active mining areas are designed to be progressively rehabilitated. Each active mining area will become available for rehabilitation once the resource has been extracted and processing has ended.
RA2	TSF	2033-2049	3.97	Available for rehabilitation once all mining and processing activities are done.
RA3	CHPP	2033-2050	12.87	Available for rehabilitation once all mining and processing activities are done and product has been removed for export.
RA4	Infrastructure	2033-2050	73.15	Available for rehabilitation once all mining and processing activities are done and product has been removed for export.

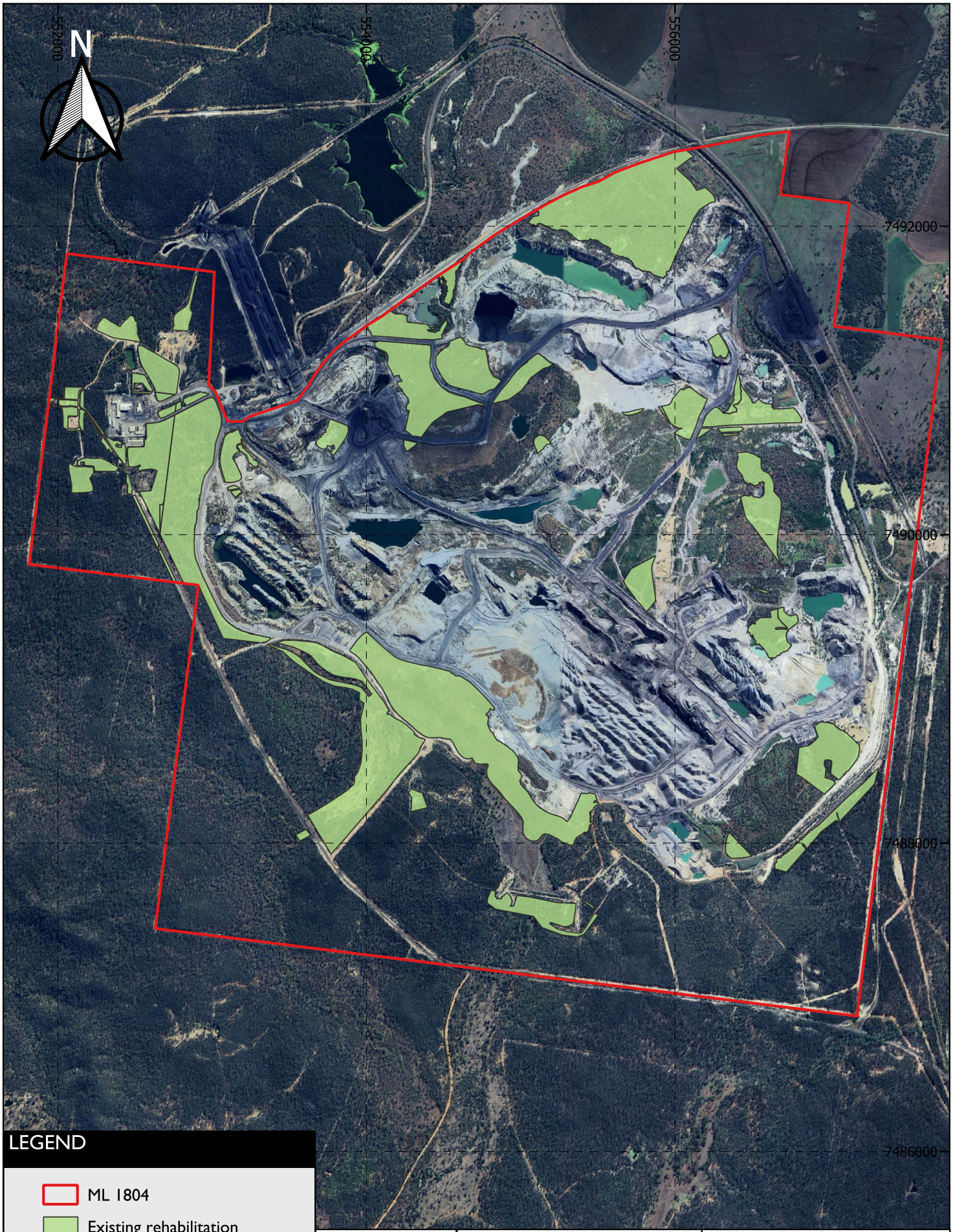
Rehabilitation area	Relevant activity	Predicted duration	Size (ha)	Availability for progressive rehabilitation
RA5	Rail infrastructure	2033-2050	11.21	Available for rehabilitation once all mining and processing activities are done and product has been removed for export.
RA6	Road infrastructure	2033-2050	104	Available for rehabilitation once all mining and processing activities are done and majority of rehabilitation is complete.
RA7	Water management	2033-2050	27.08	Available for rehabilitation once all mining and processing activities are done and majority of rehabilitation is complete.
RA8	Existing rehabilitation (Grazing)	2023-2032	289.01	Available immediately for maintenance and monitoring.
RA9	Cleared area	2023-2038	21.03	Available immediately for progressive rehabilitation.
RA10	Native ecosystem	2033-2055	20.7	Available for rehabilitation once all mining and processing activities are done and majority of rehabilitation is complete.
RA11	Existing rehabilitation (Native Ecosystem)	2023-2032	20.89	Available immediately for maintenance and monitoring.
RA12	Diversions	2033-2048	34.88	Available for rehabilitation once all mining and processing activities are done and majority of rehabilitation is complete.

3.1.4.2 Existing rehabilitation

Under section 126C(1)(j) of the EP Act, transitional PRC plans must include the following information regarding areas which have already been rehabilitated at the time of submission:

- a description of finished rehabilitation;
- timeline of finished rehabilitation; and
- whether rehabilitation are progressively certified under the EP Act.

The Mine has undergone progressive rehabilitation since acquisition by TCL in 2017. Finished rehabilitation is in Figure 11.



LEGEND

- ML 1804
- Existing rehabilitation

Scale 1 : 17 500

0 0.5 1 km

SGME

Client: TerraCom Limited		Project: Progressive rehabilitation and closure plan	
Design: SGME Pty Limited 2.09.2025 Scale: 1 : 17,500 CRS: GDA2020		Title: Existing rehabilitation	Figure: 11

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

3.2 Community consultation

The following section includes:

- details of community consultation during preparation of the PRC plan; and
- how community consultation is done in relation to rehabilitation under this PRC plan.

The extent to which each proposed PMLU is consistent with the outcome of consultation with the community during preparation of the PRC plan is in Section 3.3.3. The extent to which the NUMA is consistent with the outcome of community consultation is in Section 3.4.3.

3.2.1 Community consultation register

The community consultation register includes consultation done during preparation of this PRC plan following section 126C(1)(c)(iii) of the EP Act. Community consultation done between construction of the Mine in 1984 and its acquisition by TCL in 2017 is not well recorded. The register needs to be regularly updated and includes (Table 18):

- consultation dates;
- community member identification;
- consultation type description;
- information provided to the community;
- issues raised and discussed by the community;
- consideration of issues by the EA holders;
- the decisions and outcomes of consultation; and
- commitments made.

3.2.2 Community consultation plan

The community consultation plan was prepared following section 126C(1)(c)(iv) of the EP Act. It includes information about how continuous community consultation will occur in relation to the planned rehabilitation in this PRC plan (Table 19). All community members, as identified in Section 3.2.2.1, will have the option of being involved in the community consultation program.

3.2.2.1 Identified community members

The identified community members and their relationship and interest is in Table 20. Each identified community member has a genuine interest in:

- land where the Mine is situated;
- land adjacent to the Mine; and / or
- land and surrounding amenities that are likely to be impacted.

Table 18 Community consultation register

Consultation date	Community member	Consultation type	Information provided	Issues raised by community	Issue consideration	Decisions / outcomes	Commitments
10 October 2022	Queensland Government — State Forest	Online meeting	Information provided included: • an introduction to the PRC plan process; • mining, final landform and life of mine (LOM) plan; and • details of the proposed PMLU and NUMA.	Issues raised included: • specific requirements of State Forests including no voids; and • that slopes and vegetation type must support State Forest use.	Issues were considered by preparing completion criteria for consultation.	Outcomes included: • that voids are not located on State Forest land; and • that completion criteria will be provided for consultation.	Commitments made include: • ongoing consultation; and • that no voids will be located on State Forest land.
17 October 2022	Queensland Government — State Land	Online meeting	Information provided included: • an introduction to the PRC plan process; • mining, final landform and LOM plan; • details of the proposed PMLU and NUMA; • classification of the adjacent State Forest as low-grade timber; and • the comparative ease of forestry establishment.	Issues raised included: • that unallocated State Land is managed by the government and, therefore, costs tax payers; and • that the priority is to allocate unallocated State Land and, therefore, reduce the ongoing cost to the government or mitigate risks such as: – risks of fire to the cemetery and the State Forest; and – biosecurity risks including pests and weed species.	Issues were considered by: • considering the return of land outside of State Forest to a PMLU of grazing; and • considering the associated residual risks.	Outcomes included: • that a 'most appropriate use' assessment is to be done by the State Land department; and • that the State Land department is to have internal discussions about the PMLU.	Commitments made include ongoing consultation.
22 November 2022	Queensland Government — State Forest	Online meeting	Information provided included: • a PRC plan update; and • that the preference of the State Land department is grazing as opposed to forestry in order to minimise residual risks.	Issues raised included: • concern about the PMLU not aligning with the pre-mining land use of eucalypt woodlands or forest; • that *Cenchrus ciliaris* (Buffel Grass) is not native and, therefore, may be problematic for native forestry; • that the preference of the State Forest department is returning disturbed land, other than the voids, to forestry; and • that State Forest land should have timber and water shed protection.	Issues were considered by selecting three reference sites to ensure the completion criteria reflect the pre-mining land use of State Forest.	Outcomes included: • that departments of State Forest and State Land will discuss the project, its potential boundary realignment and departmental roles; and • that State Forest land will be returned to pre-mining land use via the pre-selected reference sites.	Commitments made include ongoing consultation and that the PMLU for State Forest lands will reflect the pre-mining land use.
12 December 2022	Queensland Government — State Land	Online meeting	Information provided included potential to freehold the land and diversions.	Issues raised included: • the inclusion of diversion relinquishment requirements in the PRC plan schedule; and • that there are several governmental groups interested in the Mine.	Issues are to be considered via ongoing consultation.	Outcomes included: • preference for the land to be classified as freehold; • that the State Land department is to determine the method of communication; and • that the State Land department is to provide a 'most appropriate use' assessment.	Commitments made include ongoing consultation.

Consultation date	Community member	Consultation type	Information provided	Issues raised by community	Issue consideration	Decisions / outcomes	Commitments
31 July 2024	Clermont community	Public Notice	Information provided advised the community of a major amendment to the environmental authority EPML00876713	Issues to be raised by the community were to be tabled directly to the DETSI as submission to the Mines lodgement office Emerald, between 1/08/24 and 28/08/24.	Issues were considered by DETSI after submission period closed.	EA amendment EPML00876713 was approved after the submission period closed	No further commitments have been made.

Table 19 Community consultation plan

Objective	Engagement type	Proposed consultation frequency	Released information	Feedback and comment consideration
Provide written advice and a copy of the plan once the PRC plan is approved.	Letter	Once	The PRC plan	Feedback and comments will be considered in the context of the proposed changes and other feedback. If technically viable and reasonably practicable, it will be incorporated into the PRC plan.
Establish and maintain positive relationships with the community.	Letter, fax or email	Annual	An overview of the status of the Mine, progressive rehabilitation, proposed rehabilitation and contact information for further details or to provide feedback.	
Gain a holistic understanding of how best to manage community expectations and the potential environmental, economic and social risks associated with closure.				
Meet with community members who have direct impact interests and provide an opportunity for comment on the planned rehabilitation and closure outcomes.	In-person meeting	Once every five years or as requested.	A workshop to discuss the planned rehabilitation and closure outcomes with community members who have direct impact interests.	
Inform community members of the rehabilitation outcomes described in the PRC plan and accept comments and feedback on the rehabilitation described in the PRC plan.	Letter, fax, email or phone call	Annual	Update on the progress of rehabilitation under the PRC plan and contact information for further details or to provide feedback.	
Consult community members prior to amending elements of the PRC plan schedule which are likely to impact the community and accept comments and feedback.	Letter, fax or email	Prior to amending elements of the PRC plan schedule which are likely to impact the community.	A description and rationale for the proposed PRC plan schedule amendment and contact information for further details or to provide feedback.	
Notify local business and suppliers of the closure of the Mine.	Letter, fax or email	Two years prior to closure if practicable.	Notification of the closure of the Mine.	

Table 20 Identified community members

Community member	Relationship	Interest type
Queensland Government	Landholder — the Mine is predominately located on unallocated State Land and State Forest.	Direct impact, environmental, health and heritage interests.
Blair Athol Station (D Mayes and J Burnett)	Neighbouring property owners.	Direct impact interest.
Glencore Australia Holdings Pty Limited (Glencore)	Majority owner and operator of the adjacent CCM.	Direct impact interest.
Glencore	Owner of the rail corridor.	Direct impact interest.
Wangan and Jagalingou Peoples	Traditional owners of the land.	Cultural interest.
Isaac Regional Council	Local government where a planning scheme for the land is in place.	Land use interest.
Clermont community	Local community.	Land use interest.

3.3 Post mining land use

Under Queensland's *Mined Land Rehabilitation Policy*, mine operators must propose a suitable PMLU with consideration of the surrounding landscape, objectives of relevant planning strategies and community values and opinions. A PMLU is defined under section 112 of the EP Act as the purpose for which land will be used after all RAs have ended. A PMLU must be rehabilitated to a stable condition which is defined under section 111A of the *EP Act* as being:

- safe and structurally stable;
- causing no environmental harm; and
- able to sustain a PMLU.

The *EP Regulation* states that each PMLU must:

- be viable in relation to land use in the surrounding region; and
- be consistent with at least one of the following:
  - pre-mining land use;
  - a development approval relating to the land;
  - a use of the land other than mining which is permitted under State or Commonwealth legislation such as a planning instrument under the *Planning Act 2016*; and / or
  - delivering, or intending to deliver, a beneficial environmental outcome.

3.3.1 Transitional provisions

This PRC plan is not needed to meet the information requirements described in section 126C(1)(i) of the EP Act because the EA, which is a land outcome document (LOD), identifies the PMLU which can be transitioned to the PRC plan schedule. A description of the nominated PMLU and its transition to the PRC plan schedule, including completion criteria, is in Section 3.3.2.

Notwithstanding, the legislative requirements under section 126C(1)(d) of the EP Act remain applicable. That is, the extent to which the PMLU is consistent with:

- outcome of community consultation as per Section 3.3.3; and
- strategies or plans for land belonging to a local government, the State or the Commonwealth as per Section 3.3.4.

3.3.2 Nominated post-mining land uses

The void is addressed in Section 3.4. The identified PMLUs for each RA follow condition F4 of EPML00876713 which states that "*all areas significantly disturbed by mining activities must be rehabilitated in accorded with Table F1 — Rehabilitation requirements*". All other areas disturbed by mining will have a PMLU of either light grazing pasture or native ecosystem (Table 21).

Table 21 Nominated post-mining land use

RA	PMLU	Area (ha)
Dump	Light grazing pasture	735.75
TSF	Light grazing pasture	3.97
Processing plant	Light grazing pasture	12.87
Infrastructure	Light grazing pasture	73.15

RA	PMLU	Area (ha)
Rail infrastructure	Light grazing pasture	11.21
Road infrastructure	Light grazing pasture	104
Water management	Light grazing pasture	27.08
Existing rehabilitation (Grazing)	Light grazing pasture	289.01
Cleared area	Light grazing pasture	21.03
Native ecosystem	Native ecosystem	20.7
Existing rehabilitation (Native ecosystem)	Native ecosystem	20.89
Diversion	Light grazing pasture	34.88

3.3.2.1 PMLU Options Analysis

An options analysis was undertaken to support the associated environmental authority (EA) amendment and address the requirements of section 126C(1)(j) of the *Environmental Protection Act 1994* (EP Act) and Section 3.2 of the *Progressive Rehabilitation and Closure Plan (PRCP) Guideline.* This assessment considered environmental, social, statutory and physical factors to justify the proposed post-mining land use of grazing pasture.

Potential land uses were evaluated against physical constraints, landform stability, environmental outcomes, and compatibility with regional land use. Options such as native ecosystem, intensive horticulture, and forestry were assessed but were not considered suitable due to limitations including long-term maintenance, lower alignment with community expectations, or regulatory constraints.

The assessment found that light grazing pasture is the most suitable PMLU. This option aligns with the pre-mining land use, the preferences of landholders and relevant authorities, and regional economic and environmental objectives. The full analysis is provided in Appendix S.

3.3.2.2 Permanent or essential management infrastructure

Roads which provide access to the cemetery will remain as essential infrastructure. Other permanent infrastructure such as fences and access tracks may remain if requested by future or neighbouring landholders. There will be no remaining infrastructure essential to land management.

3.3.2.3 Completion criteria

Proposed completion criteria can be used to determine whether PMLUs have been achieved. Completion criteria will form the final rehabilitation milestones as per PRC plan guidelines. Rehabilitation landform criteria in the EA require disturbed land to be rehabilitation to a safe, stable and non-polluting condition with self-sustaining vegetation. Assessment of these completion criteria for measuring whether the PMLU of light grazing pasture or native ecosystem has been achieved is in Table 22.

Table 22 PMLU completion criteria

Goal	Objective	Indicator	Completion criteria	Justification
Safe	Land is safe to humans and wildlife. There is no potential exposure of hazardous waste.	Land has been certified as being in a stable condition by an AQP.	Certification from an AQP that the land is in a stable condition.	Being able to provide evidence that the land is safe, structurally stable, does not cause environmental harm and is able to sustain a PMLU of light grazing pasture.
		Land has been certified by an AQP as having no exposed hazardous waste.	Certification from an AQP that no hazardous waste is exposed on the land.	Being able to provide evidence that the land is safe and there is no risk of exposure to hazardous waste.
Stable	Land is structurally stable.	Land has been certified as being in a stable condition by an AQP.	Certification from an AQP that the land is in a stable condition.	Being able to provide evidence that the land is safe, structurally stable, does not cause environmental harm and is able to sustain a PMLU of light grazing pasture or native ecosystem.
	There is sufficient groundcover for erosional stability.	Rate of erosion on the land is appropriate.	The erosion rate is comparable to adjacent undisturbed land used for grazing or forestry.	Being able to provide evidence that the erosion rate is appropriate for a PMLU of light grazing pasture or native ecosystem.
		There is no gully subsidence or erosion.	There is no gully subsidence or erosion for at least three years.	Being able to provide evidence that the landform is stable with no gully subsidence or erosion.
		There is suitable groundcover.	There is a vegetation cover of ≥ 70 %.	Being able to provide evidence that the quantity of groundcover is sufficient to mitigate the risk of erosional instability.
		There is very low probability of failure or slippage that could cause environmental harm.	Geotechnical studies confirm that there is a very low probability of failure or slippage.	Being able to provide evidence that the land is safe and stable and does not cause environmental harm.
Non-polluting	Land does not cause harm to surrounding environment.	Land has been certified as being in a stable condition by an AQP.	There is no gully subsidence or erosion for at least three years.	Being able to provide evidence that the land is safe, structurally stable, does not cause environmental harm and is able to sustain a PMLU of light grazing pasture or native ecosystem.
	Runoff or seepage discharge does not cause harm to receiving environment.	Quality of downstream water is appropriate.	Certification from an AQP that discharge is not causing environmental harm and is not significantly different in quality to water of the receiving environment.	Being able to provide evidence that discharge is not causing environmental harm and is of a similar quality to water of the receiving environment.
		Groundwater levels and quality are monitored.	Certification from an AQP that the quality of the groundwater will not significantly impact regional aquifers.	Being able to provide evidence that the groundwater quality is similar to that of the regional aquifers.
			Certification from an AQP that groundwater levels are appropriate.	Being able to provide evidence that the groundwater levels are appropriate.
Self-sustaining for the PMLU	Land sustains appropriate vegetation for grazing.	Land has been certified as being in a stable condition by an AQP.	Certification from an AQP that the land is in a stable condition.	Being able to provide evidence that the land is safe, structurally stable, does not cause environmental harm and is able to sustain a PMLU of light grazing pasture or native ecosystem.
		Land has sufficient groundcover which is established and self-sustaining.	The groundcover is established and self-sustaining.	Being able to provide evidence that the groundcover is established and self-sustaining following the conditions of the EA.
		Land has an appropriately low abundance of pest and weed species.	Certification from an AQP that the abundance of weed and pest species on the land is no higher than that of adjacent undisturbed land used for grazing or forestry.	Being able to provide evidence that the vegetation does not include a significantly higher abundance of declared pest or weed species than the surrounding environment.
	Soil suitability is the same as it was prior to mining.	Land suitability assessment matches that of the land prior to mining disturbances.	An AQP performs a land suitability assessment which certifies the land as Class 3-4 for relatively flat slopes at the top of spoil dumps and Class 4-5 for slopes of 12-15 %.	Being able to provide evidence that all rehabilitated land has the same suitability classification as the pre-disturbed land.

3.3.3 Community consultation

The PMLU of light grazing pasture and native ecosystem is consistent with the outcomes of community consultation because the:

- Preference of the State Land department is for land outside of State Forests to be returned to a PMLU of light grazing pasture;
- preference of the State Forest department is for land other than the void to be returned to a PMLU of light grazing pasture;
- area marked as State Forest Land will be returned to native ecosystem consistent with pre-disturbance; and
- PMLUs align with pre-mining land uses of light grazing pasture.

3.3.4 Land use planning

3.3.4.1 Mackay, Isaac and Whitsunday Regional Plan

The *Mackay, Isaac and Whitsunday Regional Plan* (MIW Regional Plan) identifies and interprets the State's interests in land use planning and development as described in the SPP. The MIW Regional Plan relates to the Mackay Regional Council, Isaac Regional Council and Whitsunday Regional Council LGAs. The goals of the MIW Regional Plan include:

- making land management and planning decisions which consider projected impacts of climate change such as reduced water availability;
- enhancing regional landscape values through appropriate plans, designs and management of development and infrastructure;
- protection of regional biodiversity values through improved ecological connectivity, rehabilitation of degraded areas and increased extent and quality of habitat;
- appropriate management of natural resources, including rehabilitation of disturbed land, to maintain positive economic, social and environmental contributions to the region; and
- actively consulting and engaging Traditional Owners when making planning decisions.

PMLU of light grazing pasture aligns with the MIW Regional Plan because:

- light grazing pasture is an example of rehabilitation of natural resource areas to land uses which support positive economic, social and environmental contributions.

3.3.4.2 Isaac Regional Planning Scheme

The Isaac Regional Planning Scheme (the Planning Scheme) describes the IRC's plan for the LGA. The Planning Scheme identifies the Mine as being in a rural area. Goals of the Planning Scheme include:

- liveable communities;
- a diverse economy;
- protecting natural resources and the environment;
- safety from natural and other hazards; and
- infrastructure for communities.

A PMLU of light grazing pasture is consistent with the Planning Scheme because light grazing pasture supports a diverse economy within liveable communities. Native ecosystem is also consistent with the Planning Scheme as it improves natural resources and the environment.

3.4 Non-use management area

The EP Act defines a non-use management area (NUMA) as an area of land subject to a PRC plan which is incapable of being rehabilitated to sustain a PMLU after mining has finished.

3.4.1 Transitional provisions

This PRCP has been prepared as a transitional PRCP under Chapter 5, Part 3 of the *Environmental Protection Act 1994*, in accordance with the requirements introduced by the PRCP framework in 2019. While some areas—such as the final void—have been previously approved under the existing environmental authority (e.g. Condition F4), the plan must still meet the content and justification requirements under sections 126C and 126D of the EP Act.

Specifically, sections 126C(1)(g), 126C(1)(h), and 126C(1)(j) require the PRCP to identify and justify areas that will not be rehabilitated to a post-mining land use. Section 126D(2) requires that the extent of each NUMA be either:

- not greater than reasonably necessary for the resource activity (s126D(2)(a)); or
- otherwise justified on public interest grounds (s126D(2)(b)).

Existing EA conditions provide important supporting evidence when nominating a NUMA, but do not remove the requirement to demonstrate consistency with the PRCP guideline, community consultation outcomes (s126C(1)(d)), and best practice management methodologies (s126C(1)(i)).

3.4.2 Nominated non-use management areas

The void has been identified as a NUMA in the EA and can be transitioned into the PRC plan schedule; however, it must be demonstrated within the PRC plan that the void cannot sustain a PMLU.

3.4.2.1 Inability to sustain a post-mining land use

The void is unable to sustain a PMLU because it is lower in elevation than the final landform and would receive all rainfall runoff in the absence of active management controls. If rainfall was allowed to collect in the void, salinity would increase over time and form a closed-loop system with no salt removal mechanisms (WRM 2023). This would cause salinity concentrations to exceed 40,000 µS/cm after ~300 years and 90,000 µS/cm after ~500 years. This concentration of salinity is not suitable for a PMLU of light grazing pasture as it would be unable to sustain vegetation.

Rehabilitation of the void would require large-scale infill or engineered cover systems, which would significantly disturb surrounding rehabilitated areas and require additional material sourcing and haulage. These activities would pose a greater environmental risk through erosion, dust generation, and disruption of stable landforms, compared to passive management of the void as a permanent lake. As such, the void is considered a NUMA in accordance with s126D(2)(a) of the EP Act.

Further, the area is located within the existing mining tenure, and the environmental risks associated with non-rehabilitation (i.e. localised groundwater mounding and salinity) are confined within this boundary. Managing the void as a residual risk feature aligns with public interest considerations under s126D(2)(b), by minimising unnecessary disturbance and ensuring long-term safety and environmental protection.

Supporting assessments confirm this approach. The site-specific water balance model (Appendix D) predicts a stable water level ~ 20 m below the pit crest due to ongoing groundwater inflows. The geotechnical stability assessment (Appendix I) and subsequent clarification memo (Appendix T) confirm that long-term wall stability is only achieved with engineered spoil buttressing and that a 30 m exclusion zone is required to mitigate safety

risks. The final landform design (Appendix H) incorporates the void as an intentional feature of the post-mining topography.

It is understood that the historical underground workings associated with previous mining at the site have all been removed due to the extent of the historical underground mining being contained within the open cut operations footprint (Section 3.5.4)

Practical rehabilitation alternatives, including backfilling or reshaping the void and establishing a beneficial post-mining land use, were considered but found to be unfeasible due to the absence of excess spoil, long-term salinity risks, and geotechnical constraints. Accordingly, the area meets the criteria for a NUMA under both subsections of s126D(2) of the EP Act.

3.4.2.2 Description of the land at surrender

At surrender, the nominated NUMA will consist of a permanent pit lake with a predicted long-term water level ~ 20 m below the surrounding crest, as demonstrated by the site-specific water balance model (Appendix D). The void will be surrounded by engineered spoil landforms, constructed in accordance with the approved final landform design (Appendix H) and geotechnical requirements (Appendix T).

The surrounding spoil will be shaped, stabilised, and vegetated using native species consistent with the surrounding post-mining landscape. No infrastructure will remain in the NUMA area. A 30 m exclusion zone will be established around the void to meet safety bunding requirements and minimise long-term access risks. The NUMA will be managed as a residual risk feature and maintained in accordance with best practice measures described in Section 3.4.2.4.

3.4.2.3 Relevant safety features

The final void presents ongoing geotechnical and public safety risks, primarily due to potential batter instability and uncontrolled access. A geotechnical assessment (Appendix I) and subsequent stability memo (Appendix T) identified that long-term stability is only achieved through engineered spoil buttressing, and recommended a 30 m exclusion zone around the void perimeter.

This exclusion zone will be incorporated into the final landform and managed as a no-access area. Safety bunding or equivalent physical barriers will be constructed in accordance with the final landform design (Appendix H). The void area will be monitored and managed as a residual risk feature, consistent with the PRCP guideline and Schedule 8, Section 6 of the *Environmental Protection Regulation 2019*.

3.4.2.4 Completion criteria

Completion criteria for the NUMA have been developed to reflect the permanent geotechnical and hydrological constraints of the final void. These criteria are presented in Table 23 and ensure that the area is stable, safe, and appropriately managed as a residual risk feature in accordance with the PRCP guideline and s126D(2) of the Environmental Protection Act 1994. The criteria focus on long-term structural integrity, public safety, and confirmation of predicted water levels and water quality, as supported by the geotechnical and hydrological assessments referenced in this section.

Table 23 NUMA completion criteria

Aspect	Completion Criteria
Landform geometry	Constructed landform consistent with final landform design (Appendix H), including spoil batters and drainage features.
Geotechnical stability	Void crest and surrounding landform are geotechnically stable in accordance with Appendix H and Appendix T.

Aspect	Completion Criteria
Exclusion zone	30 m exclusion zone established and clearly demarcated to prevent unauthorised access, consistent with safety requirements.
Water level stability	Final void water level demonstrated to be stable based on site-specific water balance modelling (Appendix D), with no risk of uncontrolled discharge.
Surface stabilisation	Surrounding landforms are stable, non-eroding, and vegetated with species consistent with adjacent land use areas.
Residual risk controls	Residual risk management measures (e.g. signage, bunding) are in place and acceptable to the administering authority.

3.4.3 Community consultation

The NUMA is consistent with community consultation because the:

- void is not located on State Forest land; and
- surface water will be diverted around the void to avoid contamination of downstream water.

3.4.4 Land use planning

3.4.4.1 MIW Regional Plan

The NUMA is consistent with the MIW Regional Plan because diversion of surface water around the NUMA exemplifies appropriate management of natural resources through the rehabilitation of disturbed land to protect regional biodiversity and maintain positive environmental contributions.

3.4.4.2 Planning Scheme

Extent that the Planning Scheme is consistent with the NUMA is:

- diversion of surface water around the NUMA protects the environment; and
- construction of safety features such as slopes, bunding, fencing and signage supports human safety and, therefore, the goal of liveable communities.

3.5 Rehabilitation and management methodology

3.5.1 General rehabilitation practices

3.5.1.1 Hydrogeology

Water quality impacts from mining must be predicted to determine appropriate measures for containment and management of contaminants. Predictions can also be used to identify potential impacts on EVs should contaminants be released. The following sections outline the hydrogeology of the Mine and methodologies for rehabilitation and management.

a Hydro stratigraphic units

Hydro stratigraphic units (HSUs) are zones within a hydrogeological system that have similar properties. Five HSUs have been identified within the region:

- Basement Rocks;
- Permian Sediments;
- Tertiary Basalt aquifer;
- Tertiary / Quaternary Alluvium; and
- Rejects and Spoil.

Basement Rocks

Proterozoic-Cambrian metamorphics occur at, or close to, the surface in several locations regionally and show a response to rainfall at other water table bores. Proterozoic-Cambrian metamorphics are not regarded as an aquifer because the bore yields are low. They are the hydraulic basement to other regional groundwater units.

Permian Sediments

Permian Sediments, or coal seams, are water-bearing units but are not aquifers as the yields are too low and short-lived. Generally, yields will only last a matter of hours.

Tertiary Basalt aquifer

The Basalt aquifer is in the northern and eastern areas. It is considered regionally significant because it is the main aquifer from which landholders draw stock and domestic water supplies. Groundwater in the Basalt has been observed to occur regionally within discrete, isolated fractures so that pumping from one fracture system can have little or no impact on water levels within adjacent fracture systems.

Tertiary / Quaternary Alluvials

Unconsolidated alluvial deposits occur along the ephemeral Bath and Washpool creeks and drain north to north-east. Groundwater occurrence within the Alluvials is sporadic and dependent on rainfall recharge events which allow the streams to flow.

Rejects and spoil

Spoil which has been removed to access coal seams is progressively backfilled into the voids as coal is removed. The hydraulic properties of spoil are dependent on properties of the parent rock, dumping method, degree to which spoil has been consolidated by traffic and the degree to which the spoil has settled over time.

b Groundwater quality

A groundwater assessment was done by hydrogeologist.com.au (2023) to determine groundwater quality. An updated groundwater assessment was done by hydrogeologist.com.au (2025) (Appendix C) for groundwater quality data collected between February 2014 to June 2025. This assessment described groundwater quality as:

- slightly acidic to slightly alkaline with a pH of 6.2-8.3;
- fresh to saline with total dissolved solids measured between 289 mg/L to 9,380mg/L;
- two distinct water types dependent on the host rock, including:
  - calcium-bicarbonate type water; and
  - sulphate-chloride type water.

Groundwater quality in all aquifers at the Mine are characterised in a Piper plot Figure 12 and discussed below (hydrogeologist.com.au 2025).

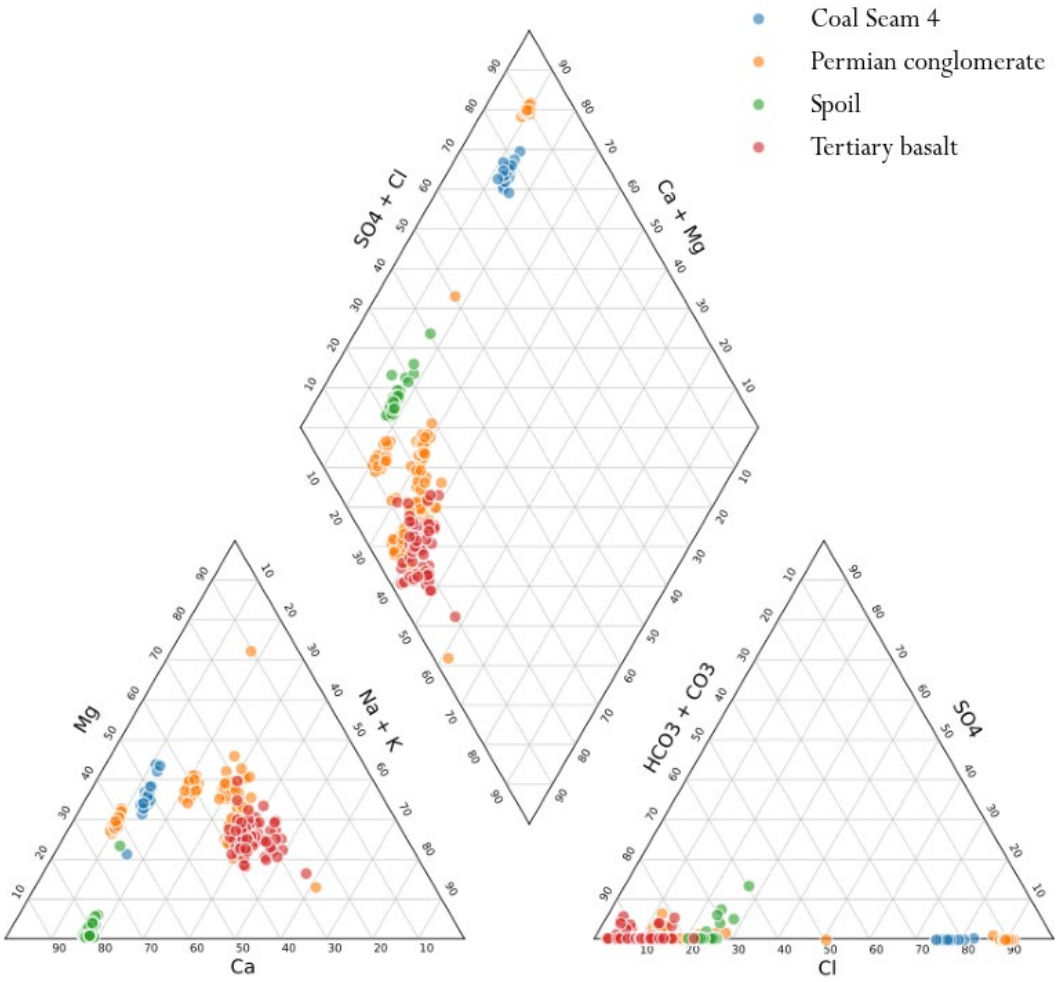


Figure 12 Blair Athol water chemistry plot

Tertiary basalt

Water quality data is available from five monitoring bores. Tertiary basalt water quality is circumneutral to slightly alkaline, with measurements of field pH recorded between 6.87 and 8.29. TDS values are between 289 mg/L and 736 mg/L, indicating fresh to brackish water. It has a calcium-bicarbonate water type, reflective of fresh rainfall recharge into the shallow basalt aquifer and short residence time.

Permian conglomerate

Water quality data was taken from six monitoring bores in the Permian conglomerate. The water quality is circumneutral, with field pH measured between 6.17 and 7.57. TDS has been observed to be highly variable, ranging between 328 mg/L (fresh water) and 9,380 mg/L (saline).

Water type is sodium-chloride, reflecting the deeper nature of the aquifer and longer residence time. However, mixing of groundwaters is observed at several monitoring bores where the Permian conglomerate is overlain by the Tertiary basalt.

Permian coal seam

Water quality data for the Permian coal seam is available from one monitoring bore (GT02) between February 2015 until September 2020. Water is circumneutral and moderately saline, with field pH measured between 7.01 and 7.37, and TDS between 3,610 mg/L and 4,560 mg/L. Water type is sulphate-chloride.

Spoil

Field pH for spoil has been measured between 6.78 and 7.85, and TDS between 585 mg/L and 676 mg/L, making it circumneutral to slightly alkaline and brackish. The water type observed in this aquifer is calcium-bicarbonate, reflecting the high proportion of rainfall recharge to the unit and limited interaction with deeper in-situ groundwaters.

c Groundwater monitoring

Groundwater monitoring and maintenance methodologies are described in Section 3.7.3.2 and include:

- sample collection following integrity measures;
- recording observations from EA compliance bores and monitoring bores;
- storing the aforementioned records for five years; and
- reporting exceedances, limit exceptions and findings of annual reviews to DESI.

d Groundwater recharge, discharge and flows

Basement Rocks

Water level monitoring indicates that the Basement Rocks, especially where they occur at surface, are recharged via direct rainfall infiltration. As storage of the Basement Rocks is relatively low compared to other local HSUs, the majority of rainfall will be reported as runoff to surface drainage systems or rejected recharge.

Permian Sediments

The Blair Athol Basin is a relatively isolated groundwater system. Although recharge mechanisms are unconfirmed, recharge is assumed to occur in marginal areas of the coal seam subcrop. There may also be occurrences of downward drainage from overlying groundwater units in particular areas. There is no natural outlet for water in the coal seams and, therefore, there is a high likelihood of the groundwater having minimal movement.

Tertiary Basalt aquifer

The Basalt aquifer is the uppermost aquifer in the groundwater system and it receives recharge directly from rainfall. Groundwater flow direction within the Basalt aquifer is controlled by movement of water from higher to lower topographic regions. Based on surface drainage, it is assumed that the aquifer to the north within the Bath Creek catchment will flow towards the Mine.

Tertiary / Quaternary Alluvials

Groundwater recharge to the Alluvials is via direct rainfall infiltration. Groundwater movement is towards surface drainage.

Rejects and spoil

Recharge to the artificial rejects and spoil aquifer is via direct rainfall infiltration. Groundwater flow direction is dependent on:

- degree to which a mounded water table forms in the spoil; and
- shape of the final landform relative to that of the surrounding area.

It is considered likely that the groundwater flow direction will continue to reflect the topography to the south towards Bath Creek.

e Groundwater uses

Hydrogeologist.com.au (2023) identifies current uses of groundwater including water supply purposes, stock watering and domestic purposes. Declared EVs for the Lower Nogoa Groundwaters include:

- aquatic ecosystems;
- industrial use;
- irrigation supply;
- farm supply and use;
- stock water;
- recreational use;
- drinking water; and
- cultural and spiritual values.

f Pre-mining conceptual groundwater modelling

A pre-mining conceptual groundwater model was prepared (Figure 13; JBT 2012) as part of the *Mine Closure Groundwater Investigation* by JBT (2012) (Appendix C). No pre-mining groundwater data is available and, therefore, the model is based on monitoring data and regional groundwater data. The pre-mining conceptual groundwater model indicates that:

- local groundwater system is recharged directly via rainfall;
- infrequent rainfall patterns result in episodic groundwater flow;
- surface water flow events provide short periods of potential recharge to the groundwater system;
- some of the creeks and drainage features within the Mine are shown as having unconsolidated alluvial matter present;
- presence of groundwater within the Alluvials is sporadic and related to rainfall events;
- the only geological unit considered an aquifer is the Tertiary Basalt;
- geological units which contain water but have very low yields are classified as aquitards;
- high yields have occurred locally within the coal measures where faulting or fracturing has caused secondary porosity;
- direction of groundwater flow reflects topography of the land;
- excavation of the voids has locally dewatered coal seams within the coal measures and created groundwater sinks;
- inflow into the voids occurs from the Tertiary Basalt and the coal measures; and
- mined-out areas are progressively backfilled with spoil which forms a local aquifer because it is directly recharged by rainfall.

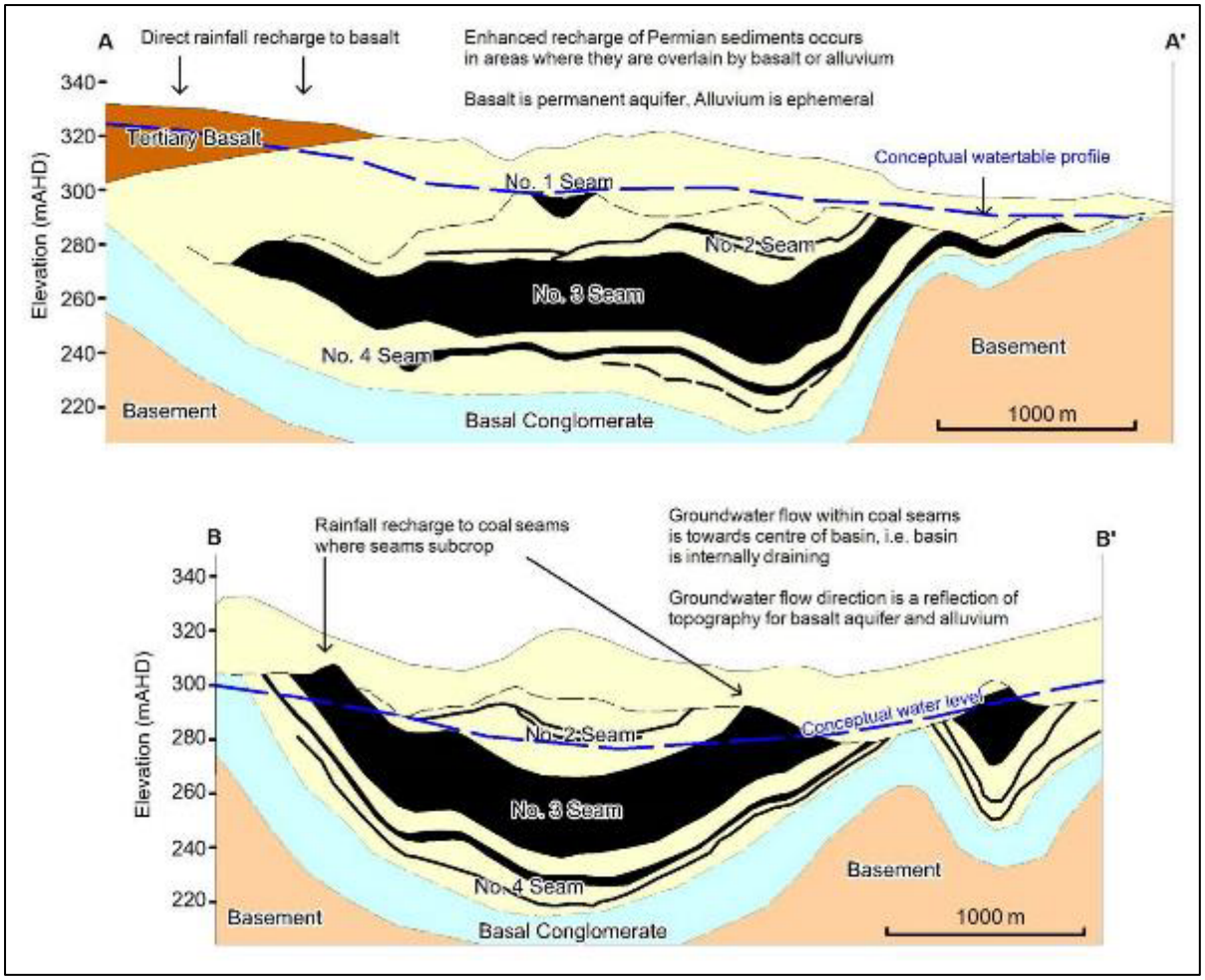


Figure 13 Pre-mining conceptual groundwater model

g Potential sources of contaminants

Potential sources of groundwater contamination include the void and CDA (hydrogeologist.com.au 2023). Other potential sources include areas in which chemicals or hydrocarbons are used or stored. Salinity of the void is projected to increase over time (WRM 2023). However, this is unlikely to impact local groundwater quality because the void will act as a sink.

Coarse and fine rejects were tested and classified as potentially acid forming (PAF) or non-acid forming (NAF) (hydrogeologist.com.au 2023). Seepage from beneath the CDA was also tested and found to be pH-neutral. Therefore, the inherent buffering capacity of the rejects will self-neutralise which will minimise contamination in the long term.

It is unlikely that seepage will occur from the CDA to the Tertiary Basalt aquifer because the:

- CDA is lower in elevation;
- CDA has been rehabilitated; and
- co-disposed rejects will be covered with at least 5 m of spoil.

3.5.1.2 Flooding

Hydrologic and hydraulic modelling was done by HydroBalance (2025a) (Appendix V) to assess flooding characteristics for the 0.1 % annual exceedance probability (AEP) design flood and peak maximum flood (PMF) following the EP Regulation. It was assumed that the final landform will comply with condition F16 of the EA, and that the Eastern and Western diversions will convey at least the 0.1 % AEP event, prior to the end of mining.

The final landform will not significantly alter downstream catchments and risk of flooding is low. Therefore, there is negligible risk of the final landform contributing to downstream flooding or erosion and of flooding impacting stability of the final landform. The Mine is not located within the flood extent of a relevant watercourse as defined by DES (2019); however, the Eastern and Western diversions are sufficient to prevent ingress of floodwater into the final landform.

Flooding is characterised by channelised flows within the eastern and western diversions. Some overbank flows exist along the Western Diversion. Flows are generally deep and high in velocity, particularly in confined portions along the Eastern Diversion. Erosion protection measures should be considered for the diversion drains.

3.5.1.3 Soil and capping assessment

The conservation of soil is a critical component of rehabilitation planning. The following sections describe:

- quality and quantity of available resources needed to complete the target rehabilitation method;
- an assessment to determine the need for ameliorants and fertiliser;
- relationship between soils and vegetation ecosystems for the PMLU and rehabilitation method; and
- soil resource management including stripping and stockpiling.

a Soil fertility, erosion and dispersion potential

A *Soil and Capping Material Assessment* was done by SGME (2024) (Appendix E).

SGME (2024) found that:

- soil stockpiles will be suitable for rehabilitation, but may need amelioration to satisfy rehabilitation outcomes;
- the majority of soil would benefit from gypsum due to high salinity which increases the erosion potential;
- P-based fertiliser may be required for soil that is phosphorus deficient;
- the majority of spoil is considered low-risk indicating that it is suitable for use in rehabilitation;
- only spoil with an ESP<15% can be used as cover material for the co-disposal waste (high-risk).

Previous studies have also found that soils will be highly susceptible to erosion if structural deterioration occurs during handling because there are high proportions of silt and fine sand (Dames & Moore 1983). Further, the A_1 horizon of soil type C_2 (Alluvial GSG) is slightly dispersive and, therefore, there is a risk of erosion if placed in drainage lines or slopes above 5°.

A *Soil and Spoil Characterisation and Suitability* assessment was done by Highlands Environmental (2018) to determine suitability for use in future rehabilitation programs. Samples taken from 11 soil stockpiles were sent to a National Association of Testing Authorities (NATA) Australia accredited laboratory for analysis. The analyte suite included:

- ammonium;
- nitrate;
- phosphorous (P);
- P buffer index;
- S;
- exchangeable cations (Ca, Mg, K, Na and Al);
- pH (water);
- pH ($CaCl_2$);
- chloride;
- EC;
- organic carbon (C);
- colour; and
- texture.

Required soil nutrient ranges for rehabilitation are in Table 24. The analysis results from each specified location are in Table 25.

Table 24 Soil nutrient ranges for rehabilitation

Parameter	Ideal range
pH	6.0-8.5
Organic C	> 1 %; however, > 2 % is preferable
Colwell P	6 parts per million (ppm)
Ca:Mg ratio	> 1.5:1
EC	0.4 decisiemens per metre (dS/m)
ESP	< 6 %
Clay plus silt particle size	< 30 %

SGME (2020)

Table 25 Soil sample results

Sample ID	Location	Description	Identified issues
1	552811, 7490227	Non-sodic topsoil which is prone to dispersion and excessive erosion because it has a very low concentration of salinity. It has deficiencies in N, P and S. It has insufficient Zn and B. Soil is suitable for use in rehabilitation with fertilisation but should be strategically placed to minimise the risk of erosion.	Issues with soil from this stockpile include: • electrochemical stability index (ESI) of 0.020; • N concentration of 5.9 mg/kg; • P concentration of < 5 mg/kg; and • S concentration of 7.8 mg/kg.
2	555349, 7487843	Non-saline and non-sodic topsoil with deficiencies in P, K and S. It has insufficient Zn and B. It is suitable for use in rehabilitation with fertilisation.	Issues with soil from this stockpile include: • P concentration of < 5 mg/kg; • K concentration of 0.12 centimoles per kilogram (cmol/kg); and • S concentration of 4.3 mg/kg.
6	554837, 7490491	Non-saline and non-sodic topsoil with deficiencies in N, P and K. It has insufficient B. It is suitable for use in rehabilitation with fertilisation.	Issues with soil from this stockpile include: • N concentration of 4.8 mg/kg; • P concentration of < 5 mg/kg; and • K concentration of 0.2 cmol/kg.
7	556308, 7489237	Moderately alkaline, non-saline and non-sodic topsoil with deficiencies in N and P. It has insufficient B. It is suitable for use in rehabilitation with fertilisation.	Issues with soil from this stockpile include: • N concentration of 5.9 mg/kg; and • P concentration of < 5 mg/kg.
7b	556489, 7489099	Very strongly alkaline topsoil which induces nutrient imbalances. It is not suitable for use in rehabilitation.	Issues with soil from this stockpile include: • pH of 9; and • P concentration of < 5 mg/kg.
8	556104, 7487895	Highly saline and strongly acidic topsoil which impacts plant establishment and growth. It is not suitable for use in rehabilitation.	Issues with soil from this stockpile include: • EC of 8.8 dS/m; • ESP of 18 %; and • P concentration of < 5 mg/kg.
9	556147, 7487854	Non-saline and non-sodic topsoil with deficiencies in N, P, K and S. It has insufficient Zn and B. Soil is suitable for use in rehabilitation with fertilisation.	Issues with soil from this stockpile include: • N concentration of 3.5 mg/kg; • P concentration of < 5 mg/kg; • K concentration of 0.16 cmol/kg; and • S concentration of 2.2 mg/kg.
832	554929, 7491303	Non-saline and non-sodic topsoil with deficiencies in N and P. It has insufficient Zn. Soil is suitable for use in rehabilitation with fertilisation.	The only identified issue with soil from this stockpile is the S concentration of 5.5 mg/kg.
A	556635, 7490690	Non-saline and non-sodic topsoil with deficiencies in N, P and S. It has insufficient Zn and B. Soil is suitable for use in rehabilitation with fertilisation.	Issues with soil from this stockpile include: • N concentration of 5.5 mg/kg; • P concentration of < 5 mg/kg; and • S concentration of 4.5 mg/kg.
B	556611, 7490706	Non-saline and non-sodic sub soil with deficiencies in N and P. It has insufficient Zn. Soil is suitable for use in rehabilitation with fertilisation.	Issues with soil from this stockpile include: • N concentration of 4.8 mg/kg; and • P concentration of < 5 mg/kg.

Sample ID	Location	Description	Identified issues
C	556122, 7487805	Very strongly alkaline sub soil which induces nutrient imbalances. It is not suitable for use in rehabilitation.	Issues with soil from this stockpile include: • pH of 9.8; • ESP of 12 %; • ESI of 0.027; • N concentration of 1.6 mg/kg; • P concentration of < 5 mg/kg; and • S concentration of 2.9 mg/kg.

Highlands (2018)

b Location and accessibility of cover soil

Soil stockpile locations and volumes were quantified by SGME (2024), which identified a total of ~787,768.78 cubic metres (m^3) available for rehabilitation. This is a deficit of ~512,581.22 m^3. Therefore, further assessments of spoil quality and quantity will be needed to determine the feasibility of replacing some of the soil deficit with spoil. There is no specific spoil registry, however the CHPP Management Plan (2017a) estimates that ~ 18,000,000 cubic metre is moved annually.

Location, quantity and soil type in each stockpile are in Table 26.

Table 26 Soil stockpiles

Soil ID	Soil type	Volume (cubic metres (m^3))
TSP_06	Vertosol	92,978.30
TSP_07	Vertosol	18,899.56
TSP_18	Vertosol	38,710.49
TSP_21	Kandosol	20,740.45
TSP_23	Vertosol	54,549.40
TSP_28	Unknown	35,975.00
TSP_30	Kandosol	10,813.19
TSP_31	Kandosol	147,748.13
TS0803	Kandosol	5,397.97
TS0906A	Kandosol	5,473.09
TS0913A	Vertosol	8,965.00
TS0913B	Vertosol	23,018.80
TS0913C	Vertosol	7,305.40
TS0913D	Vertosol	5,130.30
Total		475,705.08

SGME (2024)

There are seven additional locations containing soil volumes which are in Table 27. The volume at each additional location is recorded; however, the soil ID and type are unknown.

Table 27 Additional soil volumes

Soil location	Volume (m^3)
In situ soil from South Pit clearance	21,909.00
Black soil / subsoil	27,708.00
In situ soil from TLO Rail side	42,000.00
In situ soil from TLO Crusher Pad	36,000.00

Soil location	Volume (m^3)
In situ soil from South Pit boxcut area	116,555.70
Reclaimed Soil from West Pit rehab	64,953.00
TLO Sediment Pond	2,938.00
Total	312,063.70

TerraCom (2020c) and SGME (2024)

Table 28 Soil accounting

Soil mitigation and management strategy		Placement[1]	Strip placement	Hydromulch	Direct seed spoil	Not required
Hectares	1,688	784	165.8	17.5	48.6	672.1
Needed (m^3)	1,300,350	1,176,000	124,350	-	-	-
Available (m^3)	787,768.78	-	-	-	-	-
Excess / deficiency	-512,581.22	-	-	-	-	-

To address the topsoil deficit, different strategies are provided in the *Growth media — Mitigation and Management Strategy* (Terracom 2020c) (Appendix U).

c Ameliorants and fertilisers

Soils which are suitable for use in rehabilitation (Table 25) generally have deficiencies in N and P and, to a lesser extent, K and S. They also typically have insufficient Zn. The deficiency in P is the most limiting of these issues.

Highlands (2018) recommended that 250 kilograms per hectare (kg/ha) of Cotton Sustain fertiliser be applied to deficient soils. Cotton Sustain is an Incitec Pivot fertiliser containing 6.1 % N, 12 % P, 22.5 % K, 2.2 % S and 0.55 % Zn. Application of gypsum is recommended where spoil is characterised as sodic (Earthtrade 2021). Soils should be re-tested after application of ameliorants and before use (SGME 2020).

d Relationship between soils and vegetation ecosystems for the post-mining land use and rehabilitation method

The land suitability of rehabilitation was assessed in the EMP (TerraCom 2017a).

Results of the land suitability and Agricultural Land Classes (ALC) assessment show the rehabilitation area is unsuitable for broadacre cropping. Therefore, the land will be rehabilitated to sustain a PMLU of light grazing pasture, with the exception of the void, depending on the limitations of the particular area. Limiting factors include, but are not limited to, low plant available water capacity (PAWC), high-risk of soil loss from water erosion, and low availability of nutrients for plant uptake (pH limited).

Shallow rocky soils with little agricultural value are dominant within gravel ridge country (TerraCom 2017a). There are smaller areas of more fertile soils on basalt in the north-east section of the Mine and along creek lines. The two distinct soil types have different dominant vegetation types.

On the more fertile soils, groundcover typically consists of grasses such as Buffel Grass, *Chloris gayana* (Rhodes Grass), Black Speargrass, Queensland Blue Grass and *Cynodon dactylon* (Couch Grass). The overstorey layer on the more fertile soils is typically dominated by Poplar Box, Dawson River Blackbutt, *Eucalyptus tesselaris* (Moreton

Bay Ash), River Red Gum and Silver-leaved Ironbark (TerraCom 2017a). *Trioncinia retroflexa* (Belyando Cobblers Peg) was identified in flora surveys done in 2001-2003; however, recent surveys have failed to identify specimens of the rare and threatened species.

Grasses can be very sparse on soils of less agricultural value, and tend to be dominated by Wiregrasses. On these soils, dominant tree species include Rosewood, Lemon-scented Gum, Lancewood and Narrow-leaved Ironbark (TerraCom 2017a). Overall, there is great variability in vegetation cover and diversity in the gravel ridge country due to underlying metamorphic rocks which can weather into a range of soils with differing nutrient and soil water properties.

e Soil resource management

The *Blair Athol Soil Management Programme* (SSA 2013) supports progressive rehabilitation and provides procedures to manage soil integrity during stripping, stockpiling and spreading. Soil separation and stockpile maintenance is essential for achieving rehabilitation goals. The *Erosion and Sediment Control Plan* (TerraCom 2020) develops strategies to manage the impact of surface water on soils.

Soil stripping

Soil is one of the most important elements for successful rehabilitation. The surface is stripped to an average depth of 0.15-0.2 m. Deeper subsoil horizons are avoided based on undesirable properties, primarily sodicity and dispersive potential.

Topsoil contains bulk nutrients and organic matter, a seedbank of species associated with the previous land use, other plant propagules such as rhizomes and roots, and soil micro-organisms necessary for function and nutrient cycling. Organic matter promotes aggregation and structural stability, which is important for seedbed creation and water retention.

To avoid degradation and retain seed bank diversity, soil is transported and respread (where possible) over recontoured areas. This direct return method avoids double handling and helps maintain soil integrity.

Timing of soil stripping can be an important factor in rehabilitation as soils which are too dry or too wet can lead to compaction, loss of structure and a loss of seed viability. Clearing and soil stripping should occur after seed set, where possible, to maximise the stores of seed. Seed set will generally occur when enough moisture is available.

All machinery used in stripping operations should be clean of weeds.

Stockpiling

Preference is given to placing soil on recontoured areas after stripping to avoid double handling and to prevent deterioration. It is stockpiled when this is not possible. The following procedures are adopted to protect integrity:

- stockpiles are as low as possible with a large surface area — less than four meters high but preferably kept to two metres where possible;
- stockpiles are designed and revegetated to protect from erosion, discourage weeds and maintain active populations of beneficial microbes;
- stockpiles are placed away from drainage lines or trafficable areas;
- stormwater runoff is diverted around stockpiles;
- the length of time soil is stockpiled is kept to a minimum, ideally less than 12 months;
- stockpiles are seeded with suitable grass (or cover crop) and legume species immediately after construction, unless planned for reuse in the immediate future; and
- stockpiles are mapped and included on plans.

3.5.1.4 Waste characterisation

Waste characterisations were done as part of the *Soil and Capping Material Assessment* (SGME 2024) and the *Soil and Spoil Characterisation and Suitability* (Highlands 2018).

a Waste types, quantity and location

Wastes generated by mining include spoil and coal rejects from the coal washing plant. Site-specific wastes are also generated from historical underground workings. There is no stockpile registry specific to spoil as it is moved continuously to support mining. It is estimated that 18,000,000 bank cubic metres (bcm) of spoil is moved annually (TerraCom 2017b).

b Spoil chemical properties

A risk assessment of the mineral waste was done as part of the *Disposal Plan: Overburden, Interburden, Spoil, Coal Washery Coarse Rejects and Tailings* (The disposal plan) (SGME 2020) (Appendix F). Results indicate that:

- Spoil is low-risk mineral waste with low sulphur content of ~0.05% and low-high acid neutralising capacity (ANC). Since the landforms contain significant volumes of spoil, there is significant volumes of low-risk mineral waste available to cover smaller volumes of medium or high-risk mineral waste.
- Coal rejects are high-risk mineral waste but do not contain enriched metals. 2007 studies (EGI 2007) indicated that ~ equal portions of the samples tested had the potential to form and not form AMD.
- Tailings are high-risk mineral waste.

Three spoil samples were sent to a National Association of Testing Authorities (NATA) Australia accredited laboratory for analysis (Highlands 2018). The analyte suite included:

- ammonium;
- nitrate;
- P;
- P buffer index;
- S;
- exchangeable cations (Ca, Mg, K, Na and Al);
- pH (water);
- pH (CaCl2);
- chloride;
- EC;
- organic C;
- colour; and
- texture.

The analysis results from each specified location are in Table 29.

Table 29 Spoil sample results

Sample ID	Location	Description	Identified issues
D	555256, 7490544	Highly saline and very strongly sodic spoil which does not improve with treatment. It is not suitable for use as a surface soil in rehabilitation. The spoil requires: • significant amendment with 15 tonnes per hectare (t/ha) of Class 1 gypsum; and • covering with a non-saline and non-sodic soil.	Issues with spoil from this location include: • EC of 13.6 dS/m; • ESP of 34 %; • P concentration of 6 mg/kg; and • K concentration of 0.15 cmol/kg.
E	556079, 7490987	Highly saline and very strongly acidic spoil which is not suitable for use as a surface soil in rehabilitation. It requires: • significant amendment with 15 t/ha of Class 1 gypsum; and • covering with a non-saline and non-sodic soil.	Issues with spoil from this location include: • EC of 10.6 dS/m; • ESP of 38 %; • ESI of 0.045; • P concentration of < 5 mg/kg; and • K concentration of 0.11 cmol/kg.
F	555865, 7490727	Very strongly alkaline, moderately saline and extremely sodic spoil which is not suitable for use as a surface soil in rehabilitation. It requires: • significant amendment with 30 t/ha Class 1 gypsum; and • covering with a non-saline and non-sodic soil.	Issues with spoil from this location include: • pH of 9.7; • EC of 4.2 dS/m; • ESP of 52 %; • ESI of 0.013; • N concentration of 5.3 mg/kg; • P concentration of < 5 mg/kg; and • K concentration of 0.12 cmol/kg.

Highlands (2018)

c Disposal plan

The disposal plan (SGME 2020) describes the systems, processes and procedures used to maintain landforms and minimise environmental risks from AMD and neutral mine drainage (NMD). Objectives include:

- minimising risk of environmental harm by limiting the generation and release of acidic, saline or alkaline drainage containing dissolved metals, metalloids and non-metallic inorganic substances;
- identifying statutory obligations relating to appropriate mineral waste management and final relinquishment to be incorporated into mine management; and
- managing the long-term storage of high, medium and low-risk mineral waste to ensure physical stability, chemical stability and ability of landforms to support self-sustaining vegetation.

The CHPP is used to wash coal and manage reject disposal. Rejects are either:

- pumped to the tailings dam with additional inline flocculant added; or
- temporarily stockpiled at the CHPP.

Rejects are eventually disposed of in active mining areas and covered with at least five metres of spoil (SGME 2020).

d Rehabilitation measures

Capping potential

Low-risk spoil can be an asset for rehabilitation. Where practical, low-risk spoil can be used as a cap for high-risk mineral waste, coal rejects and waste coal. condition E9 of the EA states that waste products generated from coal washing must be covered with spoil to a depth of at least five metres. condition F10 of the EA states that all mineral waste with an ESP greater than 30 % must be covered with at least one metre of spoil with an ESP of less than 15 %.

Current estimations of the quantity of spoil needed to fulfill condition E9 and condition F10 of the EA are inaccurate because they do not account for the void becoming a residual lake. To determine actual quantity of spoil needed to fulfill condition E9 and condition F10 of the EA, further assessments would be needed to:

- determine the plausibility of using spoil instead of soil for rehabilitation in some areas;
- determine the available quantity of usable spoil; and
- determine whether a water cover can replace spoil in containing co-disposal wastes.

Amelioration

Tested spoil was typically strongly saline and strongly to very strongly sodic, necessitating amelioration with gypsum at rates of 10-20 t/ha to ensure satisfactory rehabilitation outcomes (Highlands 2018). Gypsum will be applied to the top of spoil prior to soil application and deep ripping. Deep ripping to 0.9 m would mechanically incorporate the gypsum and minimise time needed for absorption and reaction with the solid phase.

e Spontaneous combustion

Spontaneous combustion poses a risk to personnel safety with the potential for injury, fires and smoke inhalation. It is also an environmental risk as it may damage or destroy rehabilitation and surrounding areas. Appropriate management controls must be implemented to minimise risk.

Management

The *Spontaneous Combustion Management Plan* (Rio Tinto 2016a) (Appendix G) summarises the status of spontaneous combustion at the Mine and describes the controls implemented to prevent new, and manage old, occurrences.

There is a history of spontaneous combustion which can largely be attributed to the coal type, mining practices and spoil management procedures. Historical occurrences which continue to pose a risk to personnel and the environment are described by Rio Tinto (2016a); however, historical occurrences which have since been rectified are not discussed. There are three relevant categories of spontaneous combustion, namely the waste coal stockpiles, CHPP waste coal and in-situ coal.

The waste coal stockpiles comprise coal from a number of sources (Table 30). Improper management can lead to internal heating and, eventually, spontaneous combustion. There are several stockpiles assumed to pose a risk which must be capped appropriately during rehabilitation.

Locations of the stockpiles are in Figure 14 (Rio Tinto 2016a) and the management controls are in Table 31. It should be noted that these management controls were implemented prior to the update of condition E9 of the EA which allows disposal of waste in voids provided it is capped with at least five metres of spoil.

Table 30 Sources of coal in waste coal stockpiles

Source of coal	Description
Underground mine workings	The old underground mine workings were a source of oxygen and a pathway for fire to travel through the coal seams. In the early 2000s, underground workings were backfilled with spoil to rectify this issue. However, a significant quantity of burnt or burning coal was recovered and transferred to the hot coal dump which remains a spontaneous combustion risk.
Soot	Soot which is unsuitable for sale was dumped as waste and can pose a spontaneous combustion risk.
Contaminated coal	Coal recovered from the low wall via excavator or shovel which did not meet coal washing specifications was dumped and poses a spontaneous combustion risk.
	Coal which was contaminated with backfill was used in the old underground workings. Since the underground workings were backfilled with spoil in the early 2000s, this coal was dumped and poses a spontaneous combustion risk.
Dragline and cast blasting practices	Historical dragline and cast blasting practices would deposit coal near the surface of spoil piles. This poses a spontaneous combustion risk when exposed to oxygen.
Discarded seam 2 coal	Seam 2 coal was often discarded due to being highly banded and, therefore, uneconomical to mine. There is a risk of small-scale spontaneous combustion when the disposed Seam 2 coal is exposed to oxygen.
Top of coal clean-up activities	Top of coal clean-up activities sometimes resulted in coal mixing with spoil. Coal placed sporadically near the surface of spoil piles can cause water and oxygen ingress and, subsequently, pose a spontaneous combustion risk.

Rio Tinto (2016a)



Figure 14 Waste coal stockpile locations

Table 31 Waste coal stockpile management

Stockpile reference	Location description	Current management	Future management
1 and 2	Spoil contaminated by waste coal from historical dragline and cast blasting practices. These areas are not considered problematic due to their small size and low severity of spontaneous combustion.	-	Ensure remnant waste coal is buried within the final landform and a capping layer of greater than, or equal to, one metre is applied. Accurate records of observations and location of capping resources should be maintained. Alternatively, dragline and dozers can be used to mix and dissipate remnant waste coal into surrounding spoil.
3 and 4	The hot coal dump contains around one million tonnes of coal and is considered to be one of the most significant risk areas for spontaneous combustion.	The south-east is currently capped by 2-3 m of spoil; however, the surface is becoming cracked and discoloured from the underlying burning coal. There are some areas where there is no capping layer and smoke is visible. One section is capped with 3-15 m of spoil which has cracked over time due to continuous heating. There is a rehabilitated area which generates heat occasionally and could be a spontaneous combustion risk if water is removed.	Some areas may require excavation for the final landform and some areas will need to be cut below the final landform and capped. The cut spoil will be filled and compacted nearby. Caps in some areas will need to be repaired, thickened or replaced by a capping layer of as close to three metres as possible. Accurate records of observations and location of cut, fill and capping resources will be maintained. Particular caution will be exercised where water is removed.
5	This stockpile has spoil which was contaminated by coal during historical dragline and cast blasting practices. The small quantity of waste coal deems the area not problematic; however, there is a small amount of exposed coal in the highwall which may cause spontaneous combustion if not adequately managed.	Coal was pushed down-gradient and spread out by dozers before being covered by spoil. The highwall is no longer showing signs of spontaneous combustion.	Maintain or place a capping layer of at least one metre and maintain accurate records of observations and locations of capping resources.
6	Coal from historic mining in an adjacent area was buried here prior to 1985.	Waste which is prone to spontaneous combustion is buried under spoil.	
7	Coal which was contaminated from the underground backfill was dumped on the coal floor.	Some of the coal has been covered by spoil; however, there is a small uncovered portion which is not showing signs of heating.	
8	Contaminated stockpiles of waste coal.	The coal has been covered by spoil and is not showing signs of heating.	
9	Coal contaminated from the underground backfill was dumped on the coal floor. This area has been partially covered with spoil from a dump truck.	The area has been covered by spoil and is not showing signs of heating.	
10	Contaminated waste coal was dumped in this location; however, the majority has likely since been removed.	The area has been covered by spoil and is not showing signs of heating.	

Rio Tinto (2016a)

CHPP waste coal includes coal within the existing voids and coarse rejects and has very little associated spontaneous combustion risk (Rio Tinto 2016a). Reject coal has historically been used to form the wall of the washery rejects dam and in the construction of haul roads, minimising the waste available for spontaneous combustion. Coarse reject waste is identified as having a low spontaneous combustion risk based on observations from an exposed stockpile untouched for more than five years (Rio Tinto 2016a). It is assumed that rejects within the existing voids have a low-risk of spontaneous combustion; however, samples should be tested to confirm this assumption.

In-situ Coal includes that within the highwalls, end walls and sidewalls in addition to remnant coal within seams 3 and 4. The majority of spontaneous combustion risk associated with in-situ coal was mitigated when mining ended on undisturbed land (Rio Tinto 2016a). However, the height of the final landform, and whether final landform construction intersects In-situ Coal, will influence future spontaneous combustion risks.

Management practices currently implemented to minimise the risk of spontaneous combustion include:

- preventing new outbreaks by:
  - preparing an inventory of spoil; and
  - burying oxidised coal-contaminated waste to a depth of at least one metre.
- managing historical and continuous outbreaks by:
  - placing a cap of at least one metre over areas which exhibit smoke or other visible signs of spontaneous combustion prior to, or during, bulk landform reshaping;
  - reducing the angles of batter slopes;
  - track rolling batters to limit airflow; and
  - refraining from the use of water to prevent an outbreak unless open flames are identified.
- training personnel to identify and report smoke or heat associated with spontaneous combustion.

Monitoring

The *Spontaneous Combustion Monitoring Plan* (Rio Tinto 2016b) assigned thermal imaging monitoring every three years and weekly field inspections. Reviews and improvements of the management protocols will occur as triggered by unacceptable levels of carbon monoxide, hydrogen sulphide, combustibles and total volatile organic compounds.

All stockpiles in Figure 14 must be monitored. Parameters which must be measured visually include patches of dead vegetation and presence of smoke, fire or discolouration of the soil or spoil. If indicators are identified in the visual inspection, gas testing will be undertaken to determine if carbon monoxide, sulphur dioxide or nitrogen dioxide are present. Additionally, internal temperature will be measured at two metres and 10 m.

3.5.1.5 Landform design

Final landform design is a key component of rehabilitation and closure planning. It must be based on the PMLUs and NUMAs and demonstrate that land is safe and structurally stable. The *Reshape Assumptions Report* prepared by Deswik (2022) (Appendix H) outlines the final landform design, described in the following sections.

a Design plans

The final landscape is a depressed landform due to historic mining and the incorporation backfilled spoil which sits atop a void shell. This landform maximises the extent of land which can be returned to a PMLU of light grazing pasture and minimises the size of the NUMA. The final landform will not significantly modify downstream catchments.

A landform construction and rehabilitation procedure report was prepared by Rio Tinto (2016c) which outlined objectives of final landform construction including:

- reshaping and rehabilitating all areas of disturbed land which are at least five hectares in size;
- identification of:

- areas to be reshaped and rehabilitated;
- resources to perform rehabilitation; and
- the total cost of rehabilitation.

- completion of described design drawings including:
  - the drainage layout plan with the outer slope drainage configuration;
  - cross-sections of contour drains including outer slopes and crests; and
  - cross-sections of rock-lined crest drainage channels and rock chutes where applicable.

The final landform design plan with quantities of spoil requiring dozing or excavation, measured in thousand loose cubic meters (klcm), is in Figure 15 (Deswik 2022). The areas requiring cut or fill are in Figure 16 (Deswik 2022), with elevation of the final landform in Figure 17 (Deswik 2022).

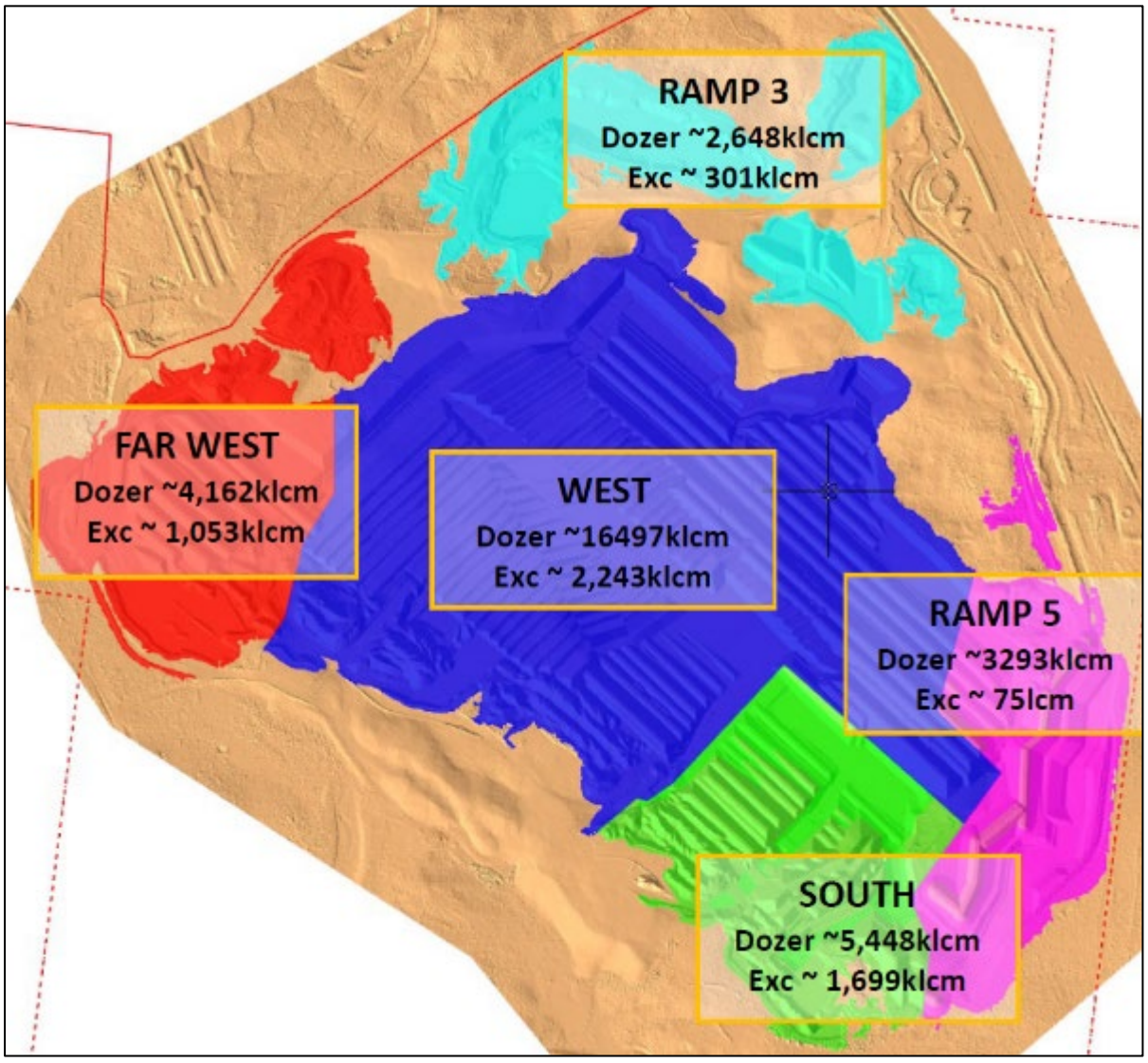


Figure 15 Final landform design

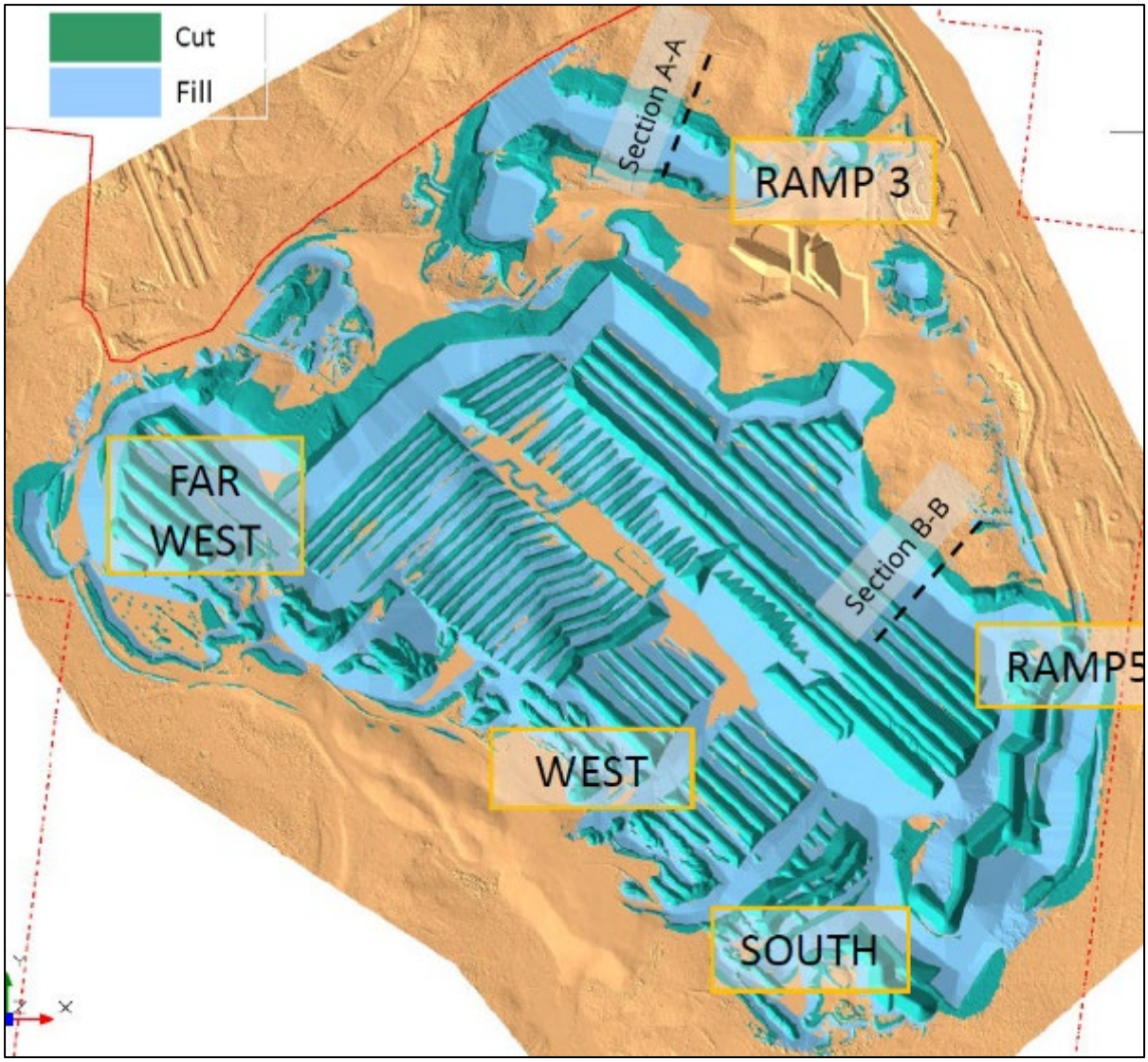
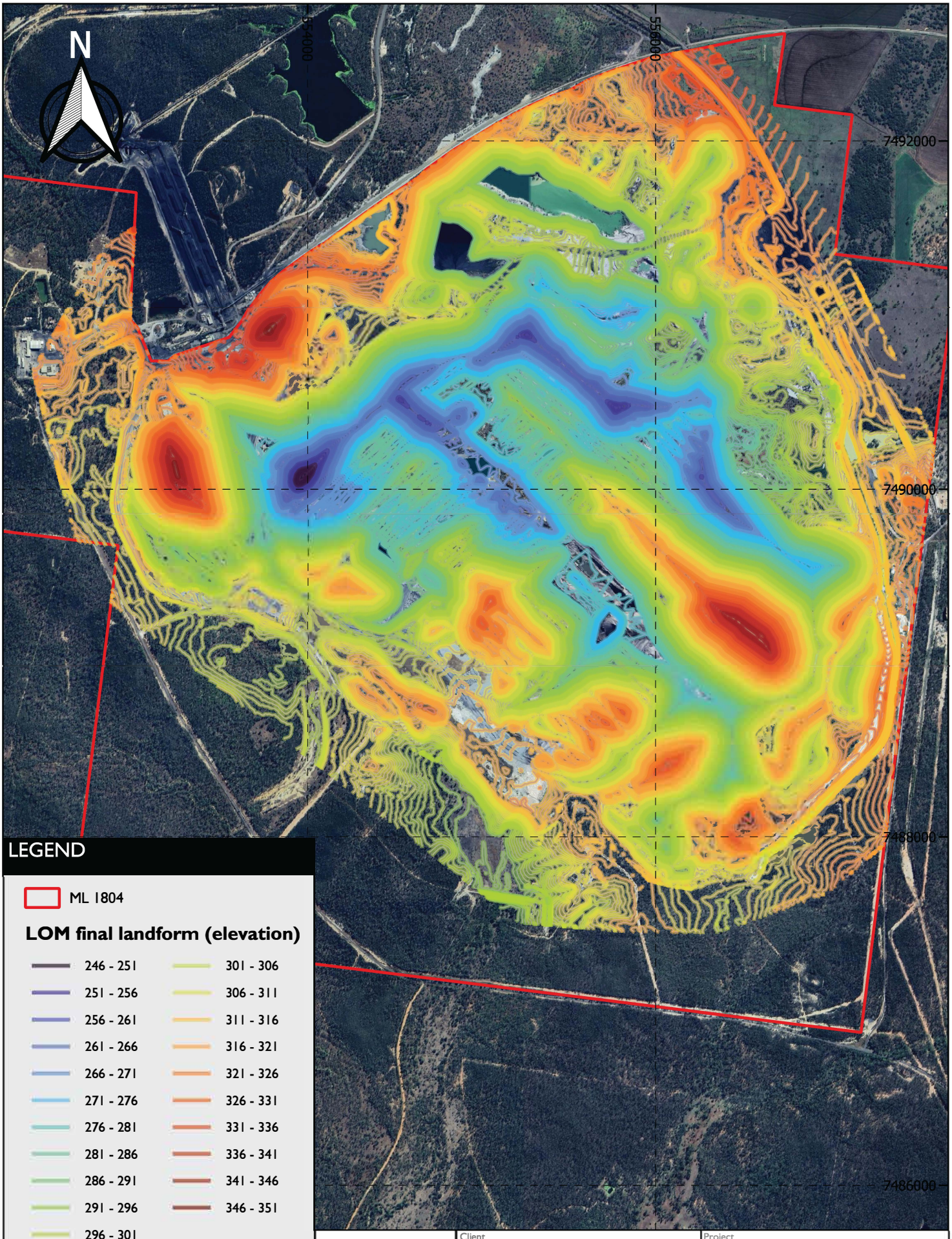


Figure 16 Cut and fill areas



LEGEND

ML 1804

LOM final landform (elevation)

246 - 251	301 - 306
251 - 256	306 - 311
256 - 261	311 - 316
261 - 266	316 - 321
266 - 271	321 - 326
271 - 276	326 - 331
276 - 281	331 - 336
281 - 286	336 - 341
286 - 291	341 - 346
291 - 296	346 - 351
296 - 301	

Scale 1 : 25 000

0 0.5 1 km

SGME

Client: TerraCom Limited

Project: Progressive rehabilitation and closure plan

Design: SGME Pty Limited 03.09.2025
Scale: 1 : 25,000
CRS: GDA2020

Title: LOM Final Landform - Elevation Map

Figure: 17

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

b Landform design plan methodology

2019 modelling was used by Deswik (2022) to decide modelling design principles. These principles included that ML area has not changed and that the final reshaped surface should be less than, or equal to, 8.5° (15 %). A final landform simulation based on the post-mining surface was generated from the mine schedule and a 15 % grade constraint. The process used to model the final landform was to:

1. generate mining solids to establish an economic mining footprint;
2. use mine scheduling to determine a practical sequence;
3. design and simulate the dump using mine scheduling to determine a post-mining surface;
4. simulate reshaping of the post-mining surface to achieve rehabilitation or closure objectives;
5. estimate the annual progressive reshaping areas based on availability; then
6. re-run a final reshaped model based on the annual progressive reshaping areas to improve the cut-to-fill ratio for each period.

Estimation of dozer push was done using split solids generated from the reshape simulation by connecting cut solids to the shortest fill solid until either the cut volume was depleted or the fill volume was exhausted and the next shortest fill block was connected. Dozer push connectors were limited to 350 m and a maximum push angle of 17°.

c Modelling of long-term stability

Geotechnical stability

Geotechnical stability of the void was assessed by Henderson Geotech Pty Limited (Henderson 2023), which concluded that the void is stable.

Erosional stability

A calibrated Water Erosion Prediction Project (WEPP) model was done to assess long-term stability of the final landform (SGME 2023) (Appendix J). WEPP modelling integrates hydrology, vegetation science, hydraulics and soil mechanics to simulate the erosion process (both detachment and transport) at a two-dimensional hillslope scale.

Laboratory testing of soil under simulated rain and overland flow was done, with a summary and recommended actions from these simulations as follows:

- landforms are considered safe and structurally stable in terms of erosion rates suitable for long-term safety;
- the WEPP model predicted erosion rates were < 10 t/ha/yr with a minimum 30 % groundcover;
- EA requires a groundcover target of ≥ 50 %;
- predicted runoff and erosion loss were below or within the adopted erosion rate threshold above which a landform will erode at an unacceptable rate (average and maximum erosion rates of < 5 t/ha/y and < 10 t/ha/y);
- erosion modelling showed an increased risk of runoff and erosion loss on bare surfaces for all landform options prior to achieving the groundcover targets;
- the use of temporary ESC measures should be considered (ie earth / mulch berms, vegetative debris and surface mulch) to manage erosion risk prior / during vegetation establishment;
- leaving current landforms as constructed is not expected to result in unacceptable runoff and erosion loss above that of the surrounding landscape or be unsuitable for human and / or animal trafficking, provided the groundcover targets are met for all landforms; and
- monitoring and inspections of all landforms should be done to identify erosion formation and / or effectiveness of ESCs measures.

Previous studies by SKM (2012) indicated that rill and gully erosion are present on all rehabilitation; however, it is generally accepted that erosion will become inactive when groundcover exceed 50 %. A recommendation was made regarding annual erosion rates which indicated that soil loss from all rehabilitation should be below 40 tonnes per hectare per year (t/ha/yr) (Rio Tinto 2016c).

d Construction methodology

Landform construction will account for geochemical properties of soil, rock and spoil. Caution will be taken with waste which is known, or assumed, to contribute to AMD, be prone to spontaneous combustion or have elevated concentrations of metals or salts. This waste will be buried away from final surfaces and will not be disturbed during construction of the final landform.

Construction of the final landform will occur in the following phases:

1. shaping and rehabilitating spoil to create an undulating landform which minimises cut and fill activities and allows for propagation of native vegetation and internal ponding;
2. completing necessary drainage works to slow and direct water flows and to minimise erosion of rehabilitation;
3. placing soil at a minimum depth of 0.1 m across the landform;
4. surface ripping where necessary;
5. revegetating the land;
6. mulching where necessary; then
7. completing remedial works.

Progressive reshaping effort involves ~1.4 million loose cubic meters (Mlcm) per year. Closure reshaping effort involves ~19.8 Mlcm of dozer push and dragline reshape and ~4.0 Mlcm of longer haul. Progressive reshape quantities by year based on the availability of land, availability of reshaping solids and estimated production capacities of equipment are provided in the landform *Reshape Assumptions Report* (Deswik 2022).

e Quality assurance and quality control requirements

Training is provided to personnel undertaking rehabilitation earthworks. This training includes demonstrating the importance of following design specifications. All rehabilitation are supervised by an AQP to ensure compliance with design and procedures. Additionally, inspections of constructed landforms are performed regularly by an AQP during the construction phase.

All equipment used for earthmoving, soil disturbance, vegetation disturbance and seeding will be inspected to ensure weed seeds are not transported to the Mine. Light vehicles belonging to contractors will undergo inspections. Seed brought for rehabilitation will be certified as being free from weeds by the supplier. These inspections and certifications will ensure the suitability of established vegetation.

f Trial methodology to verify the predicted success of the landform design

External reference sites have been established to provide baseline data which will verify the success of the final landform design. Monitoring and maintenance is described in Section 3.7.

g Limitations and assumptions of the landform design

Several assumptions were made while preparing the final landform design including the swell factor of excavated and dumped spoil.

Limitations of the landform design include possibilities of:

- small variations in the swell factor causing differences in the as-dumped profile such as the size and shape of the void; and

- changes in the mining sequence in response to market demands or operational challenges leading to a variation in the final landform design.

h Key considerations of the landform design

The landform has been designed to be generally water shedding except for areas near the void which are water retaining. A final assessment of the Mine will be needed including assessments of gully formation and of the CDA covers for infiltration or AMD formation.

The final landform will need surface water management. For example, contour drains should be built from soil and alternative measures may be incorporated if microrelief is introduced.

3.5.1.6 Cover design

a Legacy cover design

Spoil was deposited into the Ramp 2 CDA from 2000 when the wash plant operation began (ATC Williams 2010). Rejects were placed into a void formed by an embankment across two gullies during previous works. It was predicted that the CDA would become full in 2011, at which time the Ramp 3 CDA would be constructed. A cover is needed for the rejects beach.

b Design and construction methodology

Rehabilitation success relies on the management of residual waste to ensure contaminants are not released to the receiving environment. A cover system which is appropriate for encapsulating the CDA was designed to reflect a risk-based approach with the objectives of:

- being simple and easy to construct;
- maintaining structural integrity under normal external influences including erosion;
- operating as an undisturbed soil profile;
- having geochemistry similar to that of undisturbed soil; and
- limiting the potential for AMD, NMD and saline mine drainage (SD).

Ramp 2 CDA was rehabilitated in 2018-2019. The cap was constructed using spoil taken from the Ramp 3 Pit by dozer push. Testing for capacity and strength of the rejects showed that a cap of one metre would result in a moderate strength cap once consolidated. Therefore, a free-draining landform was constructed with an average capping depth of three metres. The same construction methodology will be used to construct a cover for the Ramp 3 CDA in the future; however, the thickness of the cover will be increased to at least five metres as per condition E9 of the EA.

Current rehabilitation goals focus on the construction of a cover, using spoil and soil, over the rejects beach and coarse reject embankment. This satisfies regulatory requirements for mine decommissioning and PMLUs as it minimises the risk of spontaneous combustion and AMD (ATC Williams 2010).

The final cover for the landform is a 0.15 m layer of soil across all disturbed areas. Waste characterisation (Section 3.5.1.4) indicates that the areas eroding into surrounding environments are NAF and AC, therefore an engineered cover is not needed. An EA requirement of 50% groundcover will be needed despite predicted erosion rates — meeting condition F4 of the EA.

c Capping resource availability

As in Section 3.5.1.4, an estimated 18,000,000 bcm of spoil is moved annually (TerraCom 2017b). Fertilisers or ameliorants will be needed to increase the quality of spoil prior to use as a capping resource because testing indicated that spoil is typically strongly saline and strongly to very strongly sodic (Highlands 2018). Notwithstanding, the spoil is classed as a low-risk mineral waste and it is present in quantities sufficient for use in capping high-risk mineral waste and rejects (SGME 2020).

There is a total of ~787,768.78 m^3 of stockpiled soil (Section 3.5.1.3). Fertilisers or ameliorants will be needed to improve prior to use as a capping resource because many of the stockpiles have low concentrations of N, P, K, S and Zn (Highlands 2018). Spoil may be able to replace soil assuming an assessment of its quality and quantity is favourable.

d Quality assurance and quality control measures

Quality assurance and control measures to be implemented include completion of monitoring, data analysis and reporting by an AQP on a regular basis. Records and reports will be stored by TerraCom and reviewed as necessary. Additionally, management plans will be in place which describe how deviations from the cover design can be efficiently rectified.

3.5.1.7 Water management

The management of surface and groundwater is a key consideration for long-term rehabilitation success. Operational controls are in the *Water Management Plan* (WMP) (TerraCom 2020b) (Appendix K).

a Water types

Surface water is classified by type to ensure the maintenance of appropriate management controls. The four water types are mine affected water, surface water runoff, diverted water and external water (TerraCom 2020b). These water types are discussed in the following sections.

Mine affected water

Mine affected water refers to water which has been contaminated by coal or the void and may have a high EC or exceedances in metal concentrations, hydrocarbons or various chemicals (TerraCom 2020b). Mine affected water is directed to a storage facility for operational usage such as in the CHPP or for dust suppression on haul roads. Mine affected water is managed following the WMP.

Surface water runoff

Surface water runoff refers to water from areas which have been disturbed by mining including spoil dumps and haul roads (TerraCom 2020b). It does not contain contaminants and generally has an EC of below 2,000 µs/cm; however, it may contain high sediment loads. Surface water runoff is managed following the *Erosion and Sediment Control Management Plan* (Georgiou 2012) (Appendix L).

Diverted water

Diverted Water refers to water from areas undisturbed by mining and includes runoff from rehabilitation and water from surrounding diversions.

External water

External water refers to water sourced externally and may include Mine Affected Water and Raw Water from the West Dam which is treated to be of a potable quality.

b Transfer agreement

The water management system *was* designed for the integrated project across ML 1804 and the neighbouring ML 1881 which includes the rail loop and TLO. There is a water transfer agreement between TerraCom and Glencore, the owners of CCM on ML 1881.

The *Water Transfer Agreement* relates to monitoring and maintenance of diversions, mine affected water, surface water, potable water supply and sewage treatment. There is a *Water Deed* which contains the commercial details and expectations between TerraCom and Glencore to ensure effectiveness and efficiency across both mines. (TerraCom 2020a).

c Contaminants that pose a risk to the receiving environment

Mining have potential to generate contaminants which, if not properly managed, may negatively impact the EVs of the receiving waters. Contaminants which may be generated include:

- elevated salinity;
- algae;
- altered pH;
- sediments;
- weed seeds;
- hydrocarbons;
- dissolved metals;
- total suspended solids (TSS);
- TDS; and
- altered turbidity.

d Source, pathway and fate of contaminants

Potential sources of contaminants which are likely to impact the surrounding environment are in Table 32 and a schematic diagram of the water flow pathways is in Figure 18 (WRM 2020). In summary, water from the various potential contaminant sources is transported for treatment or storage. The water is then either transferred to CCM as per the *Water Transfer Agreement* or released into the receiving environment where it is monitored (Section 3.7.2).

Table 32 Source, pathway and fate of contaminants

Potential contaminants	Source
Elevated salinity, altered pH, sediments, dissolved metals, TSS, TDS and altered turbidity.	Active spoil dumps
Sediments and weed seeds.	Soiled and seeded spoil dumps
Elevated salinity, altered pH, sediments, hydrocarbons, TSS, TDS and altered turbidity.	Voids and ramps
Sediments and weed seeds.	Soiled stockpiles
Elevated salinity, altered pH, dissolved metals, TSS, TDS and altered turbidity.	ROM or coal stockpiles
Sediments, TSS, TDS and altered turbidity.	Soiled stripped areas
Sediments, weed seeds, TSS, TDS and altered turbidity.	Cleared areas
Weed seeds.	Undisturbed areas
Elevated salinity, algae, hydrocarbons, altered pH, sediments, dissolved metals, TSS, TDS and altered turbidity.	Mine affected water dams
Elevated salinity, algae, weed seeds, altered pH, sediments, TSS, TDS and altered turbidity.	Sediment dams
Altered pH, salinity, hydrocarbons, AMD, dissolved metals, TSS, TDS and altered turbidity.	Coal rejects
Elevated salinity, sediments, altered pH, algae, TSS, TDS and altered turbidity.	Diversions
Hydrocarbons.	Dragline transformers
Hydrocarbons.	Transportable fuelling stations

TerraCom (2020b)

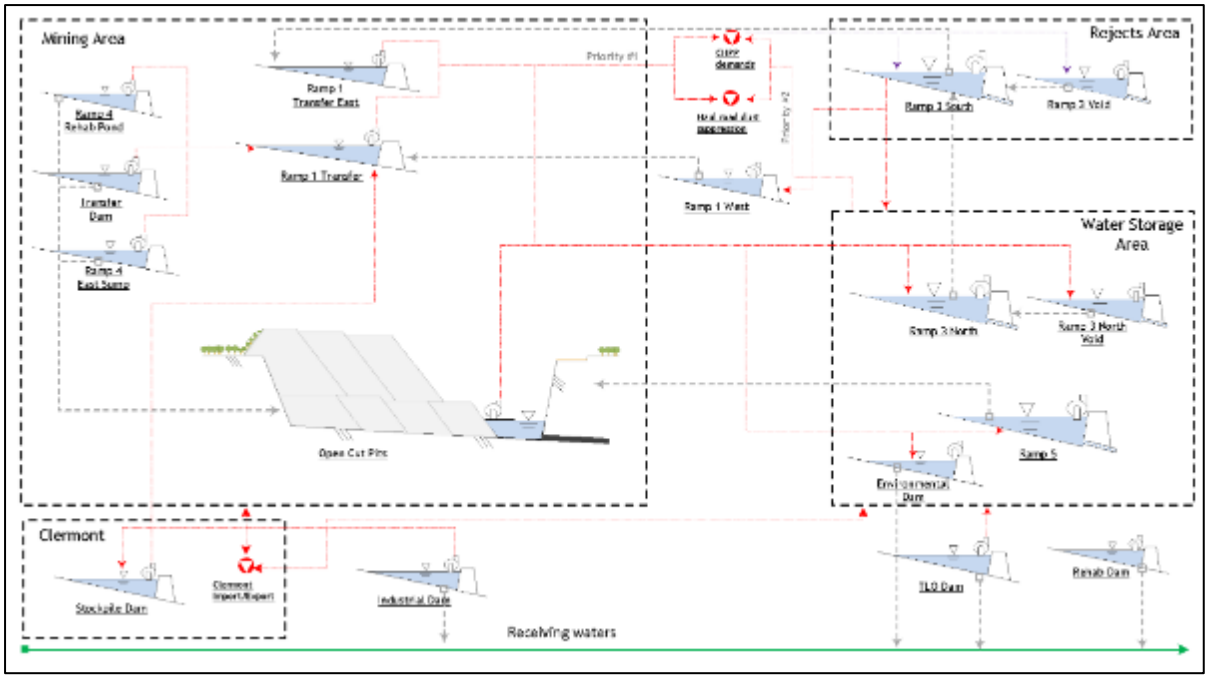


Figure 18 Water flow pathways schematic

e Infiltration and seepage intervention and collection controls

Water is typically managed as either surface water or worked water. Surface water includes clean water and potentially sediment laden water. Mine Affected Water (MAW) refers to water which has contacted industrial, processing or mining areas. The water storage infrastructure associated with the Water Management System is in Table 33.

Table 33 Water storage infrastructure

Storage name	Water type	Storage capacity (megalitres)	Overflows to
Ramp 1 transfer and ramp 1 transfer East	Mine affected water	9.355	-
Ramp 1 West	Mine affected water	1,245	Ramp 1 transfer
Environmental dam	Mine affected water	745	Receiving waters
Transfer dam	Mine affected water	265	Active voids
Ramp 4 rehabilitation pond	Mine affected water	575	Active voids
Ramp 5	Mine affected water	1,030	Active voids
Ramp 4 east sump	Mine affected water	2,140	Active voids
TLO dam	Mine affected water	5	Receiving waters
Ramp 3 South	Mine affected water	3,480	Ramp 1 transfer East
Ramp 3 void	Mine affected water		Ramp 3 South
Ramp 3 North and void	Mine affected water	2,220	Ramp 3 South
Rehabilitation dam	Surface water	325	Receiving waters
Industrial dam	Mine affected water	5	Receiving waters
Active voids	Mine affected water	9,100	Internally

WRM (2020)

f Surface water diversions

The goals of water management infrastructure are to divert, transfer and store water. Managing clean water and mine affected water ensures contaminants which have the potential to cause environmental harm are not released to receiving waters, except as permitted under the EA, to protect the EVs of the surrounding environment.

All diversions of surface water are licenced under the *Water Act 2000* and must be certified by an AQP as being in a stable condition. According to TerraCom (2017a), there are five primary creek diversions with the following functions:

- The rail loop diversion, or Breaker Creek diversion, is located north of the rail loop and diverts Breaker Creek North into Washpool Creek West to protect rail loop infrastructure and improve water harvesting for West Dam.
- The northern boundary drain transfers overflow from West Dam around the northern side of the Mine.
- The eastern diversion diverts clean water entering from the north around the Mine via the northern boundary drain along the eastern diversion and eastern diversion realignment at its confluence with Bath Creek.
- The south eastern diversion starts at the bottom of the eastern diversion after its confluence with Tea Tree Gully. It diverts flows around Ramp 5 and into the environmental dam before flowing off-lease via the original Bath Creek channel.
- The western diversion diverts clean water which enters the Mine from Breaker Creek to the north and north-west away from the mining area and the environmental dam before realigning with Bath Creek West.

Monitoring

All surface water diversions are required to have a monitoring and evaluation program that demonstrates the performance of the diversion. The monitoring and evaluation program will be done in accordance with the Index of Diversion Condition (IDC) methodology which is outlined in the *Monitoring and Evaluation Program for Bowen Basin River Diversions* (ID&A 2001) to ensure compliance with water licence conditions. Two monitoring design reports have been developed for the diversions, including:

- *Monitoring Design Report: Western Waterway Diversion — Blair Athol mine* (Alluvium 2011) (Appendix X); and
- *Monitoring Design Report: Eastern Waterway Diversion — Blair Athol mine* (Alluvium 2012) (Appendix Y).

The monitoring and evaluation program the following stages and objectives:

1. **Baseline monitoring**: To establish a baseline data set that can be used for comparison when applying for licence renewal and relinquishment.
2. **Construction monitoring**: To demonstrate works have been undertaken to specification.
3. **Operations monitoring**: To maintain channel condition, reduce risk to mining infrastructure and the environment and facilitate licence renewal.
4. **Relinquishment monitoring**: To demonstrate the diversion is operating as a waterway in equilibrium and not adversely impacting on adjoining reaches.

g Dewatering requirements

Water usage

The *Water Balance Model Report* (WRM 2020) (Appendix M) identifies the demand and supply of water at the Mine. Water demands are supplied predominantly by the Ramp 1 transfer and, when the Ramp 1 transfer is dry, the water storage area. Water usage for haul road dust suppression is ~57 kL/d based on monthly data supplied in 2018-2019. The CHPP net water usage is ~1.42 megalitres per day which accounts for ~1.27 megalitres used

for product coal per day, ~0.61 megalitres used for rejects per day, ~0.71 megalitres used for CHPP makeup per day and ~1.17 megalitres sourced from ROM coal per day.

As per the *Water Transfer Agreement,* quantities of water are transferred between the Mine and CCM when needed (TerraCom 2020a). The median predicted monthly quantity of water transferred from CCM to the Mine for 2020-2021 was 0.0 megalitres per day. The median predicted monthly quantity of water transferred from the Mine to CCM in 2020-2021 (WRM 2020) are as follows:

- January — ~285.7 and ~177.1 megalitres per month in 2020 and 2021 respectively;
- February — ~98.4 and ~92.8 megalitres per month in 2020 and 2021 respectively;
- March — ~89.3 and ~90.2 megalitres per month in 2020 and 2021 respectively;
- April — ~104.8 and ~108.7 megalitres per month in 2020 and 2021 respectively;
- May — ~79.4 and ~83.3 megalitres per month in 2020 and 2021 respectively;
- June — ~57.1 and ~75.3 megalitres per month in 2020 and 2021 respectively;
- July — ~82.4 and ~84.7 megalitres per month in 2020 and 2021 respectively;
- August — ~117.2 and ~123.6 megalitres per month in 2020 and 2021 respectively;
- September — ~207.0 and ~211.3 megalitres per month in 2020 and 2021 respectively;
- October — ~236.7 and ~249.3 megalitres per month in 2020 and 2021 respectively;
- November — ~242.3 and ~248.6 megalitres per month in 2020 and 2021 respectively; and
- December — ~226.6 and ~239.2 megalitres per month in 2020 and 2021 respectively.

Groundwater

Groundwater inflow is to the active voids and does not affect other storage infrastructure. Inflow rates from the Basalt aquifer have been reported as ~1,300 kilolitres per day (kL/d) (Rio Tinto 2016d) and 3-5 litres per second (L/s) (JBT 2012) which equates to ~350 kL/d.

Water balance findings and recommendations

The water balance model (WRM 2020) indicates that:

- there is insufficient water storage capacity to dewater the Ramp 1 Transfer and commence mining in this area within 2.5 years, necessitating the following additional storage:
  - 0.7-4.8 gigalitres (GL) under 50th percentile climate conditions; and
  - 6.5-11.8 GL under 10th percentile climate conditions;
- the minimum pumping rates to dewater the Ramp 1 Transfer within 2.5 years and allow for mining are estimated as:
  - 37-120 L/s under 50th percentile conditions; and
  - 53-133 L/s under 10th percentile climate conditions;
- over the 7.5-year LOM, the maximum inventory is predicted to:
  - increase by up to 2.4 GL under 50th percentile conditions; and
  - increase by 4.8-7.8 GL under 10th percentile conditions;
- increasing the void dewatering rate from 75 L/s to 100 L/s significantly reduces the estimated number of days of void inundation under 10th and 1st percentile climate conditions;
- the Environmental and Industrial dams have an estimated annual spill risk of < 1 %;
- the TLO Dam has a spill risk of at least 1 %; and
- recommendations to provide a more accurate representation of the Water Management System include:
  - conducting studies which determine the quantity of water stored within spoil;
  - engaging an AQP to prepare a contemporary groundwater model which predicts the quantity of inflow to the voids;
  - determining additional water storages which could be constructed to facilitate the dewatering of the Ramp 1 transfer and including this additional storage in an updated water balance model to assess its potential impact;
  - conducting regular water level monitoring of storages for parameter calibration; and
  - obtaining predicted quantities of water imported from, and exported to, CCM over the LOM.

h On-going water management and reduction requirements

It is unlikely that water management infrastructure will remain upon mine closure except for the safety bunds, fencing and signage installed around the lake for safety purposes.

Water will be managed following these plans:

- *Erosion and Sediment Control Management Plan* (Georgiou (2012);
- *Water Management Plan* prepared (TerraCom 2020b);
- *Groundwater Management Plan* prepared (TerraCom 2020a); and
- *Receiving Environment Monitoring Program* (REMP) (ESP 2020).

3.5.1.8 Revegetation

A *Revegetation Plan* has been prepared that proposed activities to establish self-sustaining vegetation communities appropriate for the PMLU of light grazing pasture (SGME 2025) (Appendix N). The following sections detail preparation needed for rehabilitation.

Application and incorporation of ameliorants

The application and incorporation of ameliorants can improve soil structure, improve moisture retention capacity, reduce the ESP, increase mineral content and correct the pH. The application of gypsum is recommended at a rate of 10-20 t/ha in areas where spoil is characterised as sodic and in areas where direct seeding will occur on sodic alkaline soils. Gypsum can be applied via agricultural spreader prior to soiling or ripping. Application of lime is recommended for acidic sodic soils. Another amelioration option is blending biosolids or other organics prior to spreading (SGME 2025b).

Soil organic carbon may need to be improved, particularly in areas where direct seeding will be applied (SGME 2025). Recommended soil ameliorants for this purpose include:

- gypsum at a rate of 10-20 t/ha;
- basaltic rock dust at a rate of 10 t/ha;
- evergreen at a rate of 2 litres per hectare (L/ha); and
- green manure plus at a rate of 1 L/ha.

Spreading of growth medium layer to a depth suitable for target vegetation

The landform is reshaped and recontoured prior to soil application. Soil is spread to a minimum depth of 0.15 m to support target vegetation. The availability of soil is in Section 3.5.1.3, which highlights a deficit. Some land may be directly seeded into spoil with the addition of ameliorants to improve spoil. Soil placement will be prioritised in native ecosystem PMLU rehabilitation areas as per the revegetation plan (SGME 2024).

The target tree species include Lemon-scented Gum, Grey Bloodwood, Red Bloodwood, River Red Gum, Forest Red Gum, Moreton Bay Ash, Mountain Coolibah, Narrow-leaved Ironbark, Siler-leaved Ironbark, Dawson River Blackbutt, *Eucalyptus exserta* (Queensland Peppermint), *Eucalyptus terminalis* (Inland Bloodwood) and *Eucalyptus leucophloia* (Snappy Gum) (SGME 2025).

The target shrub species include *Acacia bancroftii* (Bancroft's Wattle), Rosewood, *Acacia decora* (Western Silver Wattle), *Acacia holersericea* (Soapbush Wattle), *Acacia coriacea* (River Jam), *Acacia leiocalyx* (Brisbane Black Wattle), Cooba, *Acacia macrodenia* (Zig-zag Wattle), Lancewood, River She-oak, *Dodonaea viscosa* (Broadleaf Hopbush) and *Senna artemesoides* (Silver Cassia).

The target grass species include Queensland Bluegrass, *Astrebla lappacea* (Curly Mitchell Grass), *Bothriochloa pertusa* (Indian Couch Grass), *Bothriochloa insculpta* (Creeping Bluegrass), Couch Grass, *Urochloa sabi* (Sabi Grass) and *Echinochloa esculenta* (Japanese Millet).

In some areas, soil will be applied in ~10 m wide strips in an alternating pattern with bare spoil strips of the same width (TerraCom 2020c). These areas include haul roads, minor roads, the MIA and spoil. Alternating soil and bare spoil strips will have numerous benefits including:

- reducing the needed volume of soil and, therefore, doubling the potential coverage area;
- enabling the oil strip to be seeded with cover crops and native grasses to reduce erosion and runoff;
- sowing woody species on the bare strips, decreasing the competition between grass and woody species;
- cross-propagating the native grasses, trees and shrubs into the adjacent media; and
- allowing the biological components of soil to migrate into the spoil strips.

Quantities of soil, hydromulch and direct seeding resources needed for rehabilitation at each mine domain are in Table 35 and total soil accounting is presented in Table 28.

Hydromulching is a highly efficient and cost-effective method of establishing vegetation in areas which may be large, difficult to access or heavily sloped (TerraCom 2020c). It involves spraying a mix of water, seed, fertiliser, organic mulch fibres and a binder or tackifier onto the ground where vegetation establishment is desired. Hydromulching is scheduled for a portion of the Eastern Diversion and has previously been used on the Ramp 2 CDA.

Application of seed, fertiliser and irrigation

After surface preparation, soil spreading and seed treatment, seed can be spread by direct seeding, tube stock planting or aerial seeding (SGME 2025). Seed mixes will be prepared by collection from reference sites within 100 km of the Mine to ensure the vegetation:

- is acclimatised to the region;
- is resistant to local pests and diseases;
- has minimal risk of becoming a pest species itself;
- provides suitable habitat which resembles pre-mining conditions;
- requires minimal inputs such as fertiliser and water;
- helps conserve natural biodiversity; and
- blends in with local plant communities.

Rehabilitation seed species mixes are in Appendix N.

Amelioration refers to the improvement of soil and / or spoil to:

- improve soil structure;
- reduce the exchangeable sodium percentage (gypsum);
- increase mineral content;
- correct pH; and
- enhance moisture holding capacity.

Fertiliser recommended are in Section 3.5.1.3c. Cotton Sustain which is comprised of 6.1 % N, 12 % P, 22.5 % K, 2.2 % S and 0.55 % Zn. The recommended application rate was 250 kg/ha (Highlands 2018). There are no requirements for irrigation in the EA or management plans.

Soil organic carbon (SOC) has typically not been addressed during amelioration. SOC improvement may be needed, particularly for direct seeding in spoil and would be subject to future investigation. A summary of recommended soil ameliorants is in Table 34 and includes recommendations for increasing SOC (SSA 2013).

Table 34 Recommended soil ameliorants

Items	Rate	Estimated amount
Cow manure for composting	40 t/ha	58,400 tonnes
Inoculant for composting	50 g/tonne cow manure	2,920 kg
Gypsum	10 t/ha	14,600 tonnes
Basaltic rock dust	10 t/ha	14,600 tonnes
Evergreen	2 L/ha	2,920 L
Green manure plus	1 L/ha	1,460 L

Table 35 Growth media quantities needed for rehabilitation

Domain		Area (ha)	Soil (ha)	Strip placement (ha)	Hydromulch (ha)	Direct seeding (ha)	Growth media not needed (ha)	Rationale
Exploration		29.4	-	-	-	29.4	-	The exploration area contains small areas of disturbance such as overgrown tracks and old drill holes.
Infrastructure	Soil stockpiles	40.7	-	-	-	-	40.7	Not needed.
	Haul road	86.3	-	86.3	-	-	-	-
	Minor roads	34.9	-	-	-	-	34.9	-
	CHPP	12.6	-	12.6	-	-	-	-
	Industrial area	46.4	-	46.4	-	-	-	Mine infrastructure area.
	Laydown areas	19.2	-	-	-	19.2	-	-
	TLO	12.0	-	-	-	-	12.0	The TLO was constructed on unmined areas which had been disturbed by the construction of the diversion and as a location for soil stockpiles. Once the working surface has been removed, the deeper black soils will be exposed for revegetation.

Domain		Area (ha)	Soil (ha)	Strip placement (ha)	Hydromulch (ha)	Direct seeding (ha)	Growth media not needed (ha)	Rationale
	Borrow voids	2.3	-	2.3	-	-	-	Small areas of borrow voids from the construction of the environmental dam remain. Strip placement of soil will enable the surrounding vegetation to be re-established.
	Reshaped areas	64.6	64.6	-	-	-	-	-
Spoil	Spoil	493.8	493.8	-	-	-	-	-
	Tailings beach	6.6	6.6	-	-	-	-	Ramp 3 CDA is expected to be ~six hectares once capped.
Tailings	Active pit	84.0	84.0	-	-	-	-	-
Pits	Voids	291.6	-	-	-	-	291.6	-
Water management	Storages	26.0	-	-	-	-	26.0	Storages require removal and rehabilitation.
	Cleared	8.6	-	-	-	-	8.6	The vegetation has only been cleared without the surface being disturbed.
Miscellaneous	Creeks and diversions	66.0	-	18.2	17.5	-	30.3	Eastern Diversion only — ~17.5 ha.
	Historical rehabilitation — RIO	344.5	-	-	-	-	344.5	Finished rehabilitation.
	Rehabilitation — TER	102.9	-	-	-	-	102.9	Finished rehabilitation.

Domain		Area (ha)	Soil (ha)	Strip placement (ha)	Hydromulch (ha)	Direct seeding (ha)	Growth media not needed (ha)	Rationale
	Proposed rehabilitation	135.0	135.0	-	-	-	-	To be finished within estimated rehabilitation cost period.
	1,688	784.0	165.8	17.5	48.6	672.1	-	

3.5.2 Co-disposal areas

3.5.2.1 Environmental authority requirements

Conditions E9-E12 of the EA identify spoil and reject disposal procedures which are in Table 36.

Table 36 Reject disposal requirements of the environmental authority

Condition number	Condition
E9	Waste products generated from coal washing on or after 30 August 2017 must be disposed of in voids and covered with at least five metres of spoil.
E10	A spoil and rejects disposal plan must be implemented which, at a minimum, considers: • spoil and reject characterisation to predict the quality of runoff and seepage generated such as salinity, acidity, alkalinity and dissolved metals, metalloids and non-metallic inorganic substances; • progressive spoil and rejects sampling and characterisation must consider dispersive and non-dispersive spoil in addition to salinity, acid and alkali producing potential and metal concentrations; • a waste balance and disposal plan which considers placement and encapsulation of PAF and acid forming rejects and spoil to minimise AMD potential; • a sampling program which verifies the placement and encapsulation of PAF and acid forming rejects and spoil; • the frequency of plan review and assessment; • indicators and criteria for plan assessment; • a rehabilitation strategy; and • a plan for monitoring, rehabilitation, research and / or trials.
E11	The spoil and rejects disposal plan must be prepared by an AQP and reviewed every two years. It must be made available to the administering authority upon request.
E12	The design and construction of rejects dewatering cells must ensure that runoff and seepage is contained within the Water Management System.

3.5.2.2 Disposal methodology

The Disposal Plan (SGME 2020) (Section 3.5.1.4c) which complies with conditions E9-E12 of the EA as per Table 36 states that:

- CHPP washes coal and manages the disposal of rejects;
- thickened rejects are either:
  - pumped to the rejects dam with inline flocculant; or
  - stockpiled at the CHPP;
- rejects are disposed of in the void; and
- the void is covered with at least five metres of spoil.

3.5.2.3 Rehabilitation strategy

The final landform will be constructed by excavating, loading, hauling and dozing spoil to the needed position with a maximum slope angle of 15 % in incompetent rock and 30 % in competent rock (SGME 2020). Spoil which is considered high-risk due to potential spontaneous combustion or generation of AMD or NMD will either have an engineered cover or be buried under a minimum of one metre of low-risk track rolled spoil.

After rehabilitation, the final land use will be consistent with the underlying land tenure and will not pose a significant risk to the EVs of the receiving environment. Some infrastructure such as roads, powerlines, water storages including the lake and buildings may remain after closure if necessary for ongoing monitoring or future land use.

3.5.3 Final void

3.5.3.1 Voids in flood plains

Section 41C of E*nvironmental Protection Regulation 2019* (EP Regulation) states decision considerations for a void located wholly or partly in a flood plain as:

> *A void is considered to be in a flood plain if modelling shows that, when all relevant activities carried out on the land have ended, the land is the same height as, or lower than, the level modelled as the peak water level 0.1% annual exceedance probability (AEP) for a relevant watercourse under the guideline Australian Rainfall and Runoff (2019) (ARR).*

Hydrologic and hydraulic modelling (HydroBalance 2025a) (Appendix V) was done to assess flooding characteristics for the 0.1% AEP design flood and PMF as per DES (2019 & 2020) and EP Regulation requirements.

HydroBalance have concluded that the final landform will comply with condition F16(d) of EA EPML00876713.The eastern and western diversion drains have sufficient capacity to contain the 0.1% AEP event, therefore the risk of flood ingress into the final landform is very low.

The final landform will not significantly modify stream catchments downstream and flooding risk is negligible. Hence, risk of the final landform contributing to flooding or erosion in the downstream environment is low and final landform stability will not be impacted from flooding. The following is of note:

- The Mine is not located within the flood extent of a relevant watercourse defined by DES (2019). Notwithstanding, the Eastern and Western diversion drains are sufficient to prevent the ingress of floodwaters into the final landform.
- Flooding is characterised by channelised flows within the eastern and western diversion drains, with some overbank flows along the western diversion drain. Flows are generally deep and exhibit high velocities, particularly in the confined sections along the eastern diversion drain. It is recommended that the rehabilitation words in the eastern diversion drain are undertaken prior to closure.

3.5.3.2 Void closure plan

The void closure plan has been developed using:

- *Residual Void Management Plan* (RVMP) (SGME 2025c) (Appendix P);
- *Final Void Hydrology Report* (HydroBalance 2025b) (Appendix D);
- *Blair Athol Groundwater Numerical Modelling Report* (hydrogeologist.com.au 2024), and
- *Geotechnical Stability of Residual Voids* (Henderson Geotechnical 2023).

a Options available for minimising the void area and volume

As discussed in Section 3.5.1.5a, the final landform maximises the extent of land which can be returned to a PMLU and minimises the size and extent of the NUMA. This will be achieved by progressively backfilling the void

with spoil using trucks, hydraulic excavators and bulldozers. However, due to the geometry of coal measures, namely their shallow dip and basinal nature, it is unlikely that complete void backfilling can occur. Consequently, focus for rehabilitation is the creation of a safe and stable landform by filling as much of the void as possible and develop pit walls with appropriate factors of safety. Altering the slope angle and length was considered; however, calculations indicated that this would not significantly impact the maximum surface area of the void.

Compliance with condition F10 of the EA will be possible by disposal of coal washery wastes and spoil with exchangeable sodium percentage (ESP) >30% into the void and covering it with a minimum of one metre of spoil (ie with ESP <15%) prior to rehabilitation.

For the safety and stability of the NUMA, void walls will be constructed with factors of safety of above, or equal to, 1.5. Slopes, bunding and fencing will also be constructed to minimise access by humans and wildlife. Human access will be further minimised by installing of safety signage.

b Void dimensions

The maximum surface area of the void is 291.6 ha (HydroBalance 2025b). The depth of the void will vary based on the volume of extracted coal and the volume of swelled spoil. A deficit will exist if the volume of extracted coal exceeds the volume of swelled spoil causing the backfilled void to be below the original ground level.

c Proposed final slope angles

Condition F4 of the EA states that the slope angles are to be a maximum of 15 % in incompetent rock and 30 % in competent rock. The RVMP indicates that flattening the void slope angles is needed to ensure geotechnical stability of the highwalls and end walls (SGME 2025c). Closure options which fulfill this parameter include (SGME 2025c):

- regrading backfilled spoil to a 15 % slope on the low wall; and
- cast blasting the highwall into the void to regrade the blast spoil and slopes to a maximum of 30 %.

The impacts of a slightly larger void size due to minimised highwall and end wall slopes are considered less significant than the potential impacts of unsafe slopes.

d Void wall geotechnical and geochemical stability

Results of the stability analyses (Henderson Geotechnical 2023) indicate that the lowest factors of safety found within the proposed void design were 1.84 and 1.92. These values exceed the minimum acceptable factor of safety for long-term slope stability of 1.5. Therefore, the void is considered to have geotechnical stability.

e Void hydrology

HydroBalance Pty Limited (2025b) was engaged by SGME on behalf of TerraCom to assess residual void hydrology and long-term water quality behaviour (500 years) (Appendix D).

Due to topography, rainfall runoff reports to the residual void, which forms the lowest elevation. HydroBalance (2025b) found that the residual void:

- reaches equilibrium after ~75 years and oscillates between ~ 276.0-284.1 m AHD;
- maximum modelled water level is ~20.9 m below the pit spill point, and there is no risk of overtopping;
- salinity increases over time because of the closed-loop system with no mechanism for salt removal (Figure 20);
- salinity concentration exceeds 25,000 microsiemens per centimetre (µS/cm) after ~300 years, and 50,000 µS/cm at 500 years.

A post-mining conceptual groundwater model was made by JBT (2012) and is in Figure 19.

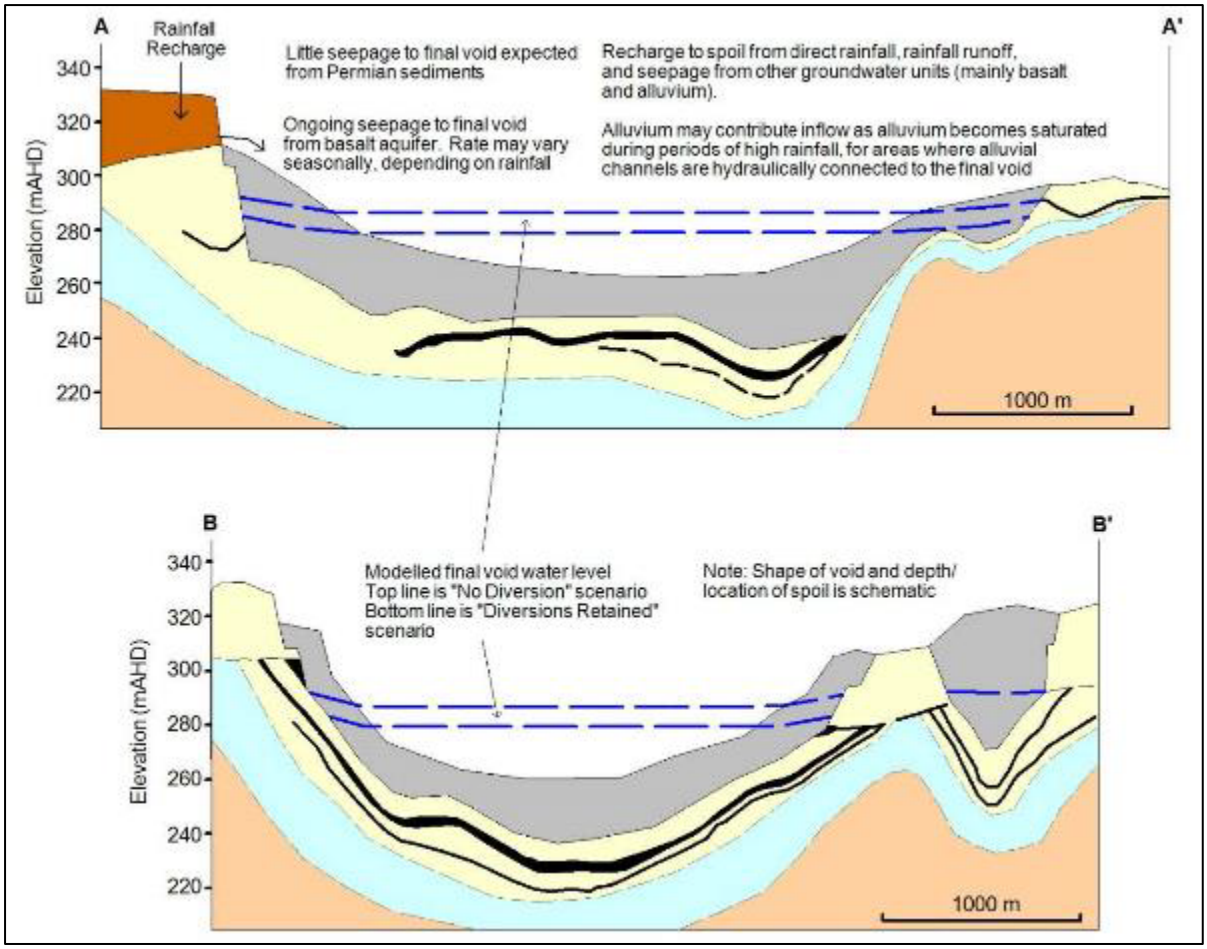


Figure 19 Post-mining conceptual groundwater model

In summary, void modelling indicates:

- void sub-floor level is 214.0 m AHD;
- final landform floor level is 246.0 m AHD;
- overflow level is 305.0 m AHD;
- minimum observed groundwater level is 295 m AHD;
- modelled average long-term water level is 276.6 m AHD; and
- modelled peak long-term water level is 282.0 m AHD.

Overflow potential was calculated during 1 % AEP, 0.1 % AEP and 0.05 % AEP storm events over a 72-hour period with an initial lake depth of the maximum equilibrium level, 284.1 m AHD (HydroBalance 2025b). The results of the storm event modelling are in Table 37.

Table 37 Lake storm event modelling results

Storm event (AEP)	Rainfall depth (mm)	Runoff volume (megalitres)	Final volume (megalitres)	Final level (m AHD)	Water level change (m)
1 %	327	5,070	36,263	285.8	1.7
0.1 %	489	7,582	38,775	286.6	2.5
0.01 %	545	8,450	39,643	286.8	2.7
PMF	1,770	27,444	58,637	291.8	7.7

In terms of water quality, the lake is predicted to have progressively increased salinity because it is a closed-loop system with no salt removal mechanisms as discussed in Section 3.4.2.1 (HydroBalance 2025b). The predicted long-term salinity concentration and load of the void is in Figure 20 (HydroBalance 2025b).

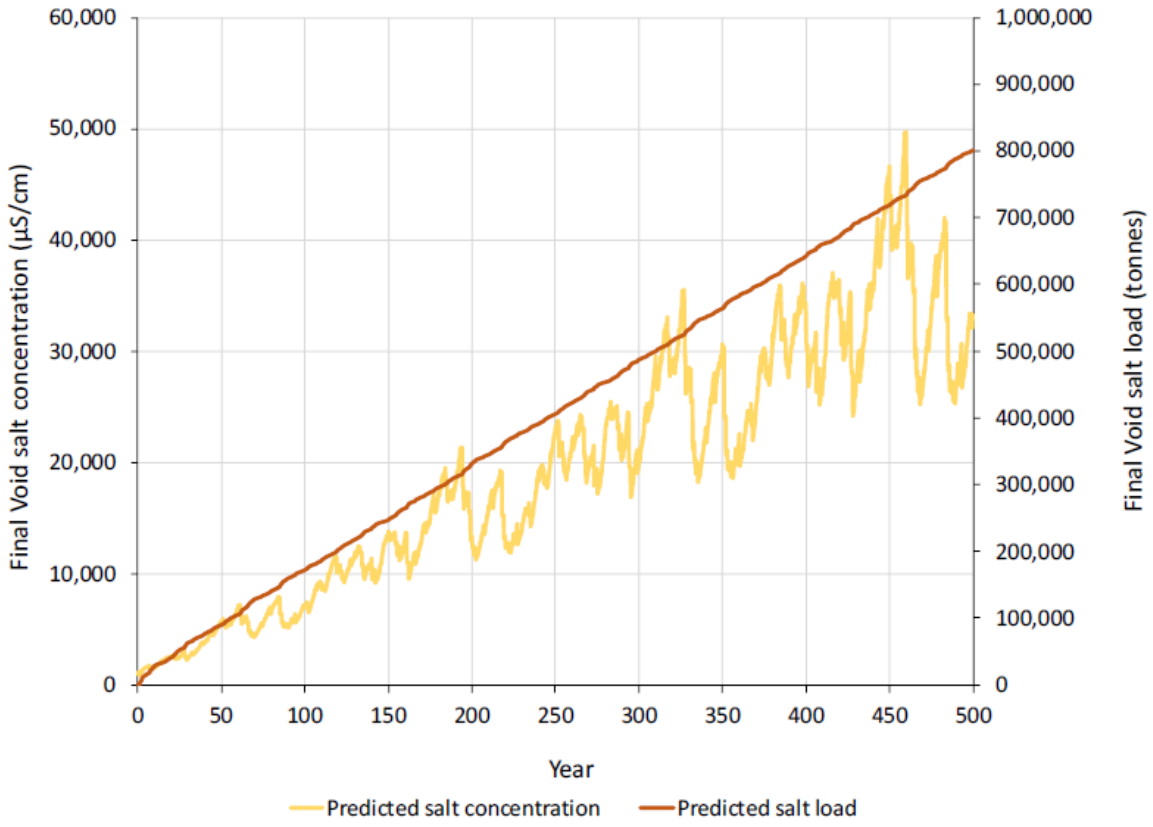


Figure 20 Final void long-term predicted salinity concentration and load

Hydrogeologist.com.au (2024) was engaged by SGME on behalf of TerraCom to develop a 3D numerical groundwater flow model to simulate long-term post-closure effects of the Mine on groundwater levels (Appendix Q). Two cross sections were generated to demonstrate the relationship of the post closure groundwater levels. The cross sections demonstrate that the final pit void lake will remain a sink into perpetuity.

f 3D void design plans

A 3D void design was generated by Henderson Geotechnical (2023) which shows the final mined shell upon which the lake will be located (Figure 21; Henderson 2023).

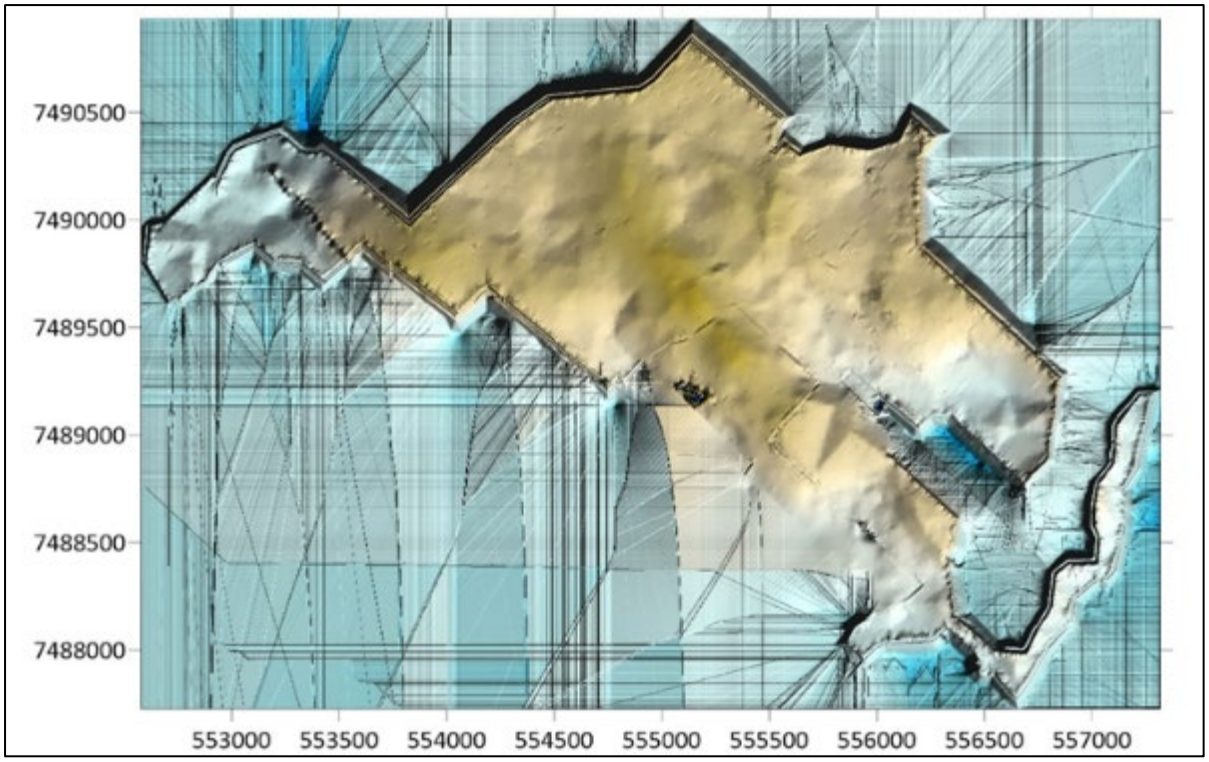


Figure 21 Void design plan

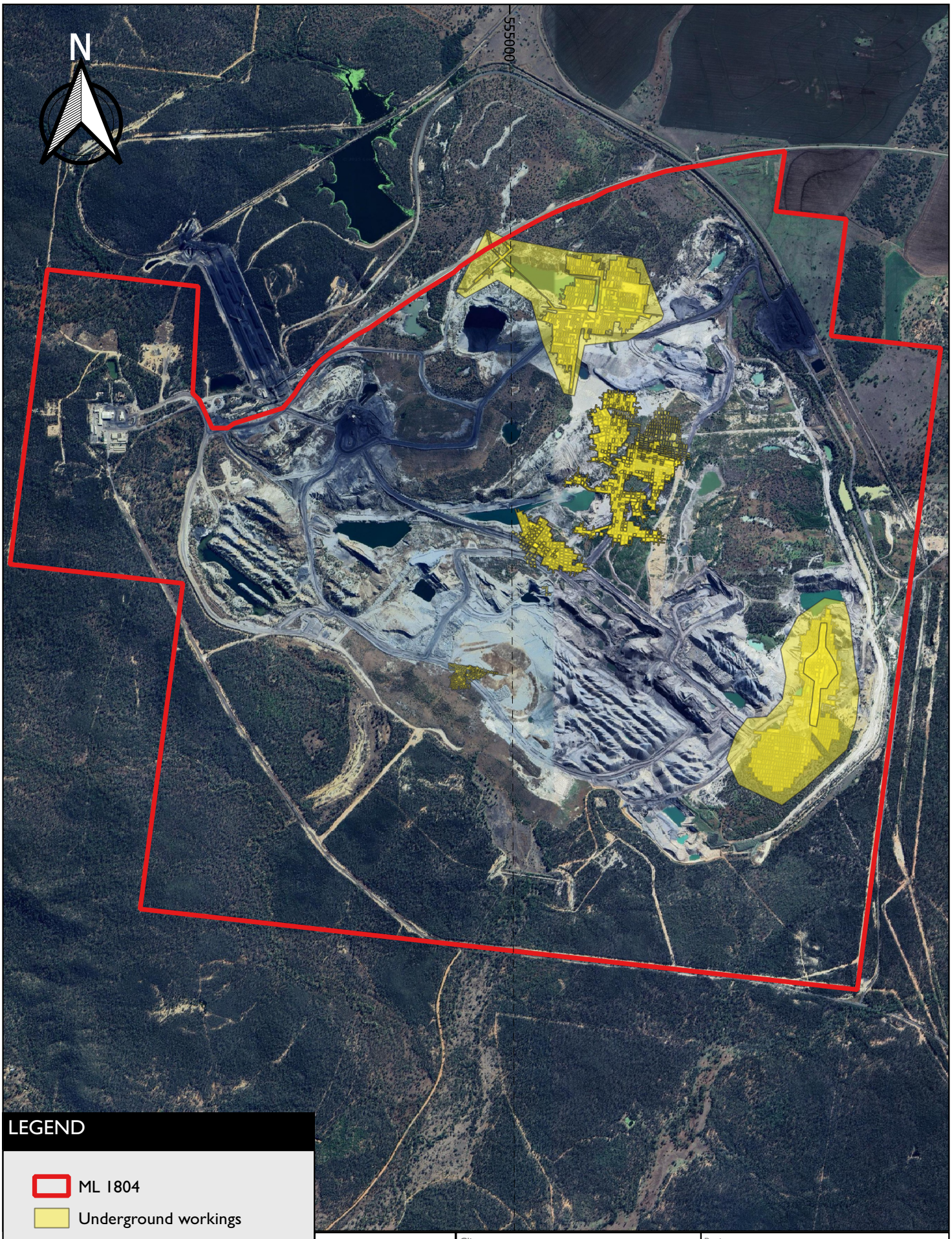
g Rehabilitation strategies

Under condition F13 of the EA, the void must not cause significant environmental harm to land, surface waters or any recognised groundwater aquifer, other than the environmental harm caused by the existence of the void itself. Recommended void rehabilitation strategies which comply with this condition can be summarised as:

- backfilling as much of the void as possible with spoil;
- constructing void walls with factors of safety of more than, or equal to, 1.5;
- constructing slopes, bunding, fencing and signage for safety purposes;
- limiting the surface area of the void to 291.6 ha;
- having a maximum slope angle of 15 % in incompetent rock;
- having a maximum slope angle of 30 % in competent rock;
- flattening existing void slope angles to ensure geotechnical stability of highwalls and end walls;
- regrading the backfilled spoil to a slope of no more than 15 % on the low wall;
- cast blasting the highwall into the void and regrading blasted spoil and slopes to a maximum angle of 30 %; and
- allowing the void to naturally fill with water to form the Lake with an equilibrium level which will not overflow into surrounding surface water or intersect with surrounding groundwater.

3.5.4 Underground mining

There is no current or scheduled underground mining. There are historic underground mine workings; however, they were backfilled with spoil in the early 2000s and do not require further management (Rio Tinto 2016a). Spatial data of the extent of the historical underground mining indicates that they are incorporated into the extent of the current open cut mining area. This is extent is provided in Figure 22.



LEGEND

- ML 1804
- Underground workings

Scale 1 : 17 500

0 0.5 1 km

SGME	Client: TerraCom Limited	Project: Progressive rehabilitation and closure plan	
	Design: SGME Pty Limited 5.09.2025 Scale: 1 : 17,500 CRS: GDA2020	Title: Underground workings	Figure: 22

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

3.5.5 Built infrastructure

3.5.5.1 Infrastructure to be decommissioned and methods for decommissioning

Some infrastructure such as roads, powerlines, water storages and buildings may remain if necessary for future monitoring or land use purposes (SGME 2020). Notwithstanding, the built infrastructure described in Section 3.1.2.2 will all be decommissioned and removed upon achieving a stable final landform provided that there are no maintenance requirements or ownership transfer agreements in place. This includes infrastructure for:

- transport;
- Port and Rail;
- resource sourcing;
- water management;
- product handling;
- storage areas;
- voids;
- historical exploration; and
- waste management.

Services such as water, power and telecommunications will be decommissioned provided they are not needed by CCM or other neighbouring, or future, landholders. Buildings including those for administration and staff accommodation will be demolished. Concrete and non-recyclable waste will be disposed of in the void. Where possible, waste such as non-ferrous scrap and heavy gauge steel will be cut to size and removed for recycling. Carbonaceous waste, remaining spoil, and rejects will be disposed of at depth in spoil dumps or in the void.

Infrastructure area surfaces will be ripped, contoured, treated and revegetated as per Section 3.5.1.8. A contamination assessment will be done by an AQP to ensure infrastructure areas and remediation will not cause significant harm to the surrounding environment. Monitoring and maintenance will be ongoing as per Section 3.7.

3.5.6 Summary of key rehabilitation and management activities

Mining is a temporary land use. Upon closure, TCL aims to return all disturbed areas, other than the void NUMA (Section 3.4), to a PMLU of either light grazing pasture or native ecosystem (Section 3.3). Existing rehabilitation is described in Section 3.1.4.2. A summary of rehabilitation and management activities is described in the *Blair Athol Management Plan: Mine Closure* (SGME 2025d) (Appendix W) and includes the following to be completed upon mine closure:

- water management activities including:
  - upholding the *Water Transfer Agreement* with Glencore;
  - installation of diversion drains;
  - implementing collection controls and infiltration and seepage intervention;
  - fulfilling dewatering requirements; and
  - monitoring to maintain EVs and protect downstream catchments;
- waste management activities including:
  - disposing of rejects in the active mining areas under a cover of at least 5 m of low-risk spoil which has been treated with gypsum; and
  - monitoring and managing spontaneous combustion;
- built infrastructure management activities including decommissioning and disposing of all services and infrastructure;
- soil and capping resource management activities including:
  - treating soil with gypsum and Cotton Sustain fertiliser; and
  - re-testing quality after treatment and prior to use for rehabilitation purposes;

- landform construction and revegetation activities including:
  - reshaping the land;
  - constructing the final landform;
  - applying and incorporating ameliorants and fertilisers;
  - completing surface preparation;
  - spreading growth media; and
  - collecting, treating and spreading seeds; and
- void construction and revegetation activities including:
  - backfilling as much of the void as possible with spoil;
  - constructing the void landform using the following dimensions and angles:
    - a maximum surface area of 291.6 ha;
    - a maximum slope in incompetent rock of 15 %; and
    - a maximum slope in competent rock of 30 %;
  - constructing void walls with factors of safety of greater than, or equal to, 1.5; and
  - allowing the void to naturally fill with water.

3.5.6.1 Relationship to the progressive rehabilitation and closure plan schedule

Rehabilitation activities and management activities which are planned for after mine closure and their relationship to the PRC plan schedule are in Table 38 and Table 39, respectively.

Table 38 Rehabilitation milestones and strategies

Milestone reference	Rehabilitation milestone	Strategies	Applicable RAs	Area (ha)	Rehabilitation timing
RM1	Infrastructure decommissioning and removal	a) decommissioning and removing services; b) removing infrastructure; c) decommissioning dams; d) removing all general and regulated waste; and e) decommissioning or converting water or monitoring bores, exploration drill holes.	RA3, RA4, RA5, RA6, RA7 and RA10	249.01	2033-2034
RM2	Remediation of contaminated land	a) removing or remediating contaminated land to a PMLU of light grazing pasture or native ecosystem; b) all contaminated sediment is removed; c) all plastic liners are removed and disposed; d) site investigation report is prepared by an AQP; and e) certification from an AQP that all contaminated land has been removed.	RA3, RA4, RA5, RA6, RA7, and RA10	249.01	2034-2035
RM3	Cover system installation	a) certification by an AQP that waste products generated from the washing of coal are buried under spoil with a minimum of thickness of five metres.	RA2	3.97	2033-2034
RM4	Landform construction and reshaping or reprofiling	a) reshaping or recontouring the landform; b) install drainage management structures; c) all major earthworks completed; d) stable landform and slope angles ~15 % average; and e) landform is assessed as geotechnically stable by an AQP. **Diversions (RA12)**	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA9, RA10 and RA12	1,044.64	2023-2040

Milestone reference	Rehabilitation milestone	Strategies	Applicable RAs	Area (ha)	Rehabilitation timing
		f) certification from an AQP that diversions are constructed as per the requirements of the certified design, and in accordance with DNRME's Guideline: *Works that interfere with water in a watercourse for a resource activity — watercourse diversions under the Water Act 2000* (OSW/2019/4599).			
RM5	Surface preparation	a) placement of a minimum of 0.15 m of soil; b) contour ripping finished; and c) fertiliser applied at rates of 250 kg/ha.	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA9 and RA10	1,009.76	2023-2040
RM6	Revegetation (light grazing pasture)	a) direct seeding at application rate determined by an AQP; b) seed mix applied contains a suitable range of trees, shrubs and perennial grass species and suitable leguminous species consistent with the surrounding area; and c) stock exclusion fencing installed until achieving surface requirements for grazing pasture.	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9 and RA12	1,312.95	2023-2040

Milestone reference	Rehabilitation milestone	Strategies	Applicable RAs	Area (ha)	Rehabilitation timing
RM7	Revegetation (native ecosystem)	a) Seed mix applied contains species consistent with RE 11.1.11 or RE 11.3.4; b) Species comprise ≥ 20 % of the average number of species described in RE 11.1.11 or RE 11.3.4 technical descriptions; c) Average height of each layer is ≥ 70 % of average layer height described in RE 11.1.11 or RE 11.3.4 technical descriptions; d) Average fractional cover of each layer is ⩾ 50 % of average fractional cover described in RE 11.1.11 or RE 11.3.4 technical description.	RA10 and RA11	41.59	2023-2040
RM8	Achievements of surface requirements (light grazing pasture)	a) species richness and diversity achieved is consistent with the sown seed mix and similar to reference sites; b) revegetation ≥70% comparable to analogue site; c) no active areas of gully erosion and drainage follows appropriate drainage paths; d) certification from an AQP that rehabilitation is resilient to fire; and e) certification by an AQP that weeds and pest species are in densities no greater than at analogue sites. **Diversions (RA12)** f) an AQP prepares an assessment report annually based on the Index of Diversion Condition (IDC) assessment, where: a. the diversions have achieved a target Geomorphic Index score of ≥ 95 % relative to baseline condition.	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9 and RA12	1,312.95	2028-2047

Milestone reference	Rehabilitation milestone	Strategies	Applicable RAs	Area (ha)	Rehabilitation timing
		b. the riparian corridor has achieved a target Riparian Index score of ≥ 70 % relative to baseline condition.			
RM9	Achieving surface requirements (native ecosystem)	a) for RE 11.1.11 species richness ≥ 15 native species: – tree species richness ≥ 2 species, including Yellow Jacket (*Corymbia liechhgardtii)*; – shrub species richness ≥ 3 species; – grass species richness ≥ 5 species; and – forb and other species richness ≥ 5 species. b) For RE 11.3.4, species richness ≥ 18 native species: – tree species richness ≥ 3 species, including Forest Red Gum (*Eucalyptus tereticornis);* – shrub species richness ≥ 4 species; – grass species richness ≥ 6 species; and – forb and other species richness ≥ 5 species. c) revegetation ≥ average fractional cover derived from RE technical descriptions for RE 11.1.11: – trees cover ≥ 57.7 %; – shrubs ≥ 36.9 %; and – grasses and forbs cover ≥ 29.3 %. d) revegetation ≥ average fractional cover derived from RE technical descriptions for the RE 11.3.4: – trees cover ≥ 37.1 %; – shrubs ≥ 4.3 %; and – grasses and forbs cover ≥ 61.6 %. e) no active areas of gully erosion and drainage follow appropriate drainage paths;	RA10 and RA11	41.59	2028-2045

Milestone reference	Rehabilitation milestone	Strategies	Applicable RAs	Area (ha)	Rehabilitation timing
		f) certification from an AQP that rehabilitation is resilient to fire; and g) certification by an AQP that weeds and pest species are in densities no greater than at analogue sites.			
RM10	Achieving PMLU to a stable condition (light grazing pasture)	a) certification from an AQP that the area has achieved stable condition; b) certification from an AQP that the landform achieved a factor of safety ≥ 1.5; c) maximum erosion rate of < 10 t/ha/yr; d) total percentage groundcover (vegetation, litter and rock combined) is > 70 %; e) there are no declared Noxious Class 1 or Class 2 weeds; f) native fauna identified at reference sites are present or indicators of these species are recorded; g) water quality complies with *Table C7* of EPML00876713. **Diversions (RA12)** h) prepare assessment report by an AQP certifying that the diversion is operating in accordance with, DNRME Guideline: *Works that interfere with water in a watercourse for a resource activity — watercourse diversions under the Water Act 2000* (OSW/2019/4599) criteria and is in a stable condition. The report will include data from the IDC assessment, showing that Geomorphic Index has maintained a score of ≥ 95 % and the Riparian Vegetation Index has maintained a score of ≥ 70 % for two consecutive years.	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9, and RA12	1,312.95	2030-2050

Milestone reference	Rehabilitation milestone	Strategies	Applicable RAs	Area (ha)	Rehabilitation timing
		i) certification from AQP that the diversions have achieved a stable condition, and are able to sustain a 0.1% AEP flood event.			
RM11	Achieving PMLU to stable condition (native ecosystem)	a) certification from an AQP that the area has achieved stable condition; b) certification from an AQP that the landform achieved a factor of safety ≥ 1.5; c) total percentage groundcover (vegetation, litter and rock combined) is ≥50 %; d) maximum erosion rate of < 10 t/ha/yr; e) there are no declared Noxious Class 1 or Class 2 weeds; f) native fauna at reference sites are present or indicators of these species are recorded; and g) water quality complies with *Table C7* of EPML00876713.	RA10 and RA11	41.59	2029-2055

Table 39 Management milestones and strategies

Milestone reference	Management milestone	Strategies	Applicable RAs	Area (ha)	Timing
MM1	Conversion of the void into a permanent waterbody	a) all major earthworks finished.	IA1	291.6	2033-2043
MM2	Highwall and low wall treatment	a) maximum slope of 30% in competent rock; b) maximum slope of 15% in incompetent rock; c) factor of safety ≥1.5; and d) void complies with condition F17 of EA EPML00876713.	IA1	291.6	2033-2043

Milestone reference	Management milestone	Strategies	Applicable RAs	Area (ha)	Timing
MM3	Achieving surface requirements	a) fencing of 1.8 m high erected around the perimeter of the void; b) warning signage posted around the perimeter of the void following the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland*: c) safety bund constructed at two metres in height, four metres in base width and 10 m beyond the area which may be affected by void edge instability; and d) direct seeding of low walls with species and application rates determined by an AQP.	IA1	291.6	2033-2043
MM4	Achieving improvement	a) certification from an AQP that the void will not cause environmental harm outside of the tenure boundary: b) certification from an AQP that the void is safe to humans and livestock; and c) certification from an AQP that the water level in the void will not cause environmental harm to the surrounding environment.	IA1	291.6	2033-2043

3.6 Risk assessment

The International Organisation for Standardisation (ISO) 31000:2018 *Risk Management — Guidelines* describes risk management as the holistic process of risk identification, analysis, evaluation and treatment. The risk management method is in Figure 23 (ISO 2018).

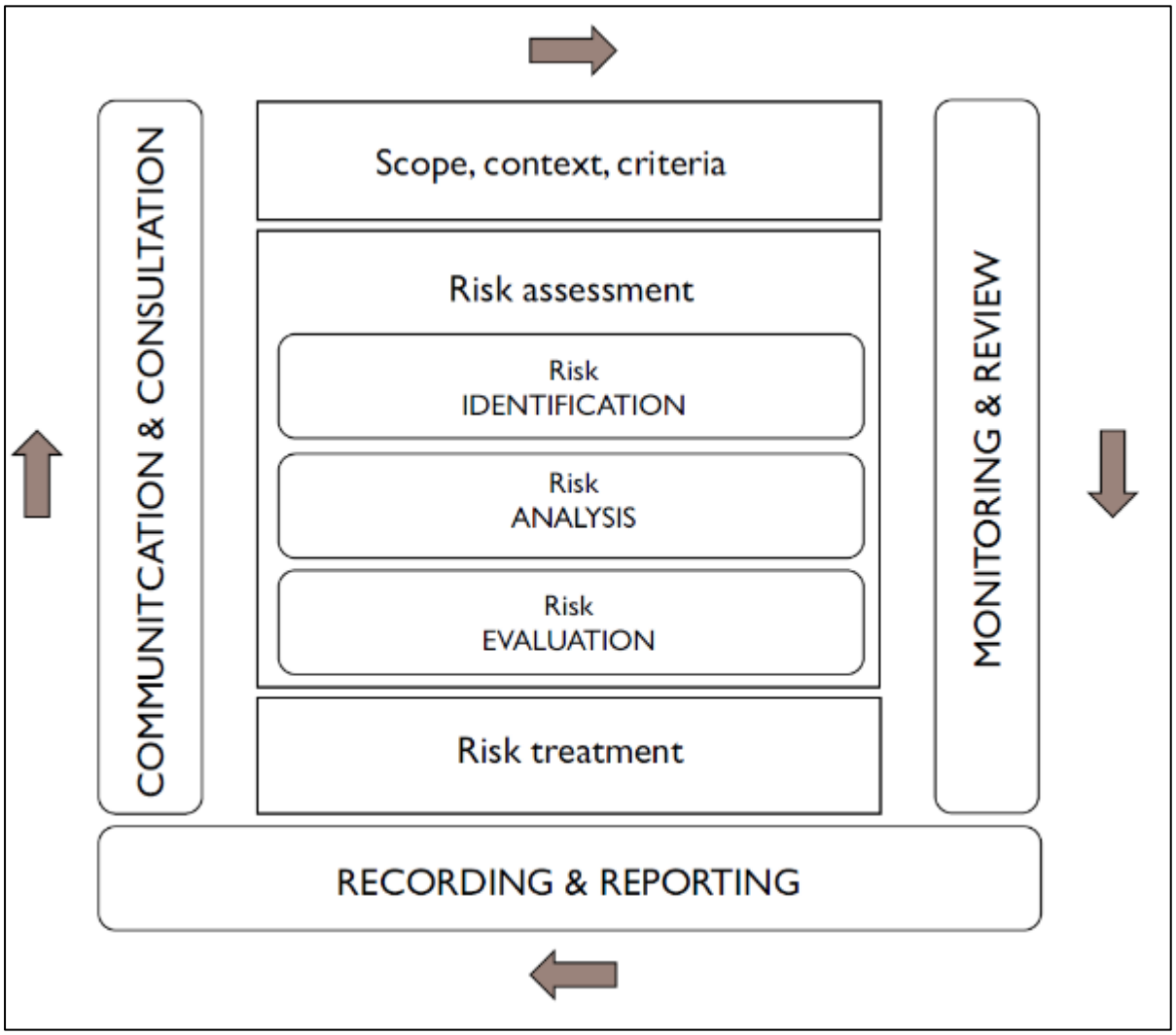


Figure 23 Risk management process

Risk assessment identifies the risks of land with a PMLU not achieving a stable condition and the risks of land identified as a NUMA failing to undergo improvement. The risk treatment plan outlines how identified risks are to be minimised so that residual risks are as low as reasonably practicable. The risk assessment and risk treatment plan are in Appendix R.

Under section 126C(1)(f) of the EP Act, risk events for a stable land condition for land which sustains a PMLU were identified for each rehabilitation milestone. Section 111A of the EP Act defines a stable land as:

- being safe and structurally stable;
- causing no environmental harm; and
- sustaining a PMLU.

Several risk events were identified for land with a PMLU not achieving stable condition including:

- failure to demolish and remove buildings which are not being formally retained by the landholder;
- failure to remove bitumen and concrete outside of buildings;
- historic exploration boreholes are not decommissioned or converted to groundwater monitoring bores;
- failure to remove asbestos;
- residual contaminated land;
- poorly managed effluent irrigation area;
- failure to remove plastic liners;
- failure to dispose of waste products generated from the CHPP;
- a final landform which includes excessive slopes;
- failure to install contour or graded drains where necessary;
- geotechnical instability of the final landform;
- insufficient or unknown availability of soil to complete surface preparation;
- unsuitable growth media for rehabilitation;
- depth of soil or growth media is too shallow to support target vegetation;
- health of soil or growth media is unable to support target vegetation;
- failure to rip the ground surface;
- failure to apply ameliorants;
- insufficient seed germination rates;
- insufficient availability of seed;
- poor seed mix and application rate;
- insufficient rainfall;
- bushfires causing a damaged or destroyed seed bank;
- insufficient rainfall causing a lack of vegetation striking;
- vegetation groundcover being significantly different to reference sites;
- greater pest and weed species abundance than at reference sites which causes failure to meet surface requirements;
- vegetation susceptibility to fire;
- bushfires damaging or destroying juvenile plans;
- rill or gully erosion;
- overall instability of landform condition;
- unsafe landform for humans and wildlife;
- high erosion rates;
- inability to meet surface water quality requirements;
- unexpected groundwater levels; and
- inability to meet groundwater quality requirements.

Several risk events were identified for land identified as a NUMA not achieving sufficient improvement including:

- highwalls battered to a slope greater than the specified angle;
- geotechnical instability of the void;
- failure to install fencing, safety bunds and signage around the void;
- the void causes environmental harm external to the tenure boundary;
- the void is unsafe to humans, wildlife and livestock;
- the void water levels are negatively impacting the surrounding environment; and
- batter slopes have not achieved the specified percentage of vegetation cover.

3.6.1 Rehabilitation trials

The RMP describes a 5.4 ha ProGanics direct seeding to spoil trial which aims to determine the feasibility of using spoil instead of, or in conjunction with, soil. If the trial is successful, *ProGanics Biotic Soil Media* may be an appropriate alternative to soil if the currently available soil is insufficient. It may also be able to improve rehabilitation outcomes where the soil stripping methodology discussed in Section 3.5.1.3e is implemented.

The *Growth Media — Mitigation & Management Strategy* (TerraCom 2020c) (Appendix U) indicates that trials have been undertaken to determine the germination and survival rates of vegetation resulting from direct seeding into spoil. Additionally, trials have been done to determine the effectiveness of soil stripping, as discussed in Section 3.5.1.3e, on areas with different disturbance types. For the latter, trials include the old helipad laydown, a scrap laydown area, a disused light vehicle road and an area with exposed spoil.

Rehabilitation trials must not delay rehabilitation. If further trials are proposed, the following information will be documented:

- objectives of the trial;
- trial design including location, underlying land characteristics and potential limitations;
- trial methodology;
- start date and duration of the trial;
- assessment criteria; and
- methodology of incorporating the trial results into rehabilitation strategies and milestones.

3.7 Monitoring and maintenance

Section 126C(1)(j) of the EP Act necessitates monitoring and maintenance to measure the success of the PRC plan following legislative requirements. TCL must demonstrate that:

- rehabilitation milestones and completion criteria have been met;
- rehabilitation has occurred progressively; and
- annual monitoring of the receiving environment is conducted following the REMP.

3.7.1 Vegetation and final landform

The *Rehabilitation Monitoring Report* (the Monitoring report) (Earthtrade 2021) ensures consistent rehabilitation monitoring following the conditions of the EA and the RMP.

3.7.1.1 Monitoring objectives

a Vegetation monitoring

Rehabilitation monitoring at one, two, five and ten years after seeding and in five-year intervals thereafter until certification from the administering authority is attained (Earthtrade 2021). Such monitoring includes:

- standard rehabilitation monitoring of 15 existing monitoring locations;
- establishment and rehabilitation monitoring of two new sites within the rehabilitated CDA;
- vegetation monitoring at the three existing reference site locations;
- monitoring of the five identified gully locations within the scheduled monitoring areas; and
- soil monitoring at the two identified persistent bare areas within the schedule monitoring areas.

b Final landform monitoring

Five monitoring locations with prominent gully erosion are assessed and classified as either active or stabilising in the Monitoring Report (Earthtrade 2021). A review of aerial photography and a landform analysis using light detection and ranging (LiDAR) are done to identify differences between locations.

Soil and spoil sampling and analyses are also in the Monitoring Report. The analytes include pH, EC, total N, total P, exchangeable Na percentage and CEC.

3.7.1.2 Monitoring methods

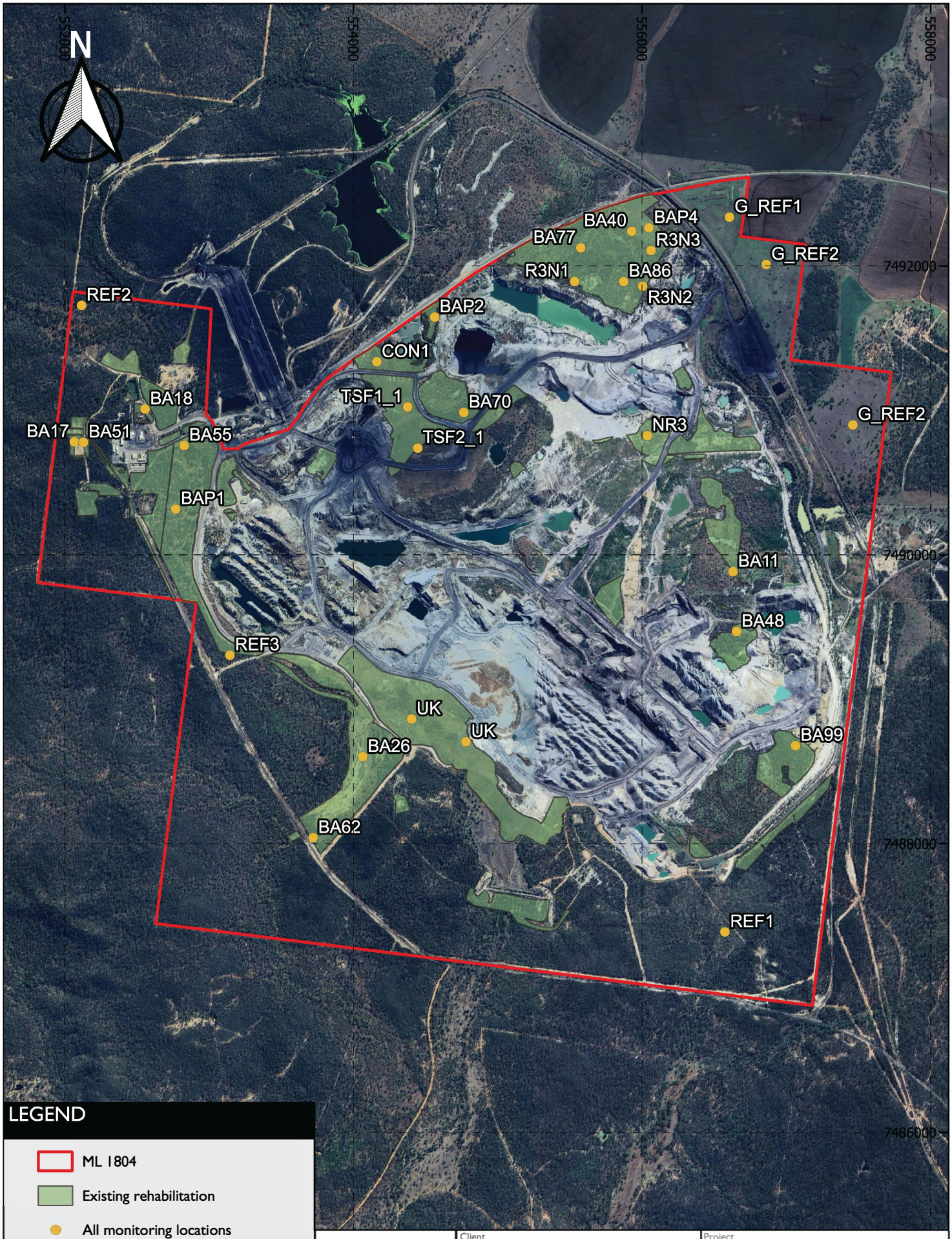
Monitoring methods must be cost effective, measurable, exchangeable, accurate and repeatable. They should have minimal potential for operator bias. A design which fulfills these criteria supports the consistent reporting of measurable parameters including species richness, coverage, soil chemistry, density and control of sediments and erosion.

a Reference sites

Data from three reference sites have been recorded in the Monitoring Report following condition F9 of the EA (Earthtrade 2021). These reference sites are located within areas of naturally occurring Regional Ecosystem 11.11.1 which is described in Section 3.1.1.9c. This RE is selected for reference sites as it is representative of the natural vegetation communities near the Mine. The three reference sites are used for comparative analysis against rehabilitation monitoring data to determine the current trajectory of the performance of rehabilitation areas.

Three proposed reference sites for grazing have been selected to be within areas of pre-existing grazing / cropping land within the Mine lease. These grazing reference sites have yet to be monitored to establish baseline condition and confirm suitability.

Locations of all current and proposed monitoring sites are provided in Figure 24 (TerraCom 2025) (Appendix O).



SGME	Client: TerraCom Limited	Project: Progressive rehabilitation and closure plan	
	Design: SGME Pty Limited 04.09.2025 Scale: 1 : 17,500 CRS: GDA2020	Title: Monitoring locations	Figure: 24

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

b Data collection and analysis

Vegetation monitoring transects of 50 m in length and 10 m in width are used to measure and record species richness and relative abundance, canopy height and cover, groundcover and weed presence (Earthtrade 2021). Where applicable, the monitoring results are compared to the minimum requirements in the EA.

Vegetation

Site-based attributes that are measured at each reference site in accordance with the *Ecological Values Report* (WSP 2019; 2020) and the *Rehabilitation Monitoring Report* (Earthtrade 2021) include:

- plot characteristics;
- weed presence / absence;
- extent of disturbance (eg erosion);
- visual record;
- climate variables;
- lower-storey density and richness;
- lower-storey cover (vegetative cover);
- pasture yield;
- soil properties;
- basal cover;
- upper-storey and mid-storey density and richness; and
- species inventory.

Weeds and diseases

c Vegetative diseases and extent and density of weed species will be documented. This information will support implementation of appropriate management controls to improve rehabilitation outcomes. Maintenance

Assessments of rehabilitation status are also made which result in one of the following classifications:

- rework — the area requires major works associated with reshaping landforms and / or gully remediation;
- maintenance — the area requires minor works including gully remediation, groundcover upkeep, reseeding and planting;
- monitor — the area is on a trajectory towards completion criteria and only requires ongoing monitoring; and
- acceptable — the area meets all performance criteria and progressive certification should be attainable.

Maintenance measures must be implemented where failures in fulfilling completion criteria occur, such as:

- insufficient drainage;
- insufficient vegetation cover;
- issues with soil fertility and erosive potential;
- occurrence of significant gully erosion;
- erosion control mechanism failure;
- sedimentation; and
- adverse effects from extreme climatic conditions or weather events.

d Annual report inclusions

An annual report on monitoring results must be produced which includes:

- descriptions of the methods used;

- descriptions and photographs of the monitoring sites;
- results of assessments;
- comparisons of vegetation to reference sites and statistical analyses;
- assessments of chemical, physical and fertility characteristics of the soil;
- identification of characteristics which are not consistent with the rehabilitation objectives;
- descriptions of trends between soil and vegetation measurements as identified by statistical analyses;
- establishment statuses of seed species;
- descriptions of management and land use potential;
- descriptions and graphical representations of the progression of erosion features;
- locations of erosion in relation to rehabilitation;
- descriptions and a map of the blocks and transect locations of reference sites and rehabilitation;
- recommendations for appropriate management of weeds and erosion.

e Adaptive management

Where opportunities to improve rehabilitation exist, adaptive management controls should be implemented. For example, remediation programs and specific management controls can be identified through careful investigations and applied as adaptive management measures.

f Adverse and unplanned events

Adverse and unplanned events which occur during rehabilitation must be reported as per legislative requirements. The report must be supplied to all stakeholders and interested parties and should include:

- the nature and extent of the event;
- actions taken, and procedures in place, to minimise the impact at the time of occurrence;
- proposed actions and procedures which remediate and monitor the event;
- potential outcomes of remediation; and
- a reporting schedule relating to the continuous management of the event.

g Quality assurance and quality control

An AQP must complete all monitoring, data analysis and reporting. TCL is responsible for consultant management and for storing and reviewing monitoring data, analyses and reporting with considerations of:

- data quality control and quality assurance;
- data collection methodologies;
- fluctuating trends in the data between previous and current reporting periods;
- accuracy of figures and graphs; and
- general conclusions which describe the rehabilitation progress.

3.7.2 Diversion monitoring

3.7.2.1 Monitoring methods

Watercourse monitoring will be done in accordance with the Index of Diversion Condition (IDC) methodology which is outlined in the *Monitoring and Evaluation Program for Bowen Basin River Diversions* (ID&A 2001) to comply with water licence conditions. A monitoring and evaluation program has been developed for both Western Waterway Diversion (Alluvium 2011) (Appendix X) and Eastern Waterway Diversion (Alluvium 2012) (Appendix Y).

The monitoring program comprises the following components:

1. Baseline monitoring;
2. Construction monitoring;

3. Operations monitoring; and
4. Relinquishment monitoring.

The IDC is a method of recording and monitoring the condition of diversions and adjacent upstream and downstream reaches. It provides an integrated suite of indicators that measures both geomorphic and riparian condition of a diversion, and its upstream control and downstream reaches. The geomorphic and riparian condition (index) of a reach is given a score out of 10 and the sum of these provides the IDC score. The following indicators include:

- Indicators for geomorphic index:
  - width of high flow channel, active channel and low flow channel;
  - bank condition;
  - piping of banks;
  - bed condition;
  - spoil piles;
  - recovery; and
  - instream structures.
- Indicators for riparian index:
  - width of riparian zone;
  - structural intactness;
  - regeneration; and
  - longitudinal continuity.

3.7.2.2 Monitoring points

Proposed monitoring transects are provided in detail for the Western Waterway Diversion in Appendix X and the Eastern Waterway Diversion in Appendix Y.

3.7.2.3 Reporting

A monitoring and evaluation repot is to be prepared and certified by a registered professional engineer (RPEQ) annually in accordance with the water licence conditions. The relinquishment monitoring phase is applicable following operational closure, when once all mining and processing activities are done.

3.7.3 Water quality

Regular monitoring and reporting of surface water and groundwater is needed to:

- comply with the EA;
- comply with the REMP;
- record trigger levels and management controls;
- easily access records when necessary; and
- support the eventual relinquishment of land.

3.7.3.1 Surface water

Recommended surface water monitoring measures include recording annual dam and structure inspection results, releases of Mine Affected Water and temporary waterway interferences. Surface water monitoring must comply with the EA, the REMP and the *Water Management Plan* as described in the following sections.

a Environmental authority

The EA necessitates the identification of adverse impacts to surface water EVs, monitoring of surface water quality and compliance with relevant conditions of the EA. Applicable conditions of the EA include:

- contaminants which cause environmental harm must not be released directly or indirectly to surrounding waters unless permitted under the EA;
- there are no approved release points for Mine Affected Water, which negates several EA conditions;
- Mine Affected Water may be released to internal water management infrastructure installed and operated under a water management plan;
- all determinations of water quality must be made by an AQP;
- an annual report must be prepared which outlines the findings of the REMP, monitoring results and interpretations and assesses the background reference water quality, downstream water quality and suitability of current discharge limits;
- Mine Affected Water can be transported to artificial water storage structures or used at properties owned by TerraCom or consenting third parties provided that the transport method is compliant with the conditions of the EA;
- an AQP must prepare a water management plan which is made available to DESI upon request;
- an AQP must prepare an ESC plan which is available to DESI upon request; and
- stormwater which is unaffected by the Mine may be released to waters via:
  - ESC structures installed and operated under an ESC plan; or
  - water management infrastructure installed and operated under a water management plan.

b Receiving environment monitoring program

Environmental conditions

The level of waterways surrounding the Mine are recorded including the upstream Bath and Washpool creeks and the downstream Breaker, Bath and Sandy creeks (ESP Pty Ltd 2020). The average daily water levels at each of the aforementioned locations are graphed, with consideration of regional rainfall data, to aid interpretation of the sampling event results.

Flow event monitoring

Water quality is sampled at a number of locations during significant rainfall events which result in creek flow (ESP Pty Ltd 2020). Automatic samplers are established in the following locations:

- two upstream samplers on:
  - Washpool Creek; and
  - Bath Creek; and
- two downstream samplers on:
  - Bath Creek downstream of the Environmental Dam Spillway and upstream of the confluence of the eastern and western portions of Bath Creek; and
  - Breaker Creek and Bath Creek West immediately downstream of the Western Diversion.

Additionally, two supplementary sites are sampled manually at the following locations:

- upstream on Breaker Creek North; and
- within the receiving environment on Bath Creek East.

Samples are taken at intervals of six hours if the water level is above the trigger level. Grab samples are collected from the supplementary sites, and at sites where the automatic sampler fails, as soon as practicable. Temperature, EC, pH, dissolved oxygen and turbidity are measured on-site and the samples are sent to a NATA Australia accredited laboratory for further analysis. The parameters investigated by the laboratory and the relevant WQOs for each parameter are in Table 40. The WQOs are based on the default guideline values for slightly to moderately disturbed freshwater aquatic ecosystems at the 95% level of protection (ESP Pty Ltd 2020).

Annual monitoring

Annual monitoring is done after the wet season in April-May depending on regional climatic conditions and water presence in the ephemeral creeks (ESP Pty Ltd 2020). The nine monitoring sites are:

- upstream sites including:
  - Site W38 at Washpool Creek;
  - Site W24 at Bath Creek;
  - Site W43 at Breaker Creek; and
  - Site WPC US at the unnamed tributary of Washpool Creek; and
- sites within the receiving environment including:
  - Site MP4 DS at Bath Creek West;
  - Site W54 at Bath Creek West;
  - Site W45 at Bath Creek downstream of the Environmental Dam Spillway and upstream of the confluence of the western and eastern portions of Bath Creek;
  - Site W53 at Bath Creek East; and
  - Site Bath Creek DS at Bath Creek downstream of the confluence of the western and eastern portions of Bath Creek.

A YSI ProDSS multi-parameter water quality sonde is used at a depth of ~20 cm below the surface at each site to measure physicochemical quality parameters including temperature, EC, pH, dissolved oxygen and turbidity (ESP Pty Ltd 2020). Grab samples are collected manually at each site from ~0.3 m below the surface and sent to a NATA Australia accredited laboratory for further analysis. The parameters investigated by the laboratory and relevant WQOs for each parameter are in Table 40.

Table 40 Laboratory parameters for surface water quality

Parameter		**WQO**
Physical	pH	6.5-8.0
	EC (µS/cm)	1,000
	Turbidity (NTU)	50
	Dissolved oxygen (% saturation)	85-110
	Suspended solids (mg/L)	1,000
	Hardness as $CaCO_3$ (mg/L)	-
	Dissolved organic C (mg/L)	-
	Alkalinity (mg/L)	-
Major ions	Sulphate (mg/L)	250
	Fluoride (mg/L)	2,000
	Na (mg/L)	115
Nutrients	Ammonia (µg/L)	900
	Nitrate (µg/L)	2,400
Dissolved metals and metalloids	Al (µg/L)	55
	As (µg/L)	13
	Cd (µg/L)	$0.2\ (\text{Hardness}/30\ (\text{H}/30))^{0.89}$
	Cr (µg/L)	1
	Cu (µg/L)	2

Parameter		WQO
	Fe (µg/L)	300
	Pb (µg/L)	3.4 $(H/30)^{1.27}$
	Hg (µg/L)	0.2
	Ni (µg/L)	11 $(H/30)^{0.85}$
	Zn (µg/L)	8 $(H/30)^{0.85}$
	B (µg/L)	370
	Co (µg/L)	90
	Mn (µg/L)	1,900
	Mo (µg/L)	34
	Se (µg/L)	10
	Ag (µg/L)	1
	U (µg/L)	1
	V (µg/L)	10
Petroleum hydrocarbons	C6-C9 (µg/L)	20
	C10-C36 (µg/L)	1,000

ESP Pty Ltd (2020)

Quality assurance and quality control

All water quality sampling is done following the *Monitoring and Sampling Manual* (DES 2018) and the REMP. Quality assurance and quality control measures implemented include:

- calibrating the water quality sonde;
- wearing nitrile gloves during grab sample collection;
- using labelled laboratory-supplied containers for grab samples;
- filtering samples through a cellulose acetate filter of 0.45 micrometres (µm) to determine dissolved or soluble values (metals only);
- keeping samples chilled;
- delivering samples to the laboratory in the needed timeframe and with a Chain of Custody form; and
- laboratory analysis of blanks, spikes and duplicates.

Data analysis

For flow event monitoring, the median for each site is calculated and compared to the relevant WQOs (ESP Pty Ltd 2020). Results from receiving environment sites are compared to historic background concentrations from previous sampling events and the 20th and 80th percentiles are used for comparison against the median values for each site. For annual monitoring, concentrations at receiving environment sites are compared to background data from upstream sites and the WQOs. Parameters are considered to be of potential concern if concentrations at all or some of the receiving environment sites exceed the relevant WQOs and background data.

Sediments

One composite sample is collected from each site which includes sediment from up to ten locations within a 10 m radius (ESP Pty Ltd 2020). Unless the site is dry, samples are sub-aqueous and are collected from low-flow stream banks before being sent to a NATA Australia accredited laboratory for analysis. This sampling methodology complies with the *Monitoring and Sampling Manual* (DES 2018) and the REMP. Quality assurance and control measures are implemented including:

- wearing nitrile gloves during sample collection;
- using labelled laboratory-supplied bags or jars to store the sample;
- taking a replicate sample from each site to identify small-scale variations;
- keeping the samples in appropriate conditions; and
- delivering samples in the needed timeframe and with a Chain of Custody form.

Results are compared to the default guideline values (DGVs) and highest limits of the sediment quality guideline values (high-GVs). DGVs indicate the highest concentrations with a low-risk of unacceptable effects occurring and is used to protect aquatic ecosystems. High-GVs indicate the concentrations at which toxicity-related issues are anticipated and should only be used to identify likely high-level toxicity problems. The DGV and high-GV for each parameter are in Table 41. Parameters in which concentrations at all of some of the receiving environment sites exceed the DGVs and background concentrations are potentially of concern.

Table 41 Laboratory parameters for sediment quality

Parameter	DGV	High-GV
As (mg/kg)	20	70
Cd (mg/kg)	1.5	10.0
Cr (mg/kg)	80	370
Cu (mg/kg)	65	270
Pb (mg/kg)	50	220
Hg (mg/kg)	0.15	1.00
Ni (mg/kg)	21	52
Zn (mg/kg)	200	410
Ag (mg/kg)	1.0	5.0
Total petroleum hydrocarbons (mg/kg)	280	550

ESP Pty Ltd (2020)

Macroinvertebrates

The methodology used to complete macroinvertebrate assessments is based on the Australian River Assessment System (AusRivAS) habitat assessment protocol (DNRM 2001) and modified where necessary (ESP Pty Ltd 2020). In order to assess macroinvertebrates of the area, aquatic habitats are assessed and classified as being in excellent, good, moderate or poor condition. Observations include:

- features of the waterbody — bank height, flow estimate, width estimate and depth of standing water;
- aquatic plants within the waterbody — cover, growth form and species;
- riparian zone details — width, canopy height and species present;
- adjacent land use and disturbance — potential impacts on aquatic habitats and communities;
- aquatic habitat — type and relative cover (%);
- channel characteristics — beds, banks, channel width and gradient; and
- sediment type details — relative cover (%) of different particle sizes and presence of anoxic sediments.

After the completion of the aquatic habitat assessments, samples are collected at each site that has sufficient water levels and habitat types (ESP Pty Ltd 2020). A standard triangular dip net is used to collect the samples from an area of 30 cm in width and 30 cm in length within bed habitat. Samples are transferred into jars, labelled, preserved in a 70 % ethanol solution and transported for macroinvertebrate classifying and identification, and statistical analysis by competently qualified aquatic ecologists.

To analyse the samples, field picking should be undertaken for a minimum of 30 minutes to extract representative samples for the required macroinvertebrate taxa, in accordance with the AusRivAS sampling and processing protocol. The macroinvertebrates are then identified to the lowest practical taxonomic level and counted or, where more than 100 individuals from a singular taxon are present, estimated as per the AusRivAS standards. Quality assurance and control measures implemented include having an appropriately qualified and AusRivAS accredited primary ecologist and having a second ecologist to confirm the identity and quantity of ~10 % of picked samples, allowing for an error rate of up to 10 % (ESP Pty Ltd 2020).

The results from all samples from a singular site are collated to calculate the total and mean standard macroinvertebrate indices in regard to taxonomic richness, PET richness and SIGNAL 2 scores. The number of families found in the sample is also used to interpret SIGNAL 2 scores by dividing the SIGNAL 2 / family bi-plots into quadrants. Each quadrant is considered indicative of the environmental conditions which influence an ecological community. For each sampled habitat, SIGNAL 2 / family bi-plots are created using the total taxonomic richness, SIGNAL 2 scores and quadrant boundaries based on the 20th percentile of biological GVs for taxonomic richness and SIGNAL scores (ESP Pty Ltd 2020).

Comparisons are made between the mean results from the receiving environment sites and the mean background ranges from upstream sites. Total results are graphed and compared to biological objectives based on the 20th-80th percentiles recorded at reference sites in the Central Coast region of Queensland (DEHP 2011), as in Table 42 (ESP Pty Ltd). This indicates the overall condition and health of the macroinvertebrate communities. Results are also compared to historical survey results to quantify changes over time and to interpret the results from receiving environment sites.

Table 42 Parameters for macroinvertebrate assessments

Parameter	Description	Guideline value
Taxonomic richness	Number of taxonomic groups within a sample.	12-21
PET richness	Number of sensitive PET taxa within a sample.	2-5
SIGNAL 2 scores	Total weighted sensitivity grades for each taxa divided by total weight factors at each site.	3.33-3.85

ESP Pty Ltd (2020)

Permutational analysis of variance is done using Plymouth Routines in Multivariate Ecological Research (PRIMER) software with location and site being the input factors (ESP Pty Ltd 2020), This determines the differences in the results between locations. Prior to testing, the data is converted to a Euclidian distance similarity matrix and a 95% confidence level is applied to determine the significance of the results. This process is then repeated to assess the changes which occurred between historical and current surveys.

c Water management plan

The *Water Management Plan* (TerraCom 2020b) identifies the routine monitoring and maintenance methods for surface water. It dictates that monitoring must be done by an AQP on a regular basis which is determined by the type of monitoring.

Monitoring equipment

Automatic samplers are triggered at appropriate sampling intervals determined by an AQP. Parameters measured include pH, EC, turbidity and flow depth. Automatic samplers are installed within gauging stations at the following monitoring locations:

- upstream in Washpool Creek;
- upstream in Bath Creek;
- downstream in the Western Diversion; and
- in the Environmental Dam Spillway.

Sampling

The following techniques are used to ensure sampling integrity:

- preparation, cleaning and calibration of field equipment;
- maintaining records of field measurements;
- sampling being undertaken following the *Monitoring and Sampling Manual* (DES 2018);
- using labelled laboratory-supplied containers to store samples;
- maintaining samples at below 4°C; and
- transporting samples to a NATA Australia accredited laboratory for analysis within the specified timeframe and with a Chain of Custody form.

Surface water monitoring

Mine Affected Water (MAW) is monitored via monthly water level surveys, monthly EC and pH field samples and quarterly laboratory analysis (TerraCom 2020b). The parameters tested during laboratory analysis are those in *Table C2* and *Table C3* of the EA as in Table 43 and Table 44 respectively.

Table 43 Summary of Table C2 of the EA

Parameter	Release limit	Monitoring frequency
EC (µS/cm)	1,000	Daily during release.
pH	6.5-9.0	
Turbidity (NTU)	Current limit or limit derived from suspended solids limit with demonstrated correlation. Must be provided to DESI following approval of a release point.	
Suspended solids (mg/L)	1,000	
Sulphate (mg/L)	500	

Table 44 Summary of Table C3 of the EA

Parameter	Trigger levels (µg/L)	Comment on trigger level	Monitoring frequency
Al	55	For aquatic ecosystem protection. Based on Queensland water quality guidelines (DEHP 2009).	Upon release and weekly during release thereafter.
As	13	For aquatic ecosystem protection. Based on Queensland water quality guidelines (DEHP 2009).	
Cd	0.2	For aquatic ecosystem protection. Based on Queensland water quality guidelines (DEHP 2009).	
Cr	1	For aquatic ecosystem protection. Based on Queensland water quality guidelines (DEHP 2009).	
Cu	2	For aquatic ecosystem protection. Based on limits of reporting (LOR) for inductively coupled plasma mass spectrometry (ICPMS).	
Fe	300	For aquatic ecosystem protection. Based on low reliability guideline.	
Pb	4	For aquatic ecosystem protection. Based on Queensland water quality guidelines (DEHP 2009).	
Hg	0.2	For aquatic ecosystem protection. Based on LOR for cold vapour-flow injection mercury system (CV-FIMS).	
Ni	11	For aquatic ecosystem protection. Based on Queensland water quality guidelines (DEHP 2009).	

Parameter	Trigger levels (µg/L)	Comment on trigger level	Monitoring frequency
Zn	8	For aquatic ecosystem protection. Based on Queensland water quality guidelines (DEHP 2009).	
B	370	For aquatic ecosystem protection. Based on Queensland water quality guidelines (DEHP 2009).	
Co	90	For aquatic ecosystem protection. Based on low reliability guideline.	
Mn	1,900	For aquatic ecosystem protection. Based on Queensland water quality guidelines (DEHP 2009).	
Mo	34	For aquatic ecosystem protection. Based on low reliability guideline.	
Se	10	For aquatic ecosystem protection. Based on LOR for ICPMS.	
Ag	1	For aquatic ecosystem protection. Based on LOR for ICPMS.	
U	1	For aquatic ecosystem protection. Based on LOR for ICPMS.	
V	10	For aquatic ecosystem protection. Based on LOR for ICPMS.	
Ammonia	900	For aquatic ecosystem protection. Based on Queensland water quality guidelines (DEHP 2009).	
Nitrate	1,100	For aquatic ecosystem protection. Based on ambient Queensland water quality guidelines (DEHP 2009).	
Petroleum hydrocarbons (C6-C9)	20	-	
Petroleum hydrocarbons (C10-C36)	100	-	
Fluoride (total)	2,000	Protection of livestock and short-term irrigation guideline.	
Na	Limit determined from receiving water reference data and best practice sedimentation control and treatment; to be provided to DESI following approval of a release point.		

Separation of Diverted Water and Mine Affected Water

Undisturbed upstream catchments are diverted around the Mine via the Eastern and Western diversions to avoid contamination (TerraCom 2020b). Monitoring of diversions must comply with applicable water licences. Diverted Water remains separate from Mine Affected Water through the following mechanisms:

- voids with spoil piles are used to store and transfer Mine Affected Water;
- up to 10,160 megalitres of Mine Affected Water can be stored across five voids and one storage area;
- the Environment Dam can store Mine Affected Water to increase evaporation rates;
- the CHPP is a Dewatering Cell and Decant Dam;
- Raw Water supplies are from the West Dam which is treated before use; and
- cross-continuity is supplied via a network of mobile pumps and pipelines between the Mine Affected Water storages and active voids.

Reporting

All monitoring data will be uploaded to, and stored in, systems which are regularly backed up. Records will be kept for five years as per the requirements of the EA. Internally; regular updates of the water status will be relayed to personnel. Reporting which considers compliance with obligations will occur on a monthly basis. Externally, regular reporting to the owner of CCM and the community will be undertaken and a report of water quality will be submitted to DESI with each Annual Return (TerraCom 2020b).

Emergency and contingency planning

Emergencies related to water management will be treated following the procedures for all other potential emergencies (TerraCom 2020b).

Auditing and review

External third-party and DESI audits may be needed as per the *Water Management Plan* and or at the discretion of DESI. The plan must undergo an internal review annually to ensure monitoring parameters and frequencies comply with the conditions of the EA. Additional internal reviews may be necessitated by non-compliance issues or changes in legislative requirements.

3.7.3.2 Groundwater

Groundwater monitoring must comply with conditions I1-I10 of the EA and the *Groundwater Monitoring Program* (TerraCom 2020a).

a Environmental authority

The EA identifies a number of conditions related to groundwater including:

- refraining from releasing contaminants to groundwater;
- implementing a groundwater monitoring program;
- groundwater monitoring must include:
  - groundwater quality and levels must be monitored on a quarterly basis at locations and frequencies identified in Table 45;
  - variations in the standing groundwater level which are not attributed to seasonal variability must be reported to DESI within seven days;
  - results of groundwater monitoring must not exceed the limits in *Table I2* of the EA which are in Table 46;
- groundwater sampling and monitoring methods must be done in accordance with the latest version of the administering authority's *'Monitoring and Sampling Manual 2018: Environmental Protection (Water) Policy 2009'*;
- results of monitoring from groundwater quality from compliance bores identified in Table 45 must not exceed any of the limits defined in Table 46 on more than three consecutive monitoring occasions; and

- the construction, maintenance, management and decommissioning of groundwater bores must not significantly impact the environment or the integrity of observations.

Table 45 Groundwater monitoring locations and frequencies (Table 11 of EA)

Monitoring point	Location (GDA2020)		Hydrogeological unit	Surface RL (mAHD)	Monitoring frequency
	Latitude	Longitude			
Reference bore-					
GW048B	-22.69090	147.55675	Permian conglomerate	314	Quarterly
Compliance bores					
BA Station (Mayes Bore)	-22.67855	147.55946	Tertiary Basalt	324	Quarterly
Curtis Windmill	-22.66615	147.56694	Tertiary Basalt	325	Quarterly

Notes:

1. Monitoring is not required where a bore has been removed as a direct result of the mining activity.
2. RL must be measured to the nearest 5cm from the top of the bore casing.
3. Reference sites must:

a. have a similar flow regime
b. be from the same bio-geographic and climatic region
c. have similar geology, soil types and topography
d. not be so close to the test sites that any disturbance at the test site also results in a change at the reference site.

Table 46 Groundwater quality limits (Table 12 of EA)

Parameter	Units	Trigger value		Trigger type
		Curtis Windmill	BA Station	
EC	µS/cm	883	631	Bore specific
pH	pH units	6.5-8.5	6.5-8.5	WQO*
Sulphate	mg/L	19	24	Bore specific
Metals (dissolved)				
Aluminium	mg/L	0.055	0.055	ANZG
Arsenic	mg/L	0.013	0.027	ANZG and bore specific
Boron	mg/L	0.94	0.94	ANZG
Cadmium	mg/L	0.0002	0.0002	ANZG
Chromium	mg/L	0.001	0.001	ANZG
Copper	mg/L	0.005	0.004	Bore specific
Lead	mg/L	0.0034	0.0034	ANZG
Manganese	mg/L	1.9	1.9	ANZG

Parameter	Units	Trigger value		Trigger type
		Curtis Windmill	BA Station	
Mercury	mg/L	0.00006	0.00006	ANZG
Molybdenum	mg/L	0.034	0.034	ANZG
Nickel	mg/L	0.012	0.011	Bore specific and ANZG
Silver	mg/L	0.0005	0.0005	ANZG
Vanadium	mg/L	0.006	0.006	ANZG
Zinc	mg/L	0.021	0.009	Bore specific
Iron	mg/L	Iron is monitored for interpretation purposes		
Major ions	mg/L	Calcium, magnesium, potassium, sodium, chloride, bicarbonate and carbonate are monitored for interpretation purposes		

b Groundwater monitoring program

The *Groundwater Monitoring Program* is based on the existing mine plan, cooperation with the neighbouring company and accessibility to the derived aquifers (TerraCom 2020a). The objectives of the program are to:

- comply with legislative and regulatory requirements;
- identify potential adverse impacts on groundwater quality and levels;
- maintain a thorough understanding of impacts on surrounding GDEs and resources; and
- implement measures which address current and future groundwater requirements and concerns of groundwater users and stakeholders.

Under the EA, the groundwater monitoring program must monitor water quality and SWLs in aquifers likely impacted by mining. The program must be updated every two years and made available to DESI upon request. The program is described in the following sections.

Sampling

Techniques used to ensure sampling integrity include (TerraCom 2020a):

- preparation, cleaning and calibration of field equipment;
- maintaining records of field measurements;
- undertaking sampling following the *Monitoring and Sampling Manual* (DES 2018);
- using labelled laboratory-supplied containers to store samples;
- maintaining samples at below 4°C; and
- transporting samples to a NATA Australia accredited laboratory for analysis within the specified timeframe and with a Chain of Custody form.

EA compliance bores

There are two EA compliance bores located at Curtis Windmill and Blair Athol Station (Mayes Bore) respectively (TerraCom 2020a). These bores are to be monitored quarterly and assessed using the EA compliance limits as previously in Table 45.

Monitoring bores

There is one EA monitoring bore (GW04B), that is monitored quarterly as per Table 11 of the EA. This bore is measured against EA groundwater quality limits (Table 12 of the EA).

Reporting

All monitoring data will be uploaded to, and stored in, systems which are regularly backed up (TerraCom 2020a). Records will be kept for five years as per the requirements of the EA and made available to DESI upon request. Exceedances to the limits previously identified in Table 46 at the EA compliance bores and reference bores that occur on more than 3 consecutive occasions will be reported to DESI. An AQP will review monitoring methodologies and results annually. A review of the groundwater monitoring program will occur every two years and will consider historical groundwater monitoring results. A report on groundwater quality will be submitted to DESI with each Annual Return.

3.7.4 Administration

It is recommended that all monitoring data be recorded and retained for at least five years. Storing, filing and managing the monitoring data will be the responsibility of TCL. All documentation should be kept in an easily accessible location for the purpose of responding to potential requests from DESI in a timely manner. Other than financial and research information, all documentation relating should be made publicly available.

3.7.4.1 PRC plan schedule audit

TCL must commission a rehabilitation auditor to carry out an audit of each PRC plan schedule every three years following Section 285 of the EP Act. The first audit must be for the three-year period which starts from the day on which the PRC plan schedule takes effect. Each subsequent audit must be for the three-year period which starts on the day after the previous audit period ended.

3.7.4.2 PRC plan schedule surrender

The PRC plan schedule will cease to have effect upon the approval of an EA surrender application under Section 269A of the EP Act. The information collected as part of the monitoring and maintenance program (Section 3.7) may be used to support surrender. A post-surrender management report is needed when applying to surrender an EA if a PRC plan schedule is in place.

References

Alluvium 2011, *Monitoring design report: Western Waterway Diversion — Blair Athol mine,* prepared for Rio Tinto Coal Australia by Alluvium Consulting.

Alluvium 2012, *Monitoring design report: Eastern Waterway Diversion — Blair Athol mine,* prepared for Rio Tinto Coal Australia by Alluvium Consulting.

ALS Environmental 2021, *Certificate of analysis — Work Order: EB2100733*, prepared for 4T Consultants Pty Limited by Australian Laboratory Services Pty Limited.

Ashton, L & McKenzie, N 2001, *Conversion of the Atlas of Australian Soils to the Australian Soil Classification,* CSIRO Land & Water, Canberra.

ASRIS 2013, *Atlas of Australian Soils,* Australian Soil Resource Information System, date retrieved from 2 September 2022 from https://www.asris.csiro.au/themes/Atlas.html#Atlas_Beginners

ATC Williams 2010, *Blair Athol Coal: Ramp 2 Tailings Storage Facility — Rehabilitation and Closure Design*, prepared for Rio Tinto Coal Australia by ATC Williams Pty Limited.

BoM 2016, *Climate classification maps, Bureau of Meteorology*, date retrieved 8 April 2022 from http://www.bom.gov.au/jsp/ncc/climate_averages/climate-classifications/index.jsp?maptype=kpngrp#maps

BoM 2022a, *Climate statistics for Australian locations*, Bureau of Meteorology, date retrieved 8 April 2022 from http://www.bom.gov.au/climate/averages/tables/cw_035019.shtml

BoM 2022b, *Climate statistics for Australian locations*, Bureau of Meteorology, date retrieved 11 April 2022 from http://www.bom.gov.au/climate/averages/tables/cw_035124.shtml

BoM 2022c, *Southern Hemisphere Tropical Cyclone Data Portal*, Bureau of Meteorology, date retrieved 11 April 2022 from http://www.bom.gov.au/cyclone/tropical-cyclone-knowledge-centre/history/tracks/

BoM 2022d, *Previous droughts, Bureau of Meteorology*, date retrieved 11 April 2022 from http://www.bom.gov.au/climate/drought/knowledge-centre/previous-droughts.shtml

Coffey 1980, *Groundwater Appraisal: Blair Athol Coalfield,* prepared for Blair Athol Coal Pty Ltd by Coffey & Partners Pty Ltd.

CSIRO & BoM 2020, *State of the Climate 2020*, Commonwealth Scientific and Industrial Research Origination and Bureau of Meteorology.

Dames & Moore 1983, *Waste Management and Rehabilitation Programme: Soil and Overburden Characterisation,* prepared for Blair Athol Coal Company by Dames & Moore Pty Ltd.

DAWE 2021, *EPBC Act Protected Matters Report*, Department of Agriculture, Water and the Environment.

DEHP 2009, *Queensland Water Quality Guidelines: Version 3,* Department of Environment and Heritage Protection.

DEHP 2011, *Environmental Protection (Water) Policy 2009: Nogoa River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Nogoa River Sub-basin*, Department of Environment and Heritage Protection.

DES 2015, *Groundwater dependent ecosystem FAQs*, Wetland Info website, Department of Environment and Science, date retrieved 07 June 2023 from https://wetlandinfo.des.qld.gov.au/wetlands/facts-maps/gdebackground/gde-faq/

DES 2018, *Monitoring and Sampling Manual: Environmental Protection (Water) Policy*, Department of Environment and Science, Brisbane.

DES 2019, *Guideline – Progressive rehabilitation and closure plans (PRC plans)*, Department of Environment and Science, Brisbane.

DES 2021, *Search regional ecosystem descriptions*, Queensland Government Environment, Land and Water, date retrieved 07 June 2023 from https://apps.des.qld.gov.au/regional-ecosystems/

DES 2023a, *Wetland maps*, Wetland Info Website, Department of Environment and Science, date retrieved 07 June 2023 from https://wetlandinfo.des.qld.gov.au/wetlandmaps/

DES 2023b, *Regional ecosystem framework*, Queensland Government Environment, Land and Water, date retrieved 07 June 2023 from https://www.qld.gov.au/environment/plantsanimals/plants/ecosystems/descriptions/framework

Deswik 2022, *Reshape assumptions report*, prepared for TerraCom Limited by Deswik Mining Consultants (Australia) Pty Limited.

DNRM 2001, *Queensland Australian River Assessment System (AusRivAS), Sampling and Processing Manual*. Queensland Department of Natural Resources and Mines, Rocklea.

Earthtrade 2021, *Blair Athol Coal Mine: Rehabilitation Monitoring Report — April 2021,* prepared for TerraCom Limited by Earthtrade.

EES 2018, *Technical Review for Blair Athol Coal Mine's Groundwater Monitoring Program*, prepared for TerraCom Limited by Environmental Earth Sciences.

ESP Pty Ltd 2020, *Receiving Environment Monitoring Program 2020 Report*, prepared for Orion Mining Pty Limited by Ecological Service Professionals Pty Limited.

Georgiou 2012, *Erosion and Sediment Control Plan*, prepared for Rio Tinto Coal Australia Pty Limited by Georgiou Group Pty Limited.

Henderson 2023, *Blair Athol Coal Mine: Geotechnical Stability of Residual Voids*, prepared for SGM Environmental Pty Limited on behalf of TerraCom Limited by Henderson Geotech Pty Limited.

Highlands 2018, *Soil and spoil characterisation and suitability*, prepared for TerraCom Limited by La Tierra Pty Limited trading as Highlands Environmental.

HydroBalance 2025a, *Blair Athol Coal Mine: Flood Assessment for the Progressive Rehabilitation and Closure Plan*, prepared for TerraCom Limited by HydroBalance Pty Limited.

HydroBalance 2025b, *Blair Athol Coal Mine: Final Void Hydrology Report*, prepared for TerraCom Limited by HydroBalance Pty Limited.

Hydrogeology.com.au 2024, *Blair Athol Groundwater Numerical Modelling Report*, prepared for TerraCom Limited by Oasis Hydrogeology, Pty Limited (trading as hydrogeology.com).

IRC 2021, *Isaac Regional Planning Scheme: February 2021*, Isaac Regional Council.

ISO 2018, *ISO 31000:2018 - Risk Management — Guidelines*, International Organisation for Standardisation.

JBT 2012, *Blair Athol Mine Closure Groundwater Investigation*, prepared for Rio Tinto Coal Australia by JBT Consulting Pty Ltd.

Leonard, J, Newnham, G, Opie, K, & Blanchi, R 2014, *A new methodology for state-wide mapping of bushfire prone areas in Queensland*, CSIRO, Australia.

Queensland Government 2022a, *Forage Report: Regional Climate Projections*, date retrieved 11 April 2022 from www.longpaddock.qld.gov.au/forage

Queensland Government 2022b, *Drought Declarations,* date retrieved 19 October 2022 from https://www.longpaddock.qld.gov.au/drought/drought-declarations/

Queensland Government 2023, *Environmentally sensitive areas - Mining*, the State of Queensland.

Rio Tinto 2010, *Mine closure plan*, Rio Tinto Coal Australia Pty Limited.

Rio Tinto 2016a, *Spontaneous Combustion Management Plan*, Rio Tinto Coal Australia Pty Limited.

Rio Tinto 2016b, *Spontaneous Combustion Monitoring*, Rio Tinto Coal Australia Pty Limited.

Rio Tinto 2016c, *Landform Construction and Rehabilitation*, Rio Tinto Coal Australia Pty Limited.

Rio Tinto 2016d, *Blair Athol Water Management*, Rio Tinto Coal Australia Pty Limited.

SGME 2020, *Disposal plan: Overburden, Interburden, Spoil, Coal Washery Coarse Rejects and Tailings*, prepared for TerraCom Limited by SGM Environmental Pty Limited.

SGME 2022, *Estimated Rehabilitation Cost: Supporting Information Report*, prepared for Orion Mining Pty Limited by SGM Environmental (Mackay) Pty Limited.

SGME 2024, *Soil and capping material assessment*, prepared for TerraCom Limited by SGM Environmental Pty Limited.

SGME 2023, *WEPP Modelling and Conceptual Cover Design*, prepared for TerraCom Limited by SGM Environmental Pty Limited.

SGME 2025, *Revegetation Plan: Blair Athol Coal Mine*, prepared for TerraCom Limited by SGM Environmental Pty Limited.

SGME 2025b, *Blair Athol Coal Mine: Rehabilitation Management Plan*, prepared for TerraCom Limited by SGME Pty Limited.

SGME 2025c, *Residual Void Management Plan: Blair Athol Coal Mine*, prepared for TerraCom Limited by SGME Pty Limited.

SKM 2012, *Blair Athol Mine: Landform review, testing and design parameters*, prepared for Rio Tinto Coal Australia Pty Limited by Sinclair Knight Merz Pty Limited.

TerraCom 2017a, *Environmental Management Plan: January 2017*, TerraCom Limited.

TerraCom 2017b, *Coal Handling and Preparation Plan: CHPP Management Report*, TerraCom Limited.

TerraCom 2019, *Plan of operations: 1 April 2019 - 31 July 2020*

TerraCom 2020a, *Groundwater Monitoring Program*, TerraCom Limited.

TerraCom 2020b, *Water Management Plan*, TerraCom Limited.

TerraCom 2020c, *Blair Athol Coal Mine: Growth Media – Mitigation & Management Strategy*¸ TerraCom Limited.

The State of Queensland 2023a, *Environmental reports: matters of state environmental significance*, Queensland Government Department of Environment and Science.

The State of Queensland 2023b, *Pre-clearing Regional Ecosystems*, Queensland Government.

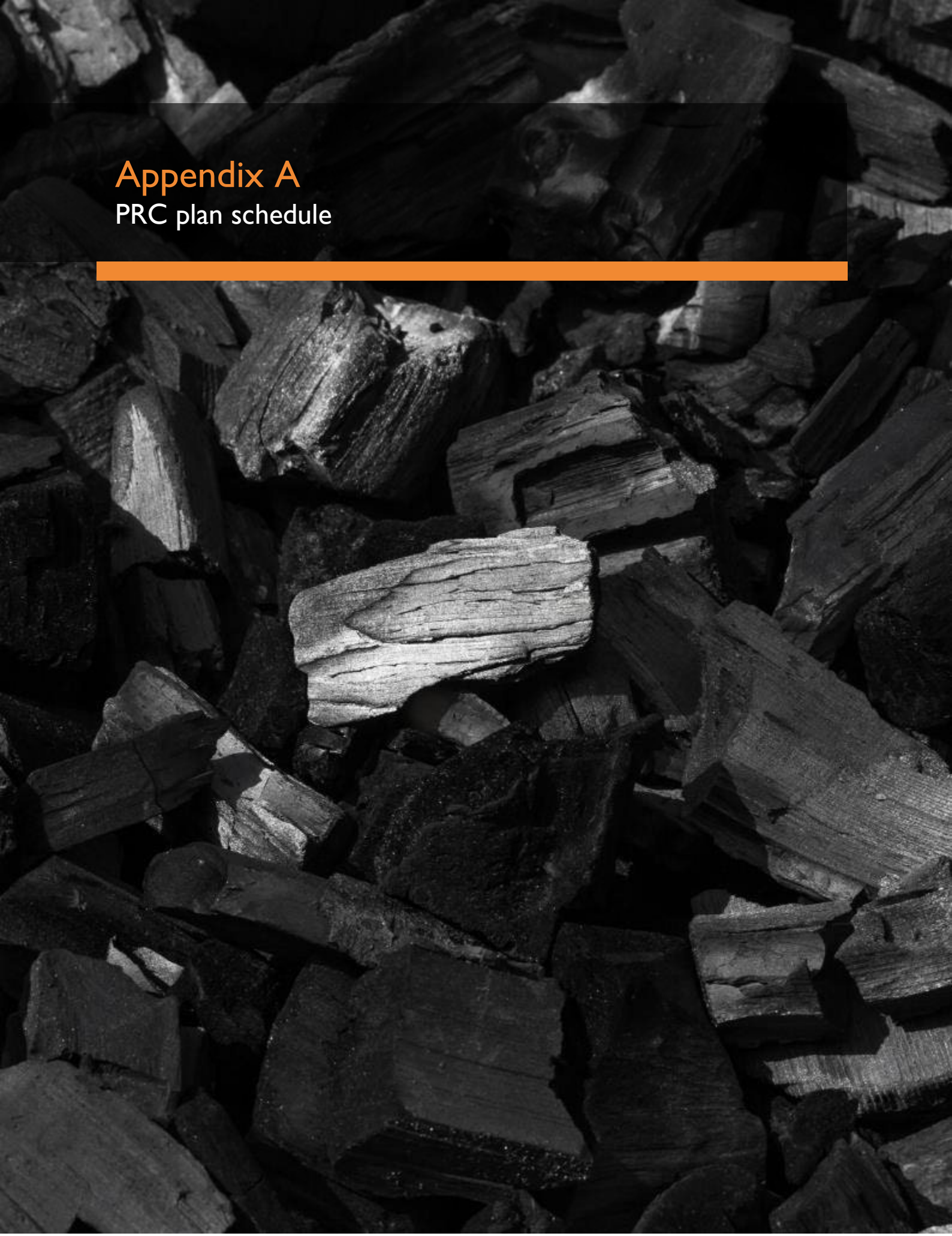
The State of Queensland 2023c, *Remnant 2021 regional ecosystems by BVG*, Queensland Government.

Wangan & Jagalingou Family Council 2023, *Who We Are*, date retrieved 07 June 2023 from https://wanganjagalingou.com.au/who-we-are/

WRM 2020, *Water balance model report*, prepared for TerraCom Limited by WRM Water & Environment Pty Limited.

WRM 2023, *Final void hydrology report: Blair Athol Coal Mine*, prepared for SGM Environmental Pty Limited on behalf of TerraCom Limited by WRM Water & Environment Pty Limited.

WSP 2019, *Ecological Values Report: Blair Athol Coal Mine,* prepared for TerraCom Limited by WSP Australia Pty Limited.



Appendix A
PRC plan schedule

PRC plan schedule

The PRC plan schedule contains rehabilitation milestones and milestone criteria that relate to completion of progressive rehabilitation. The PRC plan schedule is prepared following section 126D of the EP Act.

The schedule includes:

- a PMLU for land within the resource tenures including undisturbed land;
- identification of when land becomes available for rehabilitation or improvement;
- rehabilitation milestones to meet the PMLU;
- milestone criteria that demonstrate when each rehabilitation milestone is met;
- completion dates for each milestone; and
- any conditions considered needed or desirable.

A.1 Final site design

The final site design delineates the total area planned for surrender and includes maximum disturbance footprint, resource tenure boundaries, PMLUs for the land within the resource tenures and flood plain extent; reflecting the determinations made in Section 3.3 and Section 3.4. Final site design is in Figure 25, showing:

- the maximum disturbance foot print;
- resource tenure boundaries;
- PMLUs and the NUMA for the land within the MLs; and
- the flood plain extent

A.2 Rehabilitation areas

The PMLU and NUMA identified in the final site design have been divided into the following rehabilitation areas, each with a common rehabilitation methodology. The reference map for rehabilitation and improvement areas boundaries are in Figure 26:

- IA1 – Residual void;
- RA1 – Dump;
- RA2 – TSF;
- RA3 – CHPP;
- RA4 – Infrastructure;
- RA5 – Rail infrastructure;
- RA6 – Road infrastructure;
- RA7 – Water management;
- RA8 – Existing rehabilitation (Grazing);
- RA9 – Cleared areas;
- RA10 – Native ecosystem;
- RA11 – Existing rehabilitation (Native ecosystem); and
- RA12 – Diversions.

A.3 Schedule of land availability

Land will become progressively available for rehabilitation throughout the LOM. Land is considered available for rehabilitation when the land:

- is no longer being mined;

- is no longer being used for operating infrastructure or machinery for mining including dam or water storage;
- is not needed for mining of a probable or proved ore reserve; or
- contains permanent infrastructure that will remain on the land for a PMLU.

A.4 Rehabilitation and management milestones and criteria

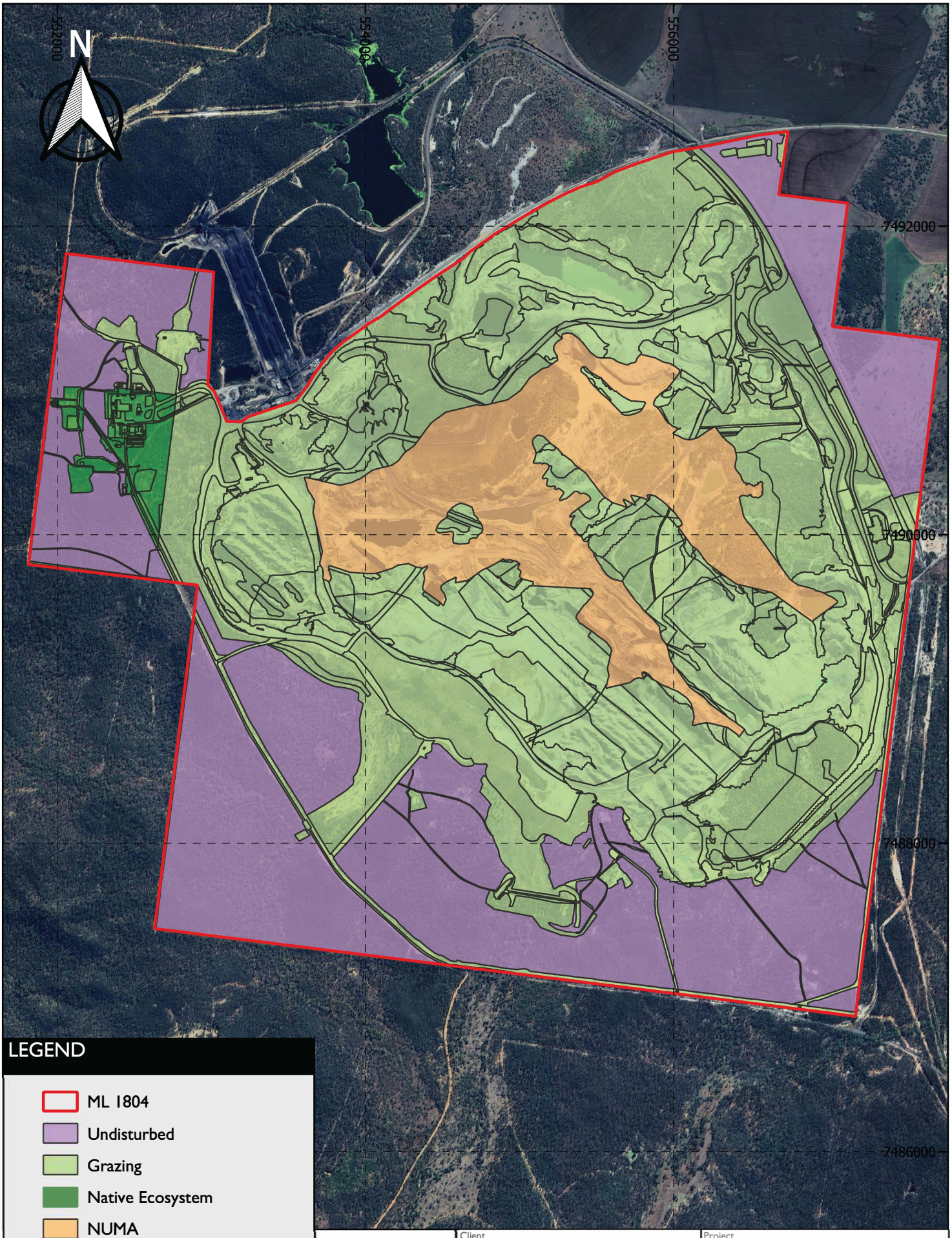
Rehabilitation milestones identify each significant event or step needed to reach a stable condition. Milestone criteria are used to demonstrate each rehabilitation milestone.

Rehabilitation milestones and milestone criteria for each rehabilitation area (PMLU) are in Table 47.

Management milestones and milestone criteria for the NUMA are in Table 48.

A.5 Proposed PRC plan schedule

The PRC plan schedule template has been submitted as part of the PRC plan application.



LEGEND

- ML 1804
- Undisturbed
- Grazing
- Native Ecosystem
- NUMA

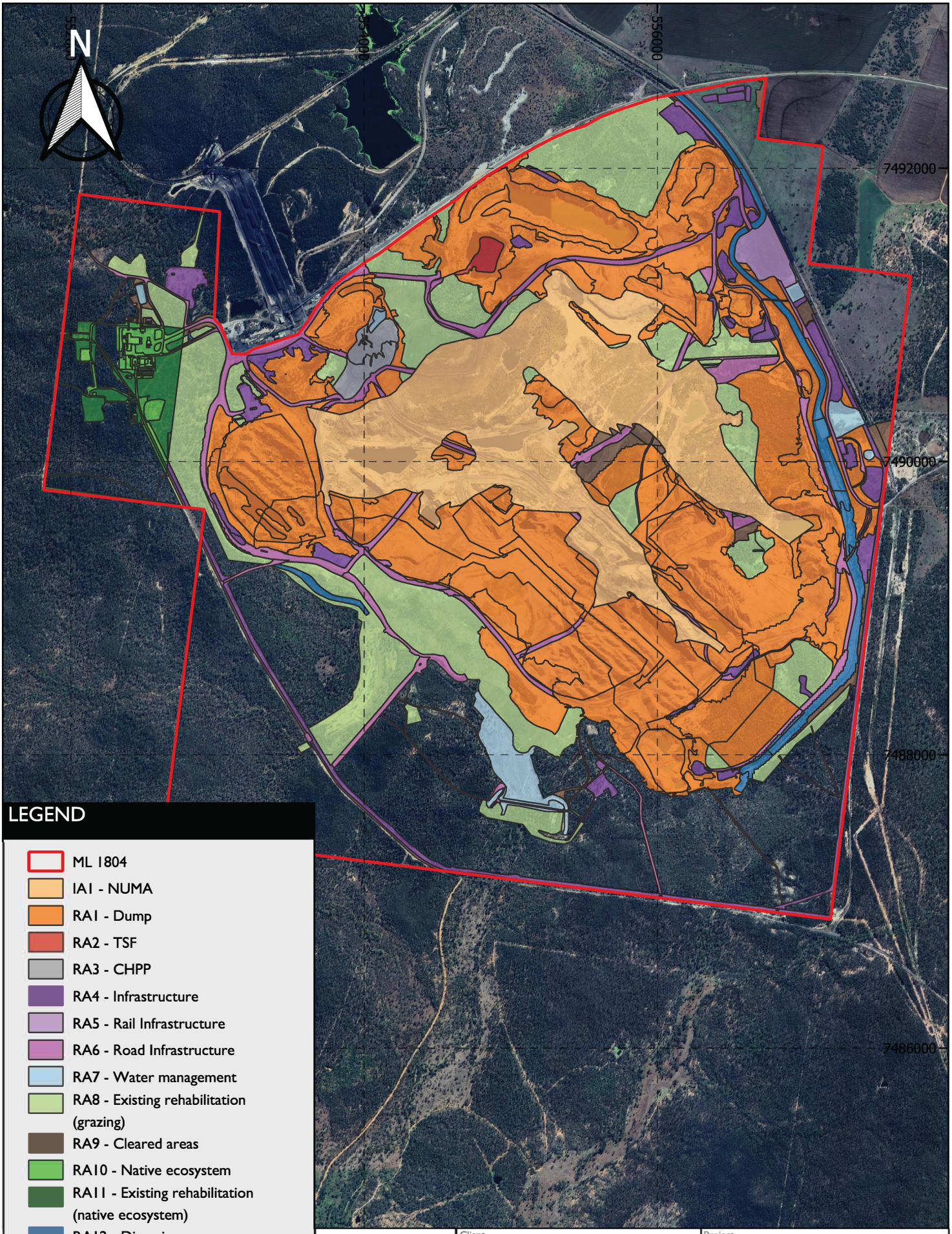
Scale 1 : 17 500

0 0.5 1 km

SGME

Client: TerraCom Limited	Project: Progressive rehabilitation and closure plan
Design: SGME Pty Limited 2.09.2025 Scale: 1 : 17,500 CRS: GDA2020	Title: Final site design Figure: 25

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.



LEGEND

- ML 1804
- IA1 - NUMA
- RA1 - Dump
- RA2 - TSF
- RA3 - CHPP
- RA4 - Infrastructure
- RA5 - Rail Infrastructure
- RA6 - Road Infrastructure
- RA7 - Water management
- RA8 - Existing rehabilitation (grazing)
- RA9 - Cleared areas
- RA10 - Native ecosystem
- RA11 - Existing rehabilitation (native ecosystem)
- RA12 - Diversions

Scale 1 : 17 500

0 0.5 1 km

SGME

Client: TerraCom Limited	Project: Progressive rehabilitation and closure plan
Design: SGME Pty Limited 2.09.2025 Scale: 1 : 17,500 CRS: GDA2020	Title: Rehabilitation areas Figure: 26

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

Table 47 Rehabilitation milestones and milestone criteria

Milestone reference	Rehabilitation milestone	Milestone criteria	Rehabilitation area
RM1	Infrastructure decommissioning and removal	a) decommissioning and removing services; b) removing infrastructure; c) decommissioning dams; d) removing all general and regulated waste; and e) decommissioning or converting water or monitoring bores, exploration drill holes.	RA3, RA4, RA5, RA6, RA7 and RA10
RM2	Remediation of contaminated land	a) removing or remediating contaminated land to a PMLU of light grazing pasture or native ecosystem; b) all contaminated sediment is removed; c) all plastic liners are removed and disposed; d) site investigation report is prepared by an AQP; and e) certification from an AQP that all contaminated land has been removed.	RA3, RA4, RA5, RA6, RA7, and RA10
RM3	Cover system installation	a) certification by an AQP that waste products generated from the washing of coal are buried under spoil with a minimum of thickness of five metres.	RA2
RM4	Landform development and reshaping or reprofiling	a) reshaping or recontouring the landform; b) install drainage management structures; c) all major earthworks completed; d) stable landform and slope angles ~15 % average; and e) landform is assessed as geotechnically stable by an AQP. **Diversions (RA12)** f) certification from an AQP that diversions are constructed as per the requirements of the certified design, and in accordance with DNRME's Guideline: *Works that interfere with water in a watercourse for a resource activity — watercourse diversions under the Water Act 2000* (OSW/2019/4599).	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA9, RA10 and RA12

Milestone reference	Rehabilitation milestone	Milestone criteria	Rehabilitation area
RM5	Surface preparation	a) placement of a minimum of 0.15 m of soil; b) contour ripping finished; and c) fertiliser applied at rates of 250 kg/ha.	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA9 and RA10
RM6	Revegetation (light grazing pasture)	a) direct seeding at application rate determined by an AQP; b) seed mix applied contains a suitable range of trees, shrubs and perennial grass species and suitable leguminous species consistent with the surrounding area; and c) stock exclusion fencing installed until achieving surface requirements for grazing pasture.	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9 and RA12
RM7	Revegetation (native ecosystem)	a) Seed mix applied contains species consistent with RE 11.1.11 or RE 11.3.4; b) Species comprise ≥ 20 % of the average number of species described in RE 11.1.11 or RE 11.3.4 technical descriptions; c) Average height of each layer is ≥ 70 % of average layer height described in RE 11.1.11 or RE 11.3.4 technical descriptions; d) Average fractional cover of each layer is ⩾ 50 % of average fractional cover described in RE 11.1.11 or RE 11.3.4 technical description.	RA10 and RA11
RM8	Achieving surface requirements (light grazing pasture)	a) species richness and diversity achieved is consistent with the sown seed mix and similar to reference sites; b) revegetation ≥70% comparable to analogue site; c) no active areas of gully erosion and drainage follows appropriate drainage paths; d) certification from an AQP that rehabilitation is resilient to fire; and e) certification by an AQP that weeds and pest species are in densities no greater than at analogue sites. **Diversions (RA12)** f) an AQP prepares an assessment report annually based on the Index of Diversion Condition (IDC) assessment, where:	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9 and RA12

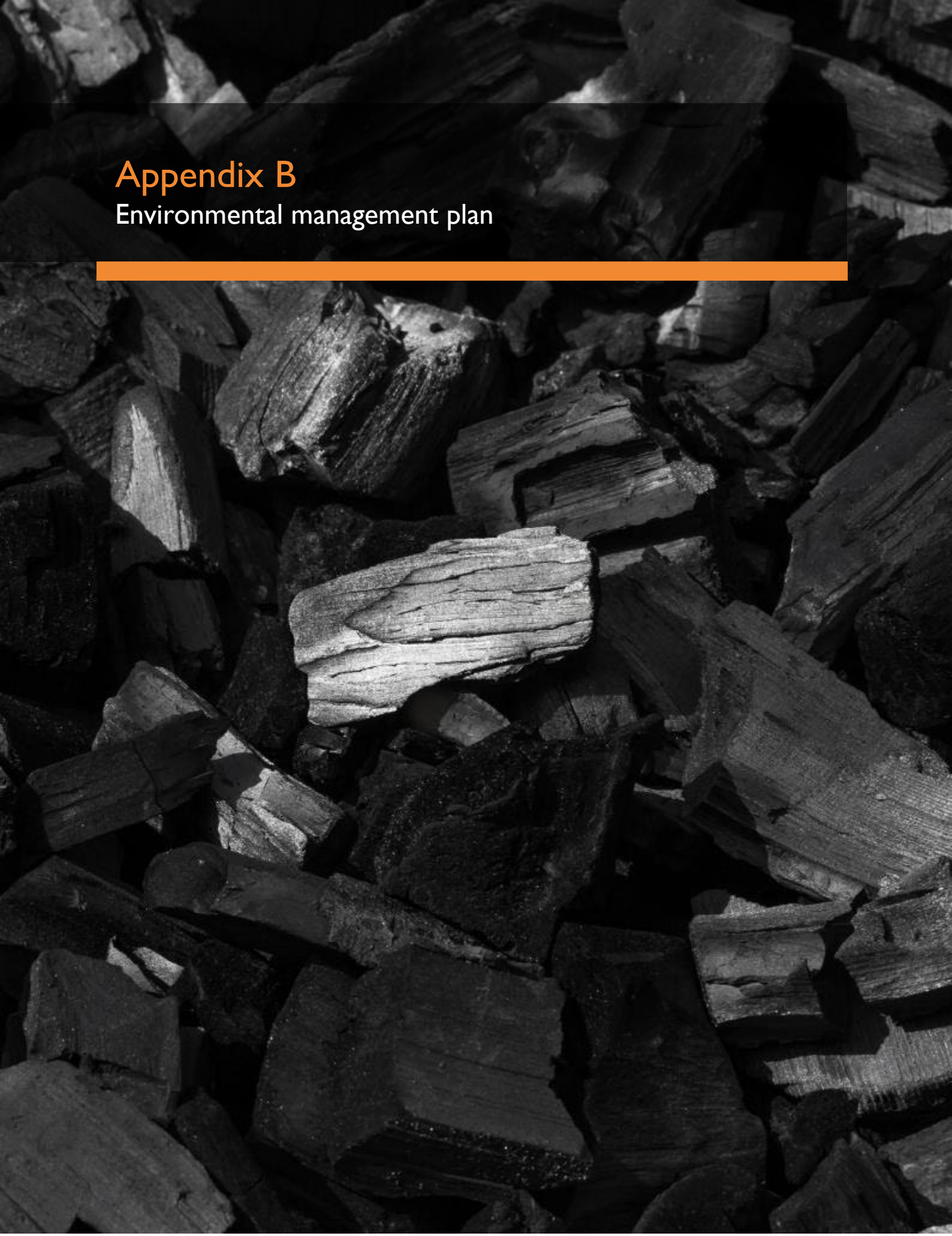
Milestone reference	Rehabilitation milestone	Milestone criteria	Rehabilitation area
		a. the diversions have achieved a target Geomorphic Index score of ≥ 95 % relative to baseline condition. b. the riparian corridor has achieved a target Riparian Index score of ≥ 70 % relative to baseline condition.	
RM9	Achieving surface requirements (native ecosystem)	a) for RE 11.1.11 species richness ≥ 15 native species: – tree species richness ≥ 2 species, including Yellow Jacket (*Corymbia liechhgardtii)*; – shrub species richness ≥ 3 species; – grass species richness ≥ 5 species; and – forb and other species richness ≥ 5 species. b) For RE 11.3.4, species richness ≥ 18 native species: – tree species richness ≥ 3 species, including Forest Red Gum (*Eucalyptus tereticornis);* – shrub species richness ≥ 4 species; – grass species richness ≥ 6 species; and – forb and other species richness ≥ 5 species. c) revegetation ≥ average fractional cover derived from RE technical descriptions for RE 11.1.11: – trees cover ≥ 57.7 %; – shrubs ≥ 36.9 %; and – grasses and forbs cover ≥ 29.3 %. d) revegetation ≥ average fractional cover derived from RE technical descriptions for the RE 11.3.4: – trees cover ≥ 37.1 %; – shrubs ≥ 4.3 %; and – grasses and forbs cover ≥ 61.6 %. e) no active areas of gully erosion and drainage follow appropriate drainage paths; f) certification from an AQP that rehabilitation is resilient to fire; and	RA10 and RA11

Milestone reference	Rehabilitation milestone	Milestone criteria	Rehabilitation area
		g) certification by an AQP that weeds and pest species are in densities no greater than at analogue sites.	
RM10	Achieving PMLU to stable condition (light grazing pasture)	a) certification from an AQP that the area has achieved stable condition; b) certification from an AQP that the landform achieved a factor of safety ≥ 1.5; c) maximum erosion rate of < 10 t/ha/yr; d) total percentage groundcover (vegetation, litter and rock combined) is > 70 %; e) there are no declared Noxious Class 1 or Class 2 weeds; f) native fauna identified at reference sites are present or indicators of these species are recorded; g) water quality complies with *Table C7* of EPML00876713. **Diversions (RA12)** h) prepare assessment report by an AQP certifying that the diversion is operating in accordance with, DNRME Guideline: *Works that interfere with water in a watercourse for a resource activity — watercourse diversions under the Water Act 2000* (OSW/2019/4599) criteria and is in a stable condition. The report will include data from the IDC assessment, showing that Geomorphic Index has maintained a score of ≥ 95 % and the Riparian Vegetation Index has maintained a score of ≥ 70 % for two consecutive years. i) certification from AQP that the diversions have achieved a stable condition, and are able to sustain a 0.1% AEP flood event.	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9, and RA12
RM11	Achieving PMLU to stable condition (native ecosystem)	a) certification from an AQP that the area has achieved stable condition; b) certification from an AQP that the landform achieved a factor of safety ≥ 1.5; c) total percentage groundcover (vegetation, litter and rock combined) is ≥50 %; d) maximum erosion rate of < 10 t/ha/yr; e) there are no declared Noxious Class 1 or Class 2 weeds; f) native fauna at reference sites are present or indicators of these species are recorded; and	RA10 and RA11

Milestone reference	Rehabilitation milestone	Milestone criteria	Rehabilitation area
		g) water quality complies with *Table C7* of EPML00876713.	

Table 48 Management milestones and milestone criteria

Milestone reference	Management milestone	Milestone criteria	Improvement area
MM1	Conversion of the void into a permanent waterbody	a) all major earthworks finished.	IA1
MM2	Highwall and low wall treatment	a) maximum slope of 30% in competent rock; b) maximum slope of 15% in incompetent rock; c) factor of safety ≥1.5; and d) void complies with condition F17 of EA EPML00876713.	IA1
MM3	Achieving surface requirements	a) fencing of 1.8 m high erected around the perimeter of the void; b) warning signage posted around the perimeter of the void following the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland*: c) safety bund constructed at two metres in height, four metres in base width and 10 m beyond the area which may be affected by void edge instability; and d) direct seeding of low walls with species and application rates determined by an AQP.	IA1
MM4	Achieving enough improvement	a) certification from an AQP that the void will not cause environmental harm outside of the tenure boundary: b) certification from an AQP that the void is safe to humans and livestock; and c) certification from an AQP that the water level in the void will not cause environmental harm to the surrounding environment.	IA1



Appendix B
Environmental management plan

This page is intentionally blank.

TERRACOM

TerraCom

Environmental Management System

Environmental Management Plan

January 2017

Revision Approvals		
	Name	Position
Originator:		
Reviewer:		
Approver:		

TABLE OF CONTENTS

1. INTRODUCTION 1

1.1 Mine History 1

1.2 Project Owners and Location 1

1.3 Mining Tenures 1

1.4 Real Property Descriptions 2

1.5 Project Description 2

1.6 Blair Athol Identified Stakeholders 2

1.7 Neighbouring Land 2

1.8 Wild River Areas 2

2. DESCRIPTION OF MINING ACTIVITIES 3

2.1 Mining Method 3

2.2 Coal Processing, Rejects and Tailings 3

2.3 Transportation Activities 3

2.4 Water Management 3

2.5 Explosive Production 5

2.6 Environmental Relevant Activities and Notifiable Activities 5

2.6.1 Abrasive Blasting 5

2.6.2 Motor Vehicle Workshops 5

2.6.3 Chemical, Flammable and Combustible Storage 5

2.6.4 Sewage Treatment 6

2.6.5 Waste Disposal 6

2.7 Mining Facilities and Infrastructure 6

2.8 Integration with Clermont Coal Mine 7

2.9 Areas of Disturbance 7

3. ENVIRONMENTAL VALUES, OBJECTIVES, MANAGEMENT STRATEGIES, COMMITMENTS AND MONITORING 8

3.1 Air Quality 11

3.1.1 Climate 11

3.1.2 Sources of Air Pollution 11

3.1.3 Environmental Values 11

3.1.4 Potential Impacts on Identified Environmental Values 12

3.1.5 Environmental Protection Objectives 13
3.1.6 Management Strategies 13
3.1.7 Commitments 13
3.1.8 Monitoring 13
3.2 Water 14
3.2.1 Surface Water Quality 14
3.2.2 Groundwater 14
3.2.3 Environmental Values 15
3.2.4 Potential Impacts on Identified Environmental Values 17
3.2.5 Environmental Protection Objectives 18
3.2.6 Management Strategies 18
3.2.7 Commitments 19
3.2.8 Monitoring 19
3.3 Noise and Vibration 20
3.3.1 Environmental Values 20
3.3.2 Potential Impacts on Identified Environmental Values 20
3.3.3 Environmental Protection Objectives 20
3.3.4 Management Strategies 20
3.3.5 Commitments 20
3.3.6 Monitoring 21
3.4 Waste 21
3.4.1 Environmental Values 22
3.4.2 Management Strategies 22
3.4.3 Commitments 23
3.4.4 Monitoring 23
3.5 Land 24
3.5.1 Environmental Values 24
3.5.2 Potential Impacts on Identified Environmental Values 27
3.5.3 Environmental Protection Objectives 28
3.5.4 Management Strategies 28
3.5.5 Commitments 34
3.5.6 Monitoring 34
3.6 Water Management 35
3.6.1 Water Balance 35
3.6.2 Levees, Dams and Diversions 36

3.6.3 Environmental Values 37
3.6.4 Potential Impacts on Identified Environmental Values 37
3.6.5 Environmental Protection Objectives 38
3.6.6 Management Strategies 38
3.6.7 Commitments 39
3.6.8 Monitoring 39
3.7 Social and Cultural Heritage 40
3.7.1 European Heritage 41
3.7.2 Aboriginal Cultural Heritage 41
3.7.3 Environmental Values 41
3.7.4 Potential Impacts on Identified Environmental/Social Values 42
3.7.5 Environmental Protection Objectives 42
3.7.6 Management Strategies 42
3.7.7 Commitments 43
3.7.8 Monitoring 44
4. ENVIRONMENTAL MANAGEMENT 8
4.1 Continual Improvement 8
4.2 Records Management 8
4.3 Research and Development 8
4.4 Accountability and Responsibility 9
4.5 Environmental Training and Awareness 9
5. GLOSSARY 45
6. REFERENCES 46

1 INTRODUCTION

The EM Plan is a lifeofmine conceptual and strategic document for minimising environmental impacts resulting from mining activities.

The EM Plan presents environmental protection commitments, environmental protection objectives, standards and indicators. Specific details of how the EM Plan will be implemented are contained in the site Plan of Operations, supporting management plans and site procedures.

1.1 MINE HISTORY

Coal was first discovered at Blair Athol in the 1864 during early gold rush explorations. It was largely ignored until 1889 when the first shaft was sunk. With the extension of the Emerald to Clermont railway to Blair Athol in 1910, coal production increased from approximately 4,000 tonnes per annum to 147,000 tonnes per annum in 1920. Production fluctuated greatly between the 1930s and 1970s with peak production achieved in 1951 at 390,000 tonnes per annum (Peter Hollingsworth and Associated Consultants 1974/76). During this time 15 collieries and three small open cuts operated with the workforce based in the small township of Blair Athol, which was located near the centre of the current mining operation. Large scale operations were initially limited by the remoteness of the operation and the limited export market for thermal coal.

The Blair Athol deposit was mined commercially from 1984 until November 2012 when the former owners ceased coal production. Two mining leases (MLs), ML 1804 and ML 1881, provided tenure over the area of the coal deposit that is contained within a small isolated basin west of the main Bowen Basin coal measures. The total area encompassed by the two tenures was 3,016.7 hectares.

All mining at Blair Athol occurred within ML 1804 while ML 1881 was granted for infrastructure purposes associated with mining at Blair Athol and covers the train load out and infrastructure areas. The location of the mining tenure is illustrated in Figure 2.

With cessation of mining, the train load out and associated infrastructure was sold to the Clermont Coal Joint Venture (CCJV). To enable this transaction, the boundaries of ML1804 and ML1881 were realigned to include all coal handling facilities during 2014.

1.2 PROJECT OWNERS AND LOCATION

Orion Mining Pty Ltd became the holder of ML1804 and Environmental Authority (EA) in December 2016. Link Mining Services (Link) are contracted to undertake the mining activities and are the nominated Mine Operator.

Orion Mining Pty Ltd is a 100% subsidiary of TerraCom Limited.

Blair Athol is located 240 kilometres southwest of Mackay and 17 kilometres northwest of the Clermont Township. The location of Blair Athol is illustrated in Figure 1.

1.3 MINING TENURES

The total area encompassed by ML 1804 is 2361 hectares.

Figure – Mining lease tenure.

The real property descriptions of the land on which BACM operates are provided below in Table 1.

1.4 REAL PROPERTY DESCRIPTIONS

Table of lot and plans.

1.5 PROJECT DESCRIPTION

Blair Athol is a conventional strip-mining, open cut operation with a single dragline removing overburden to expose coal. The coal is transported from the pit by truck and shovel operations to the CHPP.

LDP description?? .

Figure 2 ?

1.6 BLAIR ATHOL IDENTIFIED STAKEHOLDERS

Blair Athol has a range of stakeholders, both internal and external to the mining operation. Identified stakeholders include:

- the Department of Environment and Heritage Protection (DEHP);
- the Department of Natural Resources and Mines (DNRM);
- the Commonwealth Department of the Environment and Energy;
- Isaac Regional Council;
- Wangan and Jagalingou Parties;
- Clermont Regional Landcare;
- Clermont Consultative Committee;
- neighbouring property holders D. Mayes and J. Burnett of Blair Athol Station (both old and new Blair Athol homesteads are located on this property)

1.7 NEIGHBOURING LAND

Land use on land surrounding Blair Athol includes State Forests, grazing and some limited cropping. Blair Athol State forest adjoins the east, south and west sides of the mine.

The residential sensitive places located nearest to the mine are D. Mayes (new Blair Athol Homestead, 2.5 kilometres north of the ML boundary) and J. Burnett (old Blair Athol Homestead, 500 metres east of the ML boundary). The nearest commercial operation is Capricorn Bulk Handling (operated by D. Mayes), a domestic coal screening and crushing facility, is located 800 metres east of the ML boundary. The vicinity of the residential sensitive places in relation to the mine is illustrated in Figure 3.

1.8 WILD RIVER AREAS

Blair Athol is not located within any declared wild river area (Wild River Act 2005) and mining activities will not impact on any declared wild river area.

Figure of sensitive receptors – homestead locations

2 DESCRIPTION OF MINING ACTIVITIES

2.1 MINING METHOD

Mining at BACM will only occur in areas that have been previously disturbed. This means mining through exposed loose spoil, existing water infrastructure and rehabilitated areas. The mining sequence therefore s at the BACM site are detailed as below:

- Spoil is removed by truck-shovel and / or dragline with emplacement scheduled to enable the required landform to be developed;
- interburden is drilled and blasted and removed,
- blasting activities are conducted using a rotary drill rig and contractor bulk explosive manufacturing trucks;
- the spoil material is transported to dedicated inpit and outofpit spoil dumps using either draglines or trucks;
- the exposed coal seam is ripped by dozers and mined by a hydraulic excavator or frontend loader and loaded into haul trucks;
- raw coal was hauled to the preparation plant, that consists of three stages of crushing and screening, or dumped on the runofmine (ROM) stockpile;
- bulk earthworks and reshaping to create landform profile with the installation of drainage structures; and
- topsoil placement and seeding complete the rehabilitation with regular monitoring to understand the extent of stabilisation and achieving criteria.

2.2 COAL PROCESSING, REJECTS AND TAILINGS

Fifty percent of ROM coal will not require washing to achieve the product specifications. This coal passes through three stages of crushing and screening. Coal is dumped into a hopper and passed through an apron feeder into a hammer crusher that reduced the size of ROM coal to <500 millimetres. This feeds the twin rotary breakers at the secondary sizing station where it is reduced to <120 millimetres. Product coal from the breakers passes over a screen to take out product sized coal (<50 millimetres). Final product coal is then conveyed to the coal stockpile or fed directly into the train loading bin.

Construction of a small coal wash plant with a processing capacity 300 tph was completed in 1999. This allowed coal to be washed reducing the ash and sulphur content in the product coal.

2.3 TRANSPORTATION ACTIVITIES

An access road, approximately 17 kilometres in length, has been in place since large scale production commenced at Blair Athol in 1984. The road extends from the Peak Downs Highway to the operating site.

Coal will be railed from site to the Dalrymple Bay Coal Terminal for export.

2.4 WATER MANAGEMENT

Surface drainage in the area is controlled by the Drummond Range to the north and west. This mountain range forms the watershed between the Burdekin drainage system in the north and the Fitzroy system to the south. The mining tenure is drained by Bath and Washpool Creeks, both streams converging at a point on the southern boundary of ML1804. Both creeks were diverted to allow mining operations to proceed. The total

catchment area for this system is approximately 65 kilometres^2 (includes the system both within and outside of the lease areas) (refer Figure 4).

The water management system at BACM, governed by the Water Management Plan, is comprised of two key components:

- an external catchment (clean water) diversion system; and
- an internal catchment (mine affected) collection and recycling system.

There are a number of water storage management structures on site that manage these catchments. Table 2 details these structures.

Figure 5 details the mine affected water dams and water distribution pipelines. Figure 6 illustrates the current clean water management system including locations of the clean water dams and current diversions and Figure 7 provides a schematic of both the mine affected and clean water management system.

A network of mobile pumps and pipelines provides cross continuity between the various mine water storages and pits. Imported pipeline raw water and water available in the various mine storages and pits is used to meet any site demands as required

Table 2 current water storage management

Catchment figure

At present, runoff water from all catchments within the mining tenures is contained on site by the mine water management system (refer Water Management Plan). Water from undisturbed catchments north and west of the rail loop is diverted around the site via diversions (refer Section 3.6).

The Stockpile Dam is the only authorised discharge point to release water off site. This dam is used to control the final water quality prior to release, or to hold contaminated water prior to pumping back into the mine affected water system. The Stockpile Dam is located off lease within the Glencore owned tenement.

The Environmental Dam holds approximately 600 megalitres of water and has a surface area of 21.3 hectares. The dam wall was designed to contain 900 megalitres, however it will start to spill once the water reaches the spillways (600 megalitre mark).

During operation, onsite surface flows were captured, stored and used in the CHPP, for road watering, vehicle wash down, and where suitable, personal hygiene and drinking water. Process water for haul road watering, coal washing and dust suppression is sourced from pit water and water harvested from runoff. BACM also has water licences for the extraction of up to 1,200 megalitres per year of surface water from the Environmental Dam and West Dam.

A water treatment plant treats raw water from West Dam, an earth embankment dam, to provide potable water to the site. West Dam is located off lease within ML1881. It holds approximately 1,500 megalitres of water and has a surface area of 44 hectares. The West Dam captures runoff water from the Washpool Creek and Breaker North catchments (undisturbed by mining activities) and is primarily used as the potable water supply for the mine site. The West Dam was designed with a flow attenuation capacity and could take a significant inflow of water above the full point. This was also designed to reduce peak flow velocities at the Combined Eastern Diversion System.

2.5 EXPLOSIVE PRODUCTION

Explosives are mixed onsite by a contract supplier using mobile manufacturing units (trucks). Explosives were generally mixed in the trucks just prior to loading into drill holes. Initiating explosives are stored onsite in the approved magazine facility located on ML 1881. Ammonium nitrate are stored off site at the contractor's compound.

Blasting activities are undertaken by a licensed contractor and the explosives storage areas are licensed in accordance with the Explosives Act 1999.

2.6 ENVIRONMENTAL RELEVANT ACTIVITIES AND NOTIFIABLE ACTIVITIES

BACM conducts Level 1 Environmentally Relevant Activities (ERA) prescribed under the Environmental Protection Regulation 2008. The ERA's are:

- Schedule 6 – 5 mining black coal;
- ERA 8 – Chemical storage;
- ERA 63 – Sewage treatment: [2(b) Sewage Treatment: >1001,500 EP];
- ERA 17 – Abrasive blasting: [Abrasive blasting – permanent location or mobile and temporary];
- ERA 18 – Boiler making or engineering;
- ERA 21 – Motor vehicle workshop operation; and
- ERA 60 – Waste disposal [2(b) Waste disposal facility (any combination of general waste and no more than 10% limited regulated waste) >2,000 5,000 t/yr)].

All notifiable activities carried out (as per Schedule 3 of the EP Act) are listed below in Table 3 and the location of each illustrated in Figure 8.

2.6.1 Abrasive Blasting

Abrasive blasting, if required, is undertaken by contractors and site personnel on the site structures to prepare the metal surfaces for corrosion protection. Abrasive blasting may also be undertaken periodically at designated shutdown sites, for maintenance of fixed or mobile equipment. Spent abrasive material is removed off site by the contractor.

2.6.2 Motor Vehicle Workshops

BACM has one heavy vehicle workshop, one light/medium vehicle workshop and one tyre and lubricant bay to service mobile site equipment. The dragline and EX3600 excavator are serviced in the field, with the remaining heavy machinery serviced periodically in the heavy vehicle workshop.

The workshop areas are all enclosed buildings and constructed on a hardstand with drains that direct any oily water and small spills to the oil/water separator located on the northern side of the workshops. The system separates the waste oil into a storage tank and the water into the Infrastructure Dam. Waste oil is collected by a regulated waste operator. The oil/water separator is inspected weekly and cleaned out as required.

2.6.3 Chemical, Flammable and Combustible Storage

Link proposes to utilise new self-bunded tanks for the storage and distribution of fuels.

The site has two decommissioned 750,000 L above ground diesel tanks and a small decommissioned underground diesel tank located near the mobile equipment servicing area. There are four 5,000 L above ground tanks storing lubricant adjacent the heavy vehicle tyre and lube workshop.

All hydrocarbon tanks and storages areas are bunded and designed in accordance with the relevant sections of AS 19402004 (The storage and handling of flammable and combustible liquids).

Fuel seepage from the underground distribution pipelines was detected and determined to be due to pipeline age. Any contaminated areas are recorded and will be appropriately remediated on closure of the mine.

2.6.4 Sewage Treatment

The sewage treatment plant was constructed in 1982 and is adjacent to the mine access road. The two-tank chlorinated anaerobic system was originally designed to treat effluent for 300400 equivalent persons (EP). The sewage treatment plant is inspected daily and sampled regularly for: dissolved oxygen, pH, suspended solids and clarity. Treated sewage effluent is pumped to a clay lined sewage effluent pond where it can evaporate. The sewage effluent pond is designed with no upstream catchment and contains all effluent material with no discharge. Faecal coliforms are tested at the sewage effluent pond on a quarterly basis.

2.6.5 Waste Disposal

The sources of waste generation from the mining operation include:

- regulated wastes hydrocarbon fuel waste, oils and lubricants, vehicle batteries, oil filters and oily rags, tyres, detergents, solvents from workshop activities;
- loss of containment from fuel storage (distillate) in above ground storage;
- mineral waste fine tailings and coarse rejects;
- sewage sludge;
- general wastes, e.g. food scraps, wrapping paper, timber products;
- recyclable waste, e.g. paper, glass bottles, steel and aluminium cans, cardboard;
- heavy vehicle tyres (that can be disposed of onsite with the locations registered); and
- light vehicle tyres (disposed offsite).

General waste, recyclable waste and regulated waste is collected and segregated onsite for reuse, recycling or disposal if necessary. Transportation of wastes off-site is via a licensed waste contractor and recorded in a waste tracking system.

Figure 12 illustrates the location of the historic landfill (considered to have regulated waste emplaced) and tyre dumps that are now buried in spoil with the outer landform rehabilitated since 1993. Monitoring of surface water and groundwater is conducted down gradient from the landfill area (refer Section 3.2.8).

2.7 MINING FACILITIES AND INFRASTRUCTURE

Blair Athol includes the following mining related facilities and infrastructure:

- access track and road construction;
- levees, dams and diversions;
- coal washing plant;
- sewage treatment plant;
- diesel, oil and other hydrocarbon storage;
- chemical storage;
- mobile lube truck operation;
- fixed heavy equipment and light vehicle refuelling station;
- heavy equipment workshop; and
- heavy equipment and light vehicle wash down facility.

2.8 INTEGRATION WITH CLERMONT COAL MINE

Supply of excess water from the Clermont site to Blair Athol will continue via the dedicated pipeline. Within EA condition W26 requirements, mine affected water can also be pumped via pipeline or transported by truck from Blair Athol to the Clermont site for production purposes. The pipeline for mine water is different to that for water supply.

2.9 AREAS OF DISTURBANCE

The total area encompassed by ML 1804 is 2,361 hectares. Of the 2,361 hectares, approximately 1,188 hectares is disturbed land (Figure 9). The annual area of disturbance for the remainder of the operational life-of-mine is presented in the Plan of Operations.

Disturbed land at Blair Athol has been rehabilitated progressively over the operational life of the mine. Significant areas of Blair Athol have been rehabilitated with native grass, shrub and tree species, in line with the surrounding biodiversity values and EA conditions.

Blair Athol's aim is to re-establish a native ecosystem to the ML. This will be achieved by the reprofiling of the dragline spoil piles remaining following the strip mining process. The overburden piles will be reprofiled to less than or equal to 15% slopes, such that they are sufficiently stable to prevent erosion and are suitable for the reestablishment of native species.

Past rehabilitation efforts have included replacement of topsoil is over the reprofiled spoil to a depth of not less than 10 centimetres, installation of drainage control banks, deep ripping using the tynes of a dozer and seeding with native species.

3 ENVIRONMENTAL MANAGEMENT

Blair Athol operates under an Environmental Management System (EMS) which defines the environmental and cultural responsibilities of all employees, contractors and visitors to Blair Athol. The EMS is aligned with the principles of Australian/New Zealand ISO14001 Environmental Management Systems ¬ Requirements with Guidance for Use.

3.1 CONTINUAL IMPROVEMENT

Continual improvement is facilitated through EMS processes such as inspections, auditing, monitoring and research and corrective actions applied from incident investigations.

Internally, Blair Athol reports environmental performance on a quarterly basis to site managers. Minutes of these meetings are recorded and actions/feedback is tabulated and action items completed are closed. Blair Athol reports annually to Rio Tinto corporate the performance outcomes against key performance targets developed for the year.

Externally, Blair Athol has opportunities to demonstrate continual improvement through the PoO external third party audit and during DEHP compliance inspections.

Any actions that are identified from checking and review processes are entered the Rio Tinto Business Solutions (RTBS), which generates a work list. The work list identifies the responsible person to complete the action, the task to be carried out and timeframes. RTBS keeps a record of the closed action on completion and signoff.

3.2 RECORDS MANAGEMENT

All records pertaining to the EMS, including regulatory required documents, are electronically stored in the HSEQ site document register. Site personnel can easily access and open the most current version documents within the register. However, only the Administrator can upload new documents and allow existing documents to be edited through the Change Management process. Three additional site personnel have administrative authorisation for operational contingency.

All printed copies of documents from the HSEQ document register are identified as uncontrolled.

All information relating to environmental management shall be recorded and stored for a minimum of five years. In reality, most the environmental information is kept (archived) for the whole mine life as it provides useful historic information.

3.3 RESEARCH AND DEVELOPMENT

RTCA is a major contributor to mining related environmental research through its own corporate research and development and through support of the Australian Coal Association Research Programme (ACARP), the Australian Centre for Mining Environmental Research (ACMER) and the University of Queensland Centre for Mined Land Rehabilitation (CMLR).

Blair Athol maintains a strong commitment to research and development, with the primary focus on mine rehabilitation techniques and the development of rehabilitation success criteria.

Past research projects include:

- Erosion investigation of mine rehabilitated land undertaken by Commonwealth Scientific and Industrial Research Organisation (CSIRO); and
- Ecological Indicators of Rehabilitation Success on Minesites. Criteria for successful native vegetation and wildlife habitat development. (Bellairs 1998).

3.4 ACCOUNTABILITY AND RESPONSIBILITY

Environmental accountability and responsibility are identified in the position description of all personnel. The level of detail provided in the position descriptions is reflective of the environmental risks and environmental influences of the position. Annual performance reviews are conducted and consider the individual's performance against the position description accountability and responsibilities.

Work instructions and standard operational procedures have been developed for high risk environmental activities carried out at the mine. These work instructions and standard operating procedures specify the environmental accountabilities and responsibility of undertaking specific tasks.

3.5 ENVIRONMENTAL TRAINING AND AWARENESS

Blair Athol has developed a training scheme, the purpose of which is to provide a clear, structured, authorised training process which ensures employee, and contractors are competent to perform the required work safely on site, minimising the risk of damage to people, equipment and environment. Contractors are treated in the same manner as a Blair Athol employee in matters related to competency and authorisation.

A training database is kept for all personnel to ensure that training needs can be identified, to track training and/or qualification expiry dates, and to record training programmes that personnel have attended.

All competency based training programmes must meet the development and delivery training requirements of the Blair Athol's Training Scheme.

All visitors must complete a visitor induction which covers safety, health and environmental aspects.

New employees and contractors must meet and provide evidence of the positions required qualifications and/or experience prior to completing the one day site induction. Challenge tests may be required of some positions to verify competency authenticity and ensure site standards can be met.

The site induction includes an environmental competency for all new employees and contractors. The competency covers the following aspects:

- company environmental policy;
- legislation;
- water management;
- rehabilitation;
- dust management;
- topsoil management;
- waste management;
- spontaneous combustion;
- conservation;
- cultural heritage; and
- environmental emergency procedures.

A short test is given at the end of the induction to ascertain understanding of the information provided.

Informal training may be conducted to improve environmental awareness or performance. The informal training methods may include toolbox sessions, memos, newsletters, PowerPoint presentations and internal emails and is conducted on an as needs basis.

4 ENVIRONMENTAL VALUES, OBJECTIVES, MANAGEMENT STRATEGIES, COMMITMENTS AND MONITORING

4.1 AIR QUALITY

4.1.1 Climate

The Clermont region experiences a transitional or subhumid climate. This is characterised by hot summers with storms and drier cold winters.

Data obtained from the Bureau of Meteorology notes that:

- December and July are the two most extreme months in terms of temperature, with daily means ranging from 34.9°C to 20.8°C in December and 23.0°C to 6.7°C in July;
- evaporation generally exceeds rainfall approximately 3 times;
- annual mean humidity is generally between 3863%;
- winds are predominantly from the southeast;
- average annual rainfall is 660mm but is unpredictable and variable with the rainfall events usually of high intensity and short duration; and
- average monthly rainfall levels in Clermont, presented in Table 4, indicates that the months of December to February are the most reliable rain periods.

Table of average rainfall

4.1.2 Sources of Air Pollution

The sources of air pollution include dust generated from equipment and products of spontaneous combustion from remnant coal or overburden stockpiles, and disturbed areas created during historical mining operations.

Air pollution in the surrounding area is localised and limited to specific activities, for example, dust from the domestic coal screening and crushing facility; soil cultivation; smoke and other contaminants from grass/bush fires and occasional dust storms.

4.1.3 Environmental Values

The environmental values of the air quality are represented by high local air quality, with some elevated particulate levels during dry periods from fire and surrounding agricultural lands.

The nearest residential sensitive receptors to the mine are D. Mayes and J. Burnett of Blair Athol Station, on which both old and new Blair Athol homesteads are located. New Blair Athol Homestead is 2.5 kilometres north of the ML boundary and old Blair Athol Homestead is 500 m east of the ML boundary (refer Figure 3). The topography and eucalypt forest protects the new Blair Athol Homestead adequately from dust impacts. During mining operations, the old Blair Athol Homestead was more likely to experience noise impacts, particularly as mining operations advanced in its direction. However, the owners of Blair Athol Station (D. Mayes) also operate a coal crushing and screening yard (Capricorn Bulk Handling) on their property within approximately two kilometres of their residence.

Background air quality has been obtained through Clermont Mine's Environmental Impact Statement (EIS) (SKM, 2004) air quality investigation. The Clermont Coal Mine is located approximately six kilometres to the east of Blair Athol. The background particulate samples from monitoring sites DG1 to DG4 collected during

the period November 2003 to October 2006 were used as representative ambient air quality levels for Blair Athol. The particulate monitoring results indicated that the mean air quality for the local landscape was 19.5 mg/m^2/day. The data also showed that the natural environment experienced sporadic extreme dust events (as shown in Table 5).

4.1.4 Potential Impacts on Identified Environmental Values

Air emissions from open cut mining can have potential impacts on the local, regional and global scale. Although dust is the predominant emission associated with the mines, there is are also a range of gaseous emissions released from coal mining.

Land clearing, material movement and excavation, blasting, exposed surfaces, coal preparation processes, coal handling facilities are all major sources of dust generation that may impact on the air quality.

Table 6 provides the average and maximum monthly dust captured at four monitoring locations at the Blair Athol ML boundaries (refer Figure 10).

The northeast dust monitoring location is 400 metres and 2,020 metres from the old Blair Athol Homestead and new Blair Athol Homestead respectively. Average dust deposition levels at the northeast dust monitoring location for the period January 1994 to December 2009 is 49.6 mg/m$^{2/}$day. The maximum dust numbers are outliers and are a result of bushfires within the state forest area and not from dust generated by the mining activity. The data shows that maximum dust levels recorded that can be attributed to the operations are around the 120mg/m2/day, however these are only experienced during prolong drought periods.

Blair Athol has a history of spontaneous combustion. Spontaneous combustion of coal is a significant safety risk for mining operations and the burning of the coal releases carbon monoxide, carbon dioxide, sulphur dioxide and methane into the atmosphere. Spontaneous combustion and the resulting fires within the historical underground operations, has previously been a significant issue at site. The major sources of spontaneous combustion have arisen from the historical underground and within pit dumps. However, in addition, Blair Athol does not mine a relatively thin coal seam located above the major coal resource and this thin coal seam removed, along with overburden, by dragline operations. Where this coal becomes exposed to oxygen in spoil areas this can lead to small scale spontaneous combustion. These areas of heating are relatively short lived as the coal is consumed during the spontaneous combustion process.

continuous sampler spontaneous combustion monitoring station located at Ramp 3 North was installed in September 2009. The monitoring station is currently used to detect smoke from spontaneous combustion. The monitoring station is located within a direct line from pit and neighbouring residence. Shortterm gas monitors (8 hour monitoring duration) are regularly set up at the residences to test for sulphur, hydrogen sulphide, sulphur dioxide and methane.

The particulate and spontaneous combustion gas emissions are not expected to create any regional or global public nuisance or health concerns. However, there is potential for there to be minor impacts on the old Blair Athol and new Blair Athol homesteads in times of low rainfall and higher wind speed where airborne particulate matter travels further.

On a regional scale there are several large mining operations and other dust intensive industries such as the domestic coal screening and crushing facility, agricultural cropping and rail activities in the area contributing the overall concentration of airborne particulate matter.

4.1.5 Environmental Protection Objectives

The air quality objective for Blair Athol is to maintain ambient air quality levels, ensure sensitive receptors are not adversely affected and that no unlawful environmental nuisance from air quality impacts can be attributed to the activities on site.

4.1.6 Management Strategies

The control strategies listed below for the management of air quality will be implemented.

Methods to reduce particulate emissions generated from site include the following:

- water haul roads and unsealed access roads during dry periods and heavy usage;
- avoid burning cleared vegetation when wind will be blowing towards sensitive receptors;
- vehicles will be regulated to the set speed limits to reduce dust generated from unsealed roads;
- disturbed land will be progressively rehabilitated as soon as practicable;
- topsoil stockpiles will be revegetated, where appropriate, to prevent dust generation;
- communication on a regular basis with neighbouring residents to gauge and respond to air quality matters, thus minimising the potential for formal complaints to be raised.

Spontaneous combustion management techniques include:

- thermal sensing has been applied on site as an early detection to identify temperature differences and identify spontaneous combustion risks;
- underground operations have been backfilled with a spoil/cement product which flows into the underground workings via holes drilled from the land surface. The mixture then hardens over time to give a product which is plasticinelike in nature. The spoil/cement mixture completely fills the void, extinguishing all spontaneous combustion. The backfilling of underground voids also prevents the influx of oxygen which would otherwise have been possible with underground workings opening to the current mining pits. All underground fires have now been extinguished via this backfilling process;
- a Principal Hazard Management Plan has been developed in conjunction with the Department of Mines and Energy to combat any future spontaneous combustion issues in underground workings;
- extinguish spontaneous combustion fires on the ground surface as soon as practicable in accordance with the Spontaneous Combustion Trigger Action Response Plan;
- accumulations of coal in spoil and waste dumps is buried as low as possible in the spoil profile, under inert material and where possible compacted to minimise oxygen circulation; and

For further details refer to the Spontaneous Combustion Management Plan.

4.1.7 Commitments

Blair Athol is committed to ensuring that air emissions impacting on sensitive receptors meet the Environmental Protection Air Policy 2008 ambient air quality requirements for PM10 and sulphur dioxide. At the sensitive receptors, the PM10 should not exceed 50 &#65533;g/m3 24 hour and sulphur dioxide 0.08 ppm 24 hour as a result of mining activities.

Blair Athol commits to taking actions to mitigate the nuisance emissions and responding to the complainant expeditiously and, where warranted the investigation of dust/fume/smoke/odour complaints.

4.1.8 Monitoring

During mine operations, a local programme to monitor dust levels on a monthly basis around the mine site had been in place since January 1994. There are four fixed gravimetric dust gauges located on the lease boundary and all of which were approximately one to two kilometres from high dust generating activities.

Results from these sites were reviewed monthly to determine if air quality levels complied with the EA conditions.

Sufficient baseline data regarding dust deposition of the mining operation at 12Mtpa is available therefore monitoring will only be undertaken following a request from DEHP.

There was a sulphur dioxide monitor permanently located at Ramp 3 North station to gauge the sulphur, hydrogen sulphide, sulphur dioxide and methane generated from the spontaneous combustion. Short¬term portable gas monitors (8 hour monitoring duration) were set up at the residences, both old and new Blair Athol Homestead, to test for sulphur, hydrogen sulphide, sulphur dioxide and methane when spontaneous combustion outbreaks occur.

4.2 WATER

4.2.1 Surface Water Quality

Blair Athol is located at the top of the Bath Creek tributary of Sandy Creek in the foothills of the Drummond Range. Sandy Creek is a subcatchment within Theresa Creek Catchment in the northwestern corner of the Fitzroy Basin (refer Figure 1).

The catchment area upstream of Blair Athol is approximately 65,000 hectares and is comprised of a number of ephemeral creeks; Breaker, Bath and Washpool Creeks. These creeks join within the lease area and flow downstream as Bath Creek. Within the catchment infrequent and unreliable rainfall patterns result in sporadic flows preceded by long dry periods. Downstream water use near the mine is restricted to stock watering and maintaning ecosystem function. Cattle and wildlife use the water from several waterholes that exist intermittently along Bath Creek in the dry season.

The diversion of Bath, Washpool and Breaker Creeks has been necessary to enable mining of the Blair Athol Coal Measures. Mining of coal at Blair Athol has been undertaken since 1889 with a number of modifications made to both Washpool and Bath Creeks, prior to the main operation commencing in 1984. At the northern extent of the mining area, West Dam collects clean water runoff from Washpool Creek, and this dam was initially constructed in the 1950's. With the development of the large open cut pit, the water is currently diverted around the mining area by the Northern Boundary Drain, along the Eastern Diversion where it meets Bath Creek where it then flows into the Environmental Dam before running off lease via the original Bath Creek Channel.

4.2.2 Groundwater

Three groundwater aquifers are known to pass through the Blair Athol leases:

- the coal measures;
- the basalt area in the north; and
- alluvials associated with the natural creek system.

Knowledge regarding the groundwater environment prior to mining at Blair Athol is generally unknown as premining baseline groundwater data is unavailable. The earliest groundwater data was obtained from exploration drilling in the 1970s and early 1980s, and includes drill holes on the current lease and immediately outside the lease. An EIS completed for the site in 1974 (Peter Hollingsworth and Associated Consultants, 1974/76) concluded that the groundwater yields in the sandstone (the coal measures) were very low, less than two litres per second. The groundwater level, at the time, was approximately 280 mRL on site, slightly higher at the northern end of the lease area, and groundwater considered to be flowing towards the south. Followup studies to the EIS identified the basalt in the north and northeast of the site to be the source of most groundwater on site (in the areas to be mined), with limited groundwater seepage in coal seams outside

of the basalt. Evidence on site has identified groundwater in the coal seams as being considerably varied from seam to seam and from location to location and that water supply from in pit seepage has significantly reduced over time and therefore it is not considered a reliable source of water for the site.

Groundwater studies by Coffey & Partners Pty Ltd (1982) indicated that there was no evidence that the aquifers are interconnected. Basalt aquifers only enter the mining area in the north-eastern part of the mining operations. Based on geological information from the EIS, the basalt was flow deposited infilling shallow depressions, and covers only a small proportion of the ML. The basalt aquifer outside the mine is largely untouched. Water quality of the basalt aquifer indicates the system is predominantly recharged by rainfall. That is, rainfall recharges into a shallow aquifer with little time for hydrogeochemical processes to occur (Terrenus 2009).

There are no production bores on site. The nearest production bores are the Curtis Windmill Bore and the Mayes bore located approximately 500 metres and 1,500 metres, respectively, northeast of the ML1804 boundary.

Basal conglomerate and sandstone aquifers are believed to be the regional aquifer in the Blair Athol Region, although the lateral extent and thickness outside of the lease boundary is unknown. The fact there are no groundwater bores near the mine that are drilled into the regional aquifer suggests that this aquifer has limited beneficial use. No artesian or sub artesian aquifers exist within the vicinity of the mine site. Most groundwater users in the area source water from the fractured basalt or tertiary alluvium aquifers that are located to the east of the mining lease. Groundwater from the basal conglomerate/sandstone aquifer receives groundwater percolating downwards from the overlaying basalt aquifer (Terrenus 2009). The general movement of water is from north to south.

Where the mining pit intercepts the regional aquifer, recent data suggests that the groundwater in the unconfined conglomerate regional aquifer (the only aquifer in the southern part of the mine not affected by the basalt) is tending to flow northwards towards the centre of the mine (260 mRL) in the mining void (Terrenus 2009). A conceptual hydrogeological model for the current mining operations is illustrated in Figure 11.

Figure 11 conceptual groundwater model for blair athol

4.2.3 Environmental Values

4.2.3.1 3.2.3.1 Surface Water

Upstream catchments vary between timbered hills to open grazing land to broad acre cropping which results in some variation in water quality entering the site. Upstream sampling of water quality has been undertaken since 1996 for Bath Creek, 2002 for Washpool Creek and 2008 for Breaker Creek, and in this time period, there was a limited number of flow events to monitor.

Supporting regional data was obtained from DEHP for Wolfang and Sandy Creeks (1962-2001). Table 7 shows the basic water quality parameters for both creeks for this period.

Sandy Creek's catchment is in the Drummond Range in Blair Athol and Bathhampton State Forests, and is similar to Breaker Creek and Washpool Creek which flow through the mining lease. Wolfang Creek's catchment is predominantly off the black cracking clay cropping and grazing lands and is similar to Bath Creek.

During a flood event in February 2008, a grab sample was collected from Sandy Creek at the Clermont Town Bridge. Water quality results from this event were as follows:

- pH– 8.5
- Electrical Conductivity 130 uS/cm
- Suspended Solids – 4,300mg/L

Table 8 summarises the collected data sets for Bath and Washpool Creek.

Table on water quality stuff

Upstream data points display similar variability in water quality to the local and regional data, with factors such as ground cover, land use and rainfall intensity all impacting on the quality of the water entering the mine. High intensity storm events at the end of the dry season also have the potential to result in poorer water quality running off from the surrounding catchments.

Water collected from ponds within rehabilitation areas often reflect the maturity of the rehabilitation development with new/bare areas resulting in poor water quality than more established rehabilitated areas. Many of the ponds within the rehabilitation areas are ephemeral with water often totally evaporating during the dry season and during droughts, which also impacts on the water quality results. Table 9 presents the water quality for two dams which receive runoff from rehabilitated land, The Ecolodge pond and the Ramp 4 1996 Rehabilitation Pond. The Ecolodge Pond is a confined pond within a rehabilitation area which was developed in 19911993 with the collection of water quality samples commencing in 1993. The Ramp 4 1996 Rehabilitation Pond is a larger pond which is located within spoil, but collects runoff solely from rehabilitated slopes which range in age from 19962001.

Table 9

4.2.3.2 3.2.3.2 Groundwater Values

Three groundwater aquifer systems were present prior to the commencement of mining:

1. the coal measures;
2. the basalt area in the north; and
3. shallow alluvial associated with the natural creek system

Research has identified that each aquifer system appears to be independent (Golder Associates 2001). The shallow alluvial aquifer system within the mining lease has largely been removed by the open cut mining operation. The systems were localised and associated with Washpool and Bath Creeks prior to the areas being disturbed by mining. These systems are no longer present within the mining area and cannot be reinstated at the end of mining as it is not possible to re-establish hydraulic conductivity from the final landform.

Groundwater sourced from the coal measures is saline in nature and is limited to the extent of the coal seams. The water in the coal seams has accumulated in the cleats over time through percolation of surface water. Currently, water sourced from coal seams is pumped into the mine affected water system as a small contributor to total mine water sources. At the completion of mining, the majority of coal seams and associated groundwater will have been removed.

BACM monitors the Curtis Windmill Bore (basalt groundwater) located on its nearest neighbour. This bore is pumped regularly for stock water. It is difficult with the pumping to identify if dropping water levels within the bore is indicative of mining impacts or regular pumping. However, bore recovery rates indicate that it is unaffected by either activity and is likely to be influenced by significant recharge events such as the 2008 central highland high rainfall event.

The average quality of the groundwater from the Curtis Windmill Bore is shown in Table 10.

Table 10

Seepage modelling of the Tailings Storage Facility (TSF) undertaken by URS (2008) suggests that most seepage will be from the embankment in the early and middle stages of construction and that the seepage rates through the embankment will be minimal in the latter operational/decommissioning stages. The long-term prediction from URS (2008) is that the most seepage will be through the TFS floor into the underlying spoil, and then into the sandstone/conglomerate aquifer (coal seam remnants). The rate of water movement through the TSF floor is expected to decrease post closure as the tailings dewater and the TSF cap and revegetation reduces rainfall recharge.

Seepage chemistry reviewed suggests that drainage beneath the TSF embankment is neutral, indicating that the inherent buffering capacity of the rejects and tailings to self neutralise may be occurring (Terrenus 2009). Geochemical investigations by EGi (2009) reported that the time lag for potentially acid forming (PAF) rejects to generate acid was likely to be within a few weeks, whereas the time lag for PAF tailings to generate acid was expected to be much longer, approximately two years. Water chemistry of the Ramp 1 Transfer Dam, the dam beneath the TSF, is also neutral and the groundwater chemistry from the adjacent ground water monitoring bore shows no impacts from the TSF (Terrenus 2009).

4.2.4 Potential Impacts on Identified Environmental Values

Mining activities which had the potential to impact water quality included:

- changes to the catchment hydrology due to containment of mine site runoff and creek diversions;
- operations of dams associated with the site water management system;
- operation of tailings and rejects disposal facilities;
- pumping of groundwater inflows in active pit areas; and
- release of surplus mine affected water downstream.

4.2.4.1 3.2.4.1 Surface Water

Potential impacts because of past mining activities that are specific to surface water may include the following:

- contamination of sheet flow with sediment, metals and salts from overburden dumps;
- in pit mixing of runoff with saline groundwater;
- contamination of natural water quality in downstream creeks following site discharge;
- contamination of runoff from other areas of disturbance (including rehabilitation and infrastructure areas);
- water contamination from hydrocarbon spills, i.e. grease, oil and fuel;
- water contamination from sewage treatment plant effluent; and
- reduction of quantity of water entering the local drainage systems due to capture of rainfall runoff in mining pits and dams associated with the pits.

4.2.4.2 3.2.4.2 Groundwater

Potential impacts because of past mining activities specific to groundwater potentially included the following:

- aquifer ingress to the operating pits and pit dewatering may adversely affect the quantity of water within basaltic and alluvial aquifers;
- drainage through wastes from spoil, rejects or tailings may potentially contaminate groundwater;
- contamination of groundwater by hydrocarbon and other chemical spillage from servicing and maintenance activities; and

- contamination of groundwater by sewage effluent.

4.2.5 Environmental Protection Objectives

The environmental protection objectives for water management at Blair Athol are to:

- separate mine affected water from clean water;
- contain mine affected water on site for reuse as dust suppression and coal processing;
- manage discharges off site to meet the EA requirements;
- to avoid degradation in physical and chemical characteristics of downstream Bath Creek which impact on the beneficial use of the water;
- to minimise the impacts of the environmental values of the downstream waterways;
- maintain the quality of water within the basalts and alluvial aquifers; and
- minimise the reduction of groundwater quantity within the aquifers at adjacent landholders bore sites.

4.2.6 Management Strategies

The mine water management system is designed to minimise the chance of an uncontrolled release of mine affected water. The shape of the coal basin and the shallow overburden stripping ratio has resulted in the majority of the spoil piles forming below natural ground level. As a result, the mining area naturally drains inwards rather than shedding to surrounding unmined areas. The maturity of the mining operation has also allowed for the development of numerous voids within spoil piles which have the capacity to store and transfer pit water around the operation without having to pump water to an out of pit storage. Where the outer slopes of spoil piles do meet with natural ground level, sediment traps and drainage lines are created to keep this water within the mining area.

Further management of water quality as part of the water management system on site is discussed in Section 3.6.

4.2.6.1 3.2.6.1 Groundwater Level and Quality Management

Groundwater level and quality is managed through performing assessments and ongoing monitoring within, and within the vicinity of, Blair Athol operations.

Basalt aquifers only enter the mining area in the northeastern part of the mining operations. Local landholders use this aquifer to source water for livestock. The Curtis Windmill Bore, less than 1 kilometre from mining operations on a neighbouring property, draws water from the basalt aquifer. Monitoring of this bore by the landholder and the mine, has not established any relationship between localised groundwater aquifer interception in the mining operation and changes in the water levels within the Curtis Windmill Bore. Seasonal fluctuations and pumping for livestock needs is representative of the changes in recorded bore levels.

Groundwater studies by Coffey & Partners Pty Ltd (1982) indicate limited potential for mining activities to affect supplies outside the Blair Athol mining area. More recent investigations by Matrix+ Consulting (2004 and 2005) indicate that:

- there is no impact on groundwater to the south of the mining tenures (eight piezometers drilled to a depth of 120 metres did not intersect groundwater); and
- bores to the east and north, located in basalt, have shown no impacts related to the adjacent mining.

Based on the current understanding of groundwater systems and void hydrology it is expected that the void will not have a significant impact on local groundwater systems. It is expected that groundwater would continue to seep from the intercepted basalt aquifer to the north and east at a rate equivalent to current

levels (approximately 1,300 kilolitres per day). As stated above, monitoring of bores in the basalt have not shown any impacts from mining. Flows from the void into downstream shallow alluvial groundwater systems are unlikely as the standing void water will be significantly lower than the aquifer with no connectivity.

4.2.7 Commitments

The impacts of Blair Athol activities on downstream surface water and groundwater quality will be minimised by:

- designing and effectively implementing a mine water management system such that there are no offsite discharges of mine affected water other than controlled discharges authorised by the EA;
- managing licensed dams and diversions that are part of the clean water management system to maintain functional integrity;
- managing regulated dams that are part of the clean water/dirty water system to maintain structural integrity and manage storage volumes; and
- establish a monitoring programme and undertake monitoring of groundwater quality and levels to detect potential environmental impacts.

4.2.8 Monitoring

Blair Athol monitors water discharged from site and the receiving waterways in accordance with the EA requirements. Surface water storage monitoring is conducted at the following dams:

- Environmental;
- Industrial;
- Ramp 4; and
- Ramp 1.

Water storages are tested for: Electrical Conductivity, pH, Total Suspended Solids and Sulphur. BACM monitors the water quality of these dams against the EA compliance limits to proactively manage compliance risks. Surface water monitoring locations, including those listed above are shown in Figure 12.

Section 3.6 discusses monitoring of aspects of the water management system, other than water quality.

Blair Athol has 14 groundwater monitoring bores sites (some sites containing a shallow and a deep bore adjacent to each other) and a further four monitoring pores installed on the embankment of the TSF. All of the GT series bores and SP (3279C) bore will be mined out over the life of the mine, but will be used to collect additional information until removed following mine closure.

Groundwater monitoring is conducted on a quarterly basis at the locations identified in Table 11. Non-regulated groundwater monitoring bores are sampled for: Chloride, Electrical Conductivity, pH, Sodium, Sulphate, Suspended Solids, Total Dissolved Salts, Total Dissolved Solids and Turbidity.

Curtis Windmill Bore is monitored in accordance with EA conditions for: Acidity, Alkalinity, Boron, Calcium, Chloride, Cobalt, Conductivity, Copper, Electrical Conductivity, Iron, Magnesium, Manganese, Nickel, pH, Potassium, Sodium, Total Dissolved Solids, Anions, Cations and Zinc. Other bores are also monitored for these parameters however this information is for internal records only. Groundwater monitoring locations are illustrated in Figure 13.

4.3 NOISE AND VIBRATION

4.3.1 Environmental Values

The nearest town to the operation is Clermont, located seventeen kilometres to the south-east. The operation has no discernible effect on the noise and vibration levels in the town.

The nearest residential sensitive receptors to the mine are D. Mayes and J. Burnett of Blair Athol Station, on which both old and new Blair Athol homesteads are located. New Blair Athol Homestead is 2.5 kilometres north of the ML boundary and old Blair Athol Homestead is 500 m east of the ML boundary (Figure 3). The topography and eucalypt forest protects the new Blair Athol Homestead. During mining activities, the old Blair Athol Homestead is more likely to experience noise. However, the owners of Blair Athol Station (D Mayes) also operate a coal crushing and screening yard (Capricorn Bulk Handling) on their property within approximately two kilometres of their residence.

Environmental noise surveys (Kamst and Simpson, 1996 and 1998) have determined the ambient noise levels at both the new and old Blair Athol Station residences. These are presented in Table 1

Ground vibration and air blast overpressure level assessment were conducted in 2006 and 2008 at both the new and old Blair Athol Homesteads. The assessments indicated that the ground vibrations and air blast overpressure levels were generally within the EA limits. Measurements demonstrated that there is a potential for air blast overpressure guideline limits to be exceeded at the old Blair Athol Homestead (the closest), particularly when blasting in the north-eastern areas of Blair Athol mining areas.

TerraCom will have a substantially smaller operation than the mine site at the peak of operation. Blast monitoring will be undertaken as required when the mining activities are expected to be closest to the homesteads or in difficult ground.

4.3.2 Potential Impacts on Identified Environmental Values

The major sources of noise from the mine were as follows:

- blasting operations;
- large mobile equipment such as haul trucks, loaders and dozers;
- process plant operations; and
- dragline operations.

4.3.3 Environmental Protection Objectives

The environmental objective for Blair Athol is to ensure that there is no unlawful environmental nuisance from noise or vibration at sensitive receptors that can be attributed to the activities on site.

4.3.4 Management Strategies

If noise producing activities are required at Blair Athol, the control strategy will be to monitor the noise at the sensitive receptors and proactively engage with the surrounding community regarding potential noise impacts. In addition, Blair Athol will investigate any noise or vibration complaint expeditiously with the aim to negate the nuisance impact and facilitate open communication with the complainant.

4.3.5 Commitments

Blair Athol endeavours to ensure that the qualities of the acoustic environment are maintained such that they are conducive to the wellbeing of the sensitive receptors, including the neighbour's opportunity to have sleep, relaxation and conversation without unreasonable interference from intrusive noise or vibration.

4.3.6 Monitoring

Given the reduced potential for noise and vibration impacts, Blair Athol only carries out monitoring if noise and/or vibration producing activities increase or if there are complaints from the community.

4.4 WASTE

Blair Athol Coal manages industrial waste in accordance with the Environmental Protection (Waste Management) Regulation 2000 and the Environmental Protection (Waste Management) Policy 2000. Waste on site is managed by implementing the following hierarchy of management principles:

1) waste avoidance 2) waste reuse 3) waste recycling 4) waste to energy 5) waste disposal.

The major waste products generated by the operation are:

- general waste;
- recyclable waste; and
- regulated wastes (waste oil, tyres, batteries, hydrocarbon contaminated materials).

Key mineral wastes are:

- overburden spoil;
- oxidised coal;
- interburden;
- coarse rejects;
- fine tailings;
- backfill material from underground workings; and
- wash pad, workshop sump and/or sediment trap material.

Characterisation of mineral waste has been undertaken through various geochemical assessments and categorised according to its ARD potential. Table 15 summaries the categorisation of mineral wastes into acid and non-acid forming materials.

The highest ARD risk on site is associated with the TSF in Ramp 2. In this area, coal tailings and rejects that were known to contain sulphide are stored and consolidated in one location.

The level of ARD risk for overburden has been generally assessed as low (Dames and Moore, 1983). In more recent investigations, some fine tailings and coarse rejects samples from Ramp 2 Washery Rejects Dam were found to be potentially acid forming (EGi, 2004).

All the overburden and interburden types tested by Dames and Moore (1983) were assessed as having a 'low' ARD risk, with the exception of a conglomerate interburden between No. 4 Seam upper and lower seams which was assessed as medium risk.

EGi (2006) identified that most of the overburden material was non-acid forming and unlikely to be a concern with respect to ARD or element toxicity. However, the study did identify that materials associated with the roof and floor of the No. 3 and No. 4 Seam coals were potentially acid forming. These materials contained pyrites and would require selective handling and blending within the overburden in order to control the ARD potential.

During the testing process a limited quantity of No. 2 Seam coal was tested, this material was also identified as PAF. The testing indicated that the potential to form acid was greater than the No. 3 or No. 4 Seam materials tested, however, would be in significantly lower quantities. The report recommended that this material should be selectively handled and blended into overburden to reduce potential impacts from ARD.

4.4.1 Environmental Values

In accordance with the Environmental Protection (Waste Management) Policy 2000, the environmental values considered to be enhanced or protected at Blair Athol are:

- the life, health and wellbeing of people;
- the diversity of ecological processes and associated ecosystems; and
- land use capability.

Non¬mineral waste will be classified and segregated at the generation source. Colour schemed and clearly labelled bins are located strategically around the site for appropriate waste collection and disposal/recycling. Waste is separated into the following categories and provided appropriate disposal facilities:
general waste, recyclable waste, waste oil, blackjack (contaminated grease), degreasers, batteries, oil filters, empty oil drums, tyres and regulated waste (rags and rubbish contaminated with oil);

- wastes are appropriately stored and separated to prevent the potential of chemical reactions and fire. Fire extinguisher equipment is located near major storage areas;
- all waste (general, recyclable and regulated) is collected by licensed waste transporters and disposed or recycled at licensed facilitates;
- Heavy equipment tyres and conveyor belting from the operation are disposed on site. The tyres and conveyor belts are placed deep in the spoil and above any groundwater. The location of the tyres and conveyor belts disposed on site are recorded. The waste tyres waiting to be disposed are stored in an area maintained to prevent a build-up of combustible material (e.g. dry grass). If an opportunity arises, Blair Athol will support the reuse of scrap tyres and conveyors as an alternative disposal method;

4.4.2 Management Strategies

4.4.2.1 Non-Mineral Waste Management Plan

The waste management hierarchy will be applied to all waste management planning and activities at the Blair Athol and underpin the implementation of the following management strategies:

- sewage sludge will be dried and disposed on site within the spoil;
- oil contaminated washdown sludge and sediment trap material from the mobile equipment serving area will be disposed of in the Tailings Dam;
- standard procedures for the storage, containment, disposal and spill response for potentially hazardous materials have been developed and are available through the Health & Safety Management System;
- material safety data sheets (MSDSs) are maintained on the Chemalert database for all chemicals stored and used on site. The MSDSs provide disposal and spill clean-up instructions of the substance;
- site inductions, tool box meetings and site meetings are used to raise awareness and communicate performance of the waste management system on site; and
- benign construction/demolition waste may be buried in spoil or final voids with approval from the relevant administering authority and in accordance with the site closure plan.

4.4.2.2 Mineral Waste Management Plan

During mining, mineral waste with low ARD potential is managed through the following strategies:

- backfill material to be dumped as close as possible to the pit floor;
- dozing interburden into a slot rather than trucking to an elevated waste dump;

- dumping waste coal as close to pit floor as practical to ensure the maximum amount of capping with spoil is possible;
- volumes and locations of all materials are to be recorded and mapped; and
- waste coal should be dumped and covered to limit the chance of spontaneous combustion.

Management of mineral waste with high ARD potential requires specific dumping and management requirements. Basic concepts of high ARD potential material management are containment and capsulation, and where appropriate, treatment. At present, high ARD potential mineral waste is being stored in the TSF. Management of the TSF is discussed in Section 3.6.

Blair Athol has developed and implemented an Acid and Metalliferous Drainage Management Guideline to address the management and disposal of ARD material, actively developing strategies to mitigate impacts of ARD on surface water and groundwater. The Acid and Metalliferous Drainage Management Guideline describes steps to:

- identify and characterise geological material;
- predict ARD potential;
- manage ARD monitoring data; and
- establish control strategies and contingency planning.

Management and control of waste materials are distinguished by the classification of the ARD potential (low or high risk).

Contingency planning and emergency response plans for mineral wastes with ARD potential are included in part of the broader management system. Key documents that address concerns about mineral waste are:

- Tailings Storage Facility – Operations and Maintenance Procedure;
- Business Resilience and Recovery Plan (BRRP);
- Emergency Management Plan; and
- TARP – Environmental Incidents.

4.4.3 Commitments

Blair Athol is committed to nonmineral waste segregation, recycling and minimising waste disposal.

4.4.4 Monitoring

Waste monitoring and tracking will be undertaken to record the movements of prescribed and regulated wastes (trackable wastes) in accordance with the Environmental Protection (Waste) Policy 2000. The regulated waste operator provides monthly statistical reports on the types, volumes of waste transported and contamination levels. These reports are used by the site to assess the actual waste results and compare against the assigned targets.

Housekeeping inspections conducted on a regular basis around the site.

Groundwater and surface water monitoring, in particular hydrocarbons, assist in determining the effective treatment and storage of mineral waste substances.

Where any additional exploration drilling is undertaken, ARD characterisation testing will included the following tests:

- total sulphur content;
- neutralization potential (NP) or Acid Neutralizing Capacity (ANC);
- pH;
- electrical conductivity;

- total metals analyses;
- Net Acid Generation (NAG) testing with hydrogen peroxide;
- Net Neutralization Potential (NNP) or Net Acid Producing Potential (NAPP); and
- carbonate content based on total organic carbon.

ARD monitoring of physical and chemical properties is also undertaken as part of the rehabilitation monitoring programme. The programme examines the changes in the soil/spoil interface within the rehabilitation areas.

Monthly water quality monitoring of pit areas in both Ramp 4 and Ramp 1 dams will indicate any changes to water quality as a response to handling and disposal of mineral wastes within the mining areas.

4.5 LAND

Blair Athol is the holder of ML 1804. The ML is held over a diverse range of land tenures. Table 1 in Section 1.4 illustrates that the predominant land tenure is Unallocated State Land and areas of State Forest, Rail Corridor, Reserve and Freehold Land.

A wide diversity of pre-mining land uses have occurred on the lease and included:

- Blair Athol township;
- 100 + years of open cut and underground coal mining operations;
- crops and grazing;
- designated stock routes; and
- a cemetery.

4.5.1 Environmental Values

4.5.1.1 Land Resources

Blair Athol is in a landscape that consists of gently sloping country derived from metamorphosed sedimentary rocks intersected by volcanic intrusions mostly to the north of the ML. Human development of the landscape is typical of Central Queensland, where large areas have been cleared for low intensity grazing and broad acre field crops with only small remnant areas of native woodland vegetation remaining mostly on upper slopes and along watercourses.

The lease area lies on the eastern flank of the Drummond Range. This range is part of the watershed of the Fitzroy and Burdekin River systems and extends from northeast to southwest. There are two differing topographic units on the ML:

- the gently sloping lowlands comprising the bulk of the mine site and extending to the north and northeast (Humboldt and Copperfield Land Systems (CSIRO 1969)); and
- the more rugged gravel ridge country flanking the Drummond Range on the western side of the site (Oxford Land System (CSIRO 1969)).

The lowlands are characterised by low slopes of 0.15 to 1.15° (1:375 to 1:50) and texture contrast soils. Local relief on the lowlands is 30 to 40m. Two distinct zones are present within this unit, namely the area influenced by the Blair Athol coal measures (Humboldt Land System) and the more fertile soils developed on the basalts (Oxford Land System). The vegetation of these soils consists mainly of grasses, with *Cenchrus ciliaris*, *Chloris gayana*, *Heteropogan contortus*, *Dichanthium sericeum* subsp. *sericeum* and *Cynodon dactylon* the most prominent. *Eucalyptus populnea*, *Eucalyptus cambageana*, *Eucalyptus tesselaris*, *Eucalyptus camaldulensis* and *Eucalyptus melanophloia* are the most dominant overstorey species.

The gravel ridge country (Copperfield Land System) is predominantly hilly to rugged. Slopes are characteristically 1.7° to 3.0° (1:35 to 1:20), with steeper localised areas, and local relief is 70 to 80m. This area has shallow rocky soil of little agricultural value. The most common plant species on this land system are *Acacia rhodoxylon* and *Eucalyptus crebra*.

The agricultural land capability of the ML has been assessed using the system of Rosser et al (1974). This system was developed mainly for use in the assessment of the capability of agricultural land to sustain production. The assessment of land capability class is based on the limiting factors of water availability, soil fertility and steepness of the hillsides. The land classes per Rosser et al (1974) are as follows:

	Land Class Description
Class I	Land suitable for all agricultural and pastoral uses
Class II	Land suitable for all agricultural uses but with slight restrictions to use for cultivation.
Class III	Land suitable for all agricultural uses but with moderate restrictions to use for cultivation.
Class IV	Land primarily suited to pastoral use but which may be used for occasional cultivation with careful management.
Class V	Land which in all other characteristics would be arable but has limitations which unless removed, make cultivation impractical and/or uneconomic.
Class VI	The land is not suitable for cultivation, but is well suited to pastoral use. The use of machinery for pasture improvement is not practicable.
Class VII	The land is not suitable for cultivation and pastoral use is only possible with careful management. Pasture improvement involving the use of machinery is not practicable.
Class VIII	The land has severe limitations, making it unsuitable for either cultivation or grazing.

A survey of the future mining areas was undertaken in 1993 by Envirosciences Pty Ltd titled Blair Athol Coal Project Soil Survey. Five soil types were mapped as listed in Table 16 and a map of stripping depths was provided.

Over 70% of ML1804 and ML1881 are classified as Class VII (34.5%) or VIII (35.9%). The less fertile areas of the low-lying lands are generally Class VII. Some slightly better Class VI land intersperses these areas. Class VI land constitutes approximately 6.7% of the lease area.

Much of the more fertile basalt derived soils are used for dryland farming. Sorghum and sunflower are the major summer crops, with wheat and barley sown in the winter. These lands are predominantly Class III. The need for intensive conservation practices on lands of this capability is evidenced by the prominence of contour banks on the properties to the north. Despite the use of contour banks, well developed rill and gully erosion is still present throughout the Class III lands. In some areas along the creek lines, the Class III lands are reduced to Class IV due to restrictions imposed by local flooding.

Table 16 soil types

Soil types have been grouped into two major soil groups for the purposes of reuse and rehabilitation commitments:

- the cracking clays are comprised of the Black uniform light clay and the Black alluvial soil; and
- the rigid soils are comprised of the Yellow brown duplex soil, Brown gradational silty loam and the Brown duplex soil.

4.5.1.2 Geology

The coal bearing sequence in the Blair Athol coal basin consists of sandstone, siltstone, mudstone, conglomerate and four significant coal seams (Seam Nos. 1, 2, 3 and 4) as shown in Figure 14. The sequence

overlies a basement of Anakie metamorphics and a basal conglomerate consisting of conglomerate, coarse sandstone and minor carbonaceous shales with stony coal seams.

Overburden material is made up of white sandstone with minor silty bands ranging from 2555m in thickness above No. 3 Seam. Overlying the coal measures are Tertiary flow basalts and quaternary alluvial deposits. The basalts occur in the north and northeast of the coalfield and average between 18m and 22m in thickness.

No. 1 Seam averages seven to eight metres in thickness, is lenticular in nature and occurs in four unconnected locations. No. 2 Seam averages 1.25 metres and is made up of two major splits, ranging from 1 to 15 metres above No. 3 Seam. No. 3 Seam averages 29 metres and has a maximum thickness in the southwest of the coalfield. The seam exists as one major coal interval with progressive floor splits towards the north of the deposit where the seam thins. Between No. 3 and 4 Seams is a sequence of five to ten metres of interbedded medium to coarse grained sandstone, siltstone (commonly carbonaceous) and granule conglomerate. No. 4 Seam averages 4.5 metres, contained in two major splits, each one dividing into several minor splits.

Generally, the seams are flat lying and rise at steeper angles towards the margins until they sub crop in the oxidation zone. In the southeast of the area a significant basement high interrupts the seam deposition. The coal seams have dips of six to eight degrees up to this feature before sub cropping. Faulting generally consists of low angle thrust faulting dipping 3045 degrees, accompanied by brecciated coal and higher amounts of clay and pyrite with only minor displacement. One major fault occurs in the west with a displacement of up to 17 metres.

4.5.1.3 Flora and Vegetation Communities

Vegetation types are influenced by land systems and soil types. Assessment of vegetation at Blair Athol has been through reviews of Regional Ecosystem (RE) mapping (Queensland Herbarium), field assessments and results of 25 years of rehabilitation monitoring. The vegetation on the more fertile soils developed on basalt consists mainly of grasses, e.g. *Cenchrus ciliaris* (Buffel), *Chloris gayana* (Rhodes Grass), *Heteropogan contortus* (Black Spear Grass), *Dichanthium sericeum* subsp. *Sericeum* (Queensland Blue Grass) and *Cynodon dactylon* (Couch). *Eucalyptus populnea* (Poplar Box), *Eucalyptus cambageana* (Blackbutt), *Eucalyptus tesselaris* (Moreton Bay Ash), *Eucalyptus camaldulensis* (River Red Gum) and *Eucalyptus melanophloia* (Silver Leaved Ironbark) are the most dominant over storey species. These species are largely restricted to the north-eastern part of the mine site and surrounding lands as along creek lines through the harder ridge country. Flora surveys from 2001 to 2003, conducted by AARC, identified the Belyando Cobblers Peg (*Trioncinia retroflexa*) which is listed as rare and threatened, within recovered blue grass areas on the ML. More recent surveys failed to find any plants, however, the Belyando Cobblers Peg is an annual and research indicates it only grows during favourable climatic conditions.

The dominant gravel ridge country with shallow rocky soils is of little agricultural value. Dominant tree species in these areas are: *Acacia rhodoxylon* (Rosewood), *Corymbia citriodora* (LemonScented Gum), *Acacia shirleyi* (Lancewood) and *Eucalyptus crebra* (Narrow Leaf Ironbark). Vegetation cover and diversity is highly variable in these areas as the underlying metaphoric rocks can weather into a range of soils with greatly differing soil water and nutrient properties. Grasses can be naturally very sparse in these areas and are often dominated by *Aristida spp*. (wire grasses).

Blair Athol has been mapped for REs as part of broader state wide mapping by the Queensland Herbarium. REs are a landscape classification system which utilises vegetation species, land resource and geology information to group vegetation patterns into communities at a mapping scale of 1:100,000. The mine site has six main REs, which were mapped from historical aerial photos and land survey information to establish pre-clearing vegetation coverage, and updated for current clearing extents using current satellite imagery. The vegetation communities as described by the mapped REs in decreasing order of dominance are:

- **11.11.1** *Eucalyptus crebra* +/*Acacia rhodoxlyn* woodland on old sedimentary rocks with varying degrees of metamorphism and folding;
- **11.11.2** *Acacia shirleyi* or *A. catenulate* low open forest on old sedimentary rocks with varying degrees of metamorphism and folding;
- **11.5.3** *Eucalyptus populnea* and/or *E. melanophloia* and/or *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces;
- **11.3.2** *Eucalyptus populnea* woodlands on alluvial plains;
- **11.3.4** *Eucalyptus tereticornis* and/or Eucalyptus spp. tall woodland on alluvial plains; and
- **11.3.25** *Eucalyptus tereticornis* or *E. camaldulensis* woodland on alluvial plains.

4.5.1.4 Fauna

Many native species of fauna have been recorded on the site during surveys by the University of Queensland (UQ) from 1996 to 2003. The UQ surveys have included a six year fauna monitoring programme in rehabilitated areas which has enabled the identification of the active movement of fauna from the surrounding forest country onto the mine site[3]. No endangered, vulnerable or rare fauna species have been identified during these surveys. Common species include: Koala (*Phascolactos cinereus*), Northern Brown Bandicoot (*Isoodon macrourus*), Brushtail Possum (*Trichosurus vulpecula*), Rufous Hare Wallaby (*Aepymnus rufescens*), Grey Kangaroo (*Macropus giganteus*), Forrest's Shorttailed Mouse (*Legedina forresti*), Common Bentwing Bat (*Miniopterus schreibersii*), and the Little Red Flying Fox (*Pteropus scapulatus*). International Union for Conservation of Nature (IUCN) listed species in the area are listed in Table 17 below.

Water storage areas on the site have become habitat for wildlife. Many species of birds use the water for feeding and nesting. These include: Black Swans (*Cygnus atratus*), Pacific Black Duck (*Anus superciliosa*), Darter (Anhinga melanogaster) and Little Pied Cormorant (*Phalarocorax melanoleucos*). Many other bird species have been sighted on the mining tenures, e.g. Cockatiel (*Nymphicus hollandicus*), Emu (*Dromacius novaehollandiae*), Hardhead (*Aythya australis*) and Australian Magpie (*Gymnorhina tibicen*).

Surveys from 1996 to 2003 have identified that the water bodies on site contain several species of fish and reptiles including Silver Perch, Eels, Saratoga and Eastern Snake Neck Turtles (*Chelodina longicollis*). Their presence on site is through natural migration during flooding into on site impoundments

Many species of amphibians and reptiles are found on the site. These include the Marbled Frog (*Limnodynastes convexiusculus*), Northern Banjo Frog (*Limnodynates terraereginae*), Crucifix Frog (*Notaden benetti*), Eastern Bearded Dragon (*Pogona barbata*), Fattailed Gekko (*Diplodactylus conspcillatus*), Lively Skink (*Carlia vivax*), Ridgetailed Monitor (*Varanus acanthurus*) and the Taipan (*Oxyuranus scutellatus*). There are also many insect species typical of the habitat types found in the area.

Dingoes, feral dogs, foxes, rabbits, feral pigs and cats are common in the district and when identified on the ML are managed in accordance with relevant legislation.

4.5.2 Potential Impacts on Identified Environmental Values

The potential impacts on land values include:

- clearing of vegetation resulting in a loss of habitat, loss of species and fragmentation along corridors;
- changes to surface slope angles and drainage due to overburden reshaping may affect land capability rankings stripping and stockpiling of topsoil;
- changes to surface slope angles and vegetation sown may result in different land uses from those occurring prior to current operations;
- use of land for construction and operation of surface facilities (including access tracks and haul roads) may adversely affect land capability rankings;

- instability of remnant highwalls and endwalls affecting postmining land use;
- spread and proliferation of weeds and pests from machinery spread and disturbed environments;
- mining pits and mining spoil changing existing landforms (including erosion and sediment rates, profile, elevation and stability); and
- potential land contamination from discharges and spills and ineffective storage of tailings and rejects.

There is also potential for mining to impact on topsoil. The primary impact of the mining operation on topsoil is reduced biological, physical and chemical potential through displacement and stockpiling. Disruption of soil physical structure is the main impact leading to hard setting, crusting, poor infiltration, increased runoff and erosion and impeding root penetration. Excessive stockpile depth also causes the compaction of topsoil and sterilises biological activity. Prolonging the period during which topsoil is stockpiled further increases these negative impacts. Erosion is another adverse impact which may occur in some areas through topsoil stockpiling particularly immediately following stockpile formation when no vegetative cover is present.

4.5.3 Environmental Protection Objectives

Blair Athol is committed to managing impacts to ensure that the enduring value of the land is maintained including implementation of the following:

- managing ecosystems to ensure biodiversity values are retained;
- enhancing knowledge and data relating to land management;
- return disturbed land to a self-sustaining native species vegetation cover which is suitable for local flora and fauna colonisation;
- restoring disturbed land to meet specified post mining land capabilities classes;
- ensure postmining landforms are stable so that postmining land use is not compromised;
- managing declared pests and noxious weeds to maximise the enduring value of the land and ensuring that mining and related activities on the land will not lead to an increased prevalence of weeds and/or pests;
- minimise the contamination of land from insufficient storage, handling and disposal of waste; and
- ensure that topsoil is managed as a valuable resource.

4.5.4 Management Strategies

Blair Athol has applied several management strategies to protect the environmental values of the land. These management strategies have been categorised and addressed below. A Land Use Management Guideline has also been developed for the site and will be used in conjunction with this EM Plan.

4.5.4.1 Land Clearing and Topsoil Management

Prior to mining or disturbing an undisturbed area of the ML an Environmental Permit (internal permitting system) must be obtained. This permit process assesses risks to potential cultural heritage, endangered REs (ERE), koala protection and disturbance of topsoil and specifies control strategies for these matters.

Vegetation is cleared after first confirming that no unauthorised ERE will be disturbed, that there are no items/areas of cultural sensitivity and that there are no koalas in the area. Areas to be cleared are clearly marked with tape, pegs or some other means and conform to the limits specified on design drawings.

Vegetation cleared is windrowed along contours to assist with erosion control and where practicable, large pieces of fallen timber are strategically placed on rehabilitated areas to provide habitat diversity. However, fallen trees may need to be crushed or burned to reduce the impact on koalas who often return to fallen trees, when displaced.

Following the clearing of vegetation, topsoil is stripped to the depth of the A horizon. This topsoil is then directly placed on a reprofiled rehabilitation area, or in circumstances where this is not possible, is stockpiled

for later use in rehabilitation. The stockpiles are kept below a maximum height of three metres to limit the biological degradation of the topsoil. Where storage space is limited, top soil can be stockpiled to four metres, but only after alternatives options are assessed and discounted. Revegetation of topsoil stockpiles using grass cover is promoted to further mitigate biological, physical, chemical and erosion impacts.

Topsoil stockpiles are placed away from natural drainage areas to prevent dispersion and erosion. Topsoil material will also be placed so as not to affect any future infrastructure requirements or coal resources to minimise excessive handling and contamination of the topsoil.

Topsoil stockpiles are identified with markers and volumes are reconciled and recorded annually. Topsoil replacement at Blair Athol is carried out in accordance with the following strategy:

- Most areas receive a coverage of topsoil or suitable growth media at 150 200mm thick;
- Recontoured spoil will receive a coverage of topsoil, or suitable growth media, at minimum 100 mm thick; and
- Topsoil spoil is ripped on the contour up to 500 mm deep to minimise sheet flows and wind erosion.

Erosion on disturbed and rehabilitated areas is controlled by a combination of the following:

- limiting areas disturbed or left unrehabilitated;
- limiting landform slopes to <15 %;
- contour bank spacing dependent on landform slope, i.e. closer spaced banks on steeper slopes;
- contour ripping during seeding;
- mould boards on rippers are used during contour ripping (mould boards increase the furrow size and hence improve water retention); and
- early establishment of ground cover.

4.5.4.2 Flora and Fauna Protection

Fauna monitoring has been conducted by Central Queensland University (19992001) and by UQ (20012005 and 2010) researchers[4]. Both undisturbed sites and rehabilitated sites have been monitored to demonstrate recolonisation of rehabilitation areas by native fauna. Monitoring has shown species diversity and abundance in rehabilitated areas to be correlated with both the presence of structure for habitat and proximity to water. Blair Athol applies the following management strategies to protect and encourage fauna recolonisation:

- where operationally practical, it is the preferred option of Blair Athol to minimise the disturbance footprint;
- environmental permits consider impacts on sensitive flora and fauna;
- trees are inspected for key fauna presence prior to clearing, where practicable, detected individuals are forced to migrate or are physically relocated prior to clearance;
- progressive rehabilitation targets are established annually;
- trees that have been dozed over during clearing will be relocated to rehabilitation areas and dumped in heaps;
- localised water ponds will be incorporated into rehabilitation designs; and
- captured native sick, injured or displaced animals will be sent to authorised wildlife carers.

Fauna monitoring undertaken in rehabilitated areas has shown that a variety of species will recolonise the rehabilitated land. Inclusion of tree trunks and branches within the soil spreading promotes habitat for reptiles, insects and small marsupials. Many of these species are building blocks within ecosystems and their presence is required to start many of the core nutrient cycling and food chain systems.

Blair Athol in conjunction with UQ studied the local koala population from 1989 to 2013. Koalas are common on some parts of the mine site and have at times been required to be relocated to allow mining to progress. As part of this relocation programme researchers from UQ attached radio tracking collars and GPS tracking collars to some animals to help understand the species development and behaviour within the local area.

The research has provided valuable input into the rehabilitation methods employed at Blair Athol to provide suitable habitat for koalas. The most important information has related to the use of different species of trees for feeding and roosting. There have also been observations of koalas using noneucalypt tree species during summer for daytime roosting and it is believed the koalas are taking advantage of the cooler temperatures offered by these trees. The main tree species used by koalas have been incorporated in the rehabilitation seed mixes to meet their requirements. Ongoing rehabilitation monitoring will validate if the rehabilitation areas are suitable koala habitat.

4.5.4.3 Land Contamination

Major fuels and chemical storages areas located around the mobile equipment servicing area are bunded in accordance with relevant standards. Contaminants from the workshops and lube and tyre bay are directed to an oil/water separator. The waste oil is separated and stored in a tank for removal off site. The treated water is directed to the internal mine water management system for site reuse.

Potential for land contamination from spillage of hydrocarbons and chemicals will be minimised through the ongoing implementation of recommended controls detailed in the MSDSs and standard operating procedures for the transport, handling and storage of these substances.

The TSF and other regulated dams will be decommissioned in accordance with approved rehabilitation designs.

Preliminary phase one and phase 2 contaminated land assessments were conducted in 2006 and 2008 respectively. The assessments identified approximately 30,000 metres^3 of contaminated material up to a depth of three metres around the underground pipeline network in the mobile equipment servicing area. The contamination is believed to have occurred from degradation of the underground hydrocarbon distribution pipelines. This affected area includes the industrial dam which accounts for about a third of the contaminated material.

Blair Athol is considering the decommissioning of the underground pipelines; however, the remediation of the contaminated land is not expected to commence until the commencement of rehabilitation.

Contamination treatment methods will depend on the depth and extent of contamination and will be detailed in the phase three contaminated land assessments. In practice, shallow contamination may be able to be remediated in situ, while deep contamination will need to be excavated and buried. Time restrictions for completion of rehabilitation may limit the ability to undertake complex or lengthy bioremediation processes. Disposal at dedicated sites within rehabilitated lands may also be possible; however, a final solution will require approval from DEHP.

4.5.4.4 Rehabilitation

The revegetation success criterion applicable to site rehabilitation is that specified in the EA. As information of criteria success and knowledge of rehabilitation techniques improve, revised rehabilitation criteria may be devised and applied. DEHP will be notified of any significant changes to any criteria which conflict with the EA conditions.

The proposed post mine rehabilitation criteria are as follows:

- the maximum slope for rehabilitated spoil is no greater than 15%, with the exception of sections of Ramp 3 which cut through competent rock;
- main internal spoil areas will be reshaped to inwardly drained undulating landforms with slopes up to 15%;
- the minimum distance between contour banks on rehabilitated spoil slopes are:
- maximum slope of final void highwalls and endwalls are required to be geotechnical stable. Geotechnical stability will be competency certified by an appropriately qualified professional accredited by a credible third party;
- ramps and lowwalls will be breached and graded with the maximum slope for rehabilitated no greater than 15%;
- tailings and sodic spoil with exchangeable sodium percentage (ESP) >30% must be covered with a minimum of one metre of benign material (i.e. with ESP <15%) prior to rehabilitation commencing;
- landforms of tailings and rejects disposal area will be externally draining and be sufficiently capped to break capillary rise of solutes and prevent the lateral migration of solutes;
- successfully rehabilitated land will have gully erosion consistent with surrounding landscapes
- regulated dams, other than those for tailings and rejects disposal, will have the walls breached and the dam drained. Salt impacted residue will either be stripped and disposed of in tailings or rejects impoundment, or capped with sufficient inert material to break the capillary rise of salts and prevent the lateral migration of solutes;
- water storages will be drained and breached unless left by written agreement with the administering authority;
- revegetation of landforms will meet the following species and abundance criteria:
- final voids that contain water permanently or semi permanently will be of land capability class VIII; and
- all other areas significantly disturbed by mining activities must be rehabilitated to a stable landform with a self-sustaining vegetation cover of a land capability class equivalent to or better than VII.

The rehabilitation schedule is built around five benchmarks as follows:

1. area recontoured (reshaped to final grade; sometimes termed reclamation);
2. area topsoiled;
3. area seeded (ripped and seeded, irrespective of germination success);
4. area established (vegetation has established, although minor reseeding/erosion repairs may be necessary); and
5. area successfully rehabilitated (compliance with rehabilitation success criteria).

Dozers reshape the angle of repose spoil piles to the final landform. Topsoil is then transported to the re-profiled area in rear dump trucks. Prior to the wet season which typically commences in November, the topsoil is spread out by a dozer to a depth not less than 10 centimetres. Contour banks are also constructed at predefined intervals down the slope of the rehabilitation area. The area is then deep ripped along the contour with the rear tynes of a dozer to a depth of approximately 50 centimetres

Seeding of the rehabilitation area primarily commences in November/December to coincide with the onset of the wet season. Seeding may occur at different times to take advantage of predicted weather patterns.

Blair Athol has two predominately distinct soil types. The topsoil derived from the Blair Athol coal measures is typically sandier in texture. The topsoil derived from the weathering of basaltic parent material support bluegrass/kangaroo grass pastures in their undisturbed state. Tree and shrub density is very low in these areas. The seed mix (refer to Table 18) is applied to all rehabilitated areas with approximately eight kilograms

of tree seeds applied per hectare and 10 kilograms of grass seed mix applied per hectare. Bentonite is also added as filler for improved seed distribution.

Proposed post mine land types over the mine will include:

- rehabilitated grassland habitat with grazing potential which comprise land capability classes VI to VII;
- rehabilitated bushland habitat which include areas of open grasslands, open woodland and woodland, which comprise land capability classes VI to VII;
- remnant bushland;
- bushland as wildlife corridors;
- final voids and ponding ecosystems;
- roads; and
- selected retained infrastructure.

While the final land use has not been finalised, Blair Athol will pursue conservation as a preferred option as the land use will be more self-sustaining in the long term. Postmining land suitability could sustain beef cattle grazing with moderate to severe stocking limitations.

Blair Athol aims to establish a series of sustainable native habitats for conservation purposes across a majority of the mining area for the post mining land use. Blair Athol considers that the early return of the land to grazing would be difficult to sustain given the fragile nature of the newly rehabilitated land. Grazing may become a suitable land use once the land and its resources have become more robust. The conservation values of the native habitat complement surrounding land values of the neighbouring State Forests.

A conceptual final landform design has been developed. Due to the nature of the coal deposit at Blair Athol, the final landform of the mined area will be a depression compared to surrounding surface level. At Blair Athol, the thickness of the main coal seam, No.3 Seam, averages 29 metres and the overburden varies from 25¬55 metres. After removal of the coal seam, the replacement of the relatively small quantity of overburden (even after allowing for swell) cannot fill the void to the previous natural surface level. The current rehabilitation landform design aims to achieve a gentle undulating landscape. Mining highwalls, ramps and low walls will regarded to slopes less than fifteen percent (15%), therefore there should be no exposed angle of repose landforms left at mine signoff.

There will be three main water pondage areas in the final landform design, however as a ‘basin’ landform the whole area could become flooded if a catastrophic flooding event occurred. Modelling has predicted that the final landform should have the capacity to store 113,000 megalitres of water. Based on one-hundred-year rainfall data, modelling has predicted that if all creek diversions were removed allowing surface water from the catchment to enter the site, a maximum of 60,000 megalitres of water would be caught on site during a 1 in 1,000 rainfall event. Blair Athol anticipates that with the estimated final water storage capacity and evaporation rates that water will not be discharged off site.

The water contained on the final landform is not expected to report back into the surrounding groundwater aquifer, as the basalt groundwater aquifer is higher than the conceptual final landform water levels. The maximum elevation of the final landform will be approximately 278 mRL, the unmined landform is approximately 300 mRL and the basalt aquifer of the unmined landform sits at approximately 290 mRL.

Decommissioning of infrastructure and that infrastructure remaining will be addressed in the mine closure plan.

The initial rehabilitation success criteria targets are described in Table 19

Progressive rehabilitation has been carried out at Blair Athol with variable results in establishing vegetation. Poor vegetation success has been determined as a result of low species richness or plant density. Specific issues required to be addressed to improve the consistency of vegetation establishment include:

- varied results due to variable seasonal conditions;
- poor establishment of tree seedlings on cracking clay soils;
- buffel grass provides early erosion protection but outcompetes tree and shrub seedlings as well as other native grasses; and
- short lived acacias may not reproduce if germination sites are taken up by buffel grass.

A review of previous research, rehabilitation methods and monitoring results was carried out by Bevan Emmerton (Soil Scientist) and James Elsol (Botanist) in April 2005. A summary of the final report recommendations to improve vegetation establishment and recommends a monitoring programme designed to demonstrate progress to a sustainable ecosystem, included:

- mulching to prevent moisture loss from deep ripped areas;
- soil testing prior to seeding to identify any deficiencies;
- different seed mixes for cracking clay soils and rigid (sandy) soils to favour species suited to soil types;
- seed mix composition to shift to species capable of forming permanent communities i.e. eucalypts, hardwood scrub species and long lived acacias;
- control of buffel grass and establishment of native grasses on topsoil stockpiles; and
- trialling of different native grasses.

These recommendations have been trialled with mixed results. Figures 15, 16 and 17 illustrate some of the sustainable landforms/rehabilitation achieved at Blair Athol.

Permanent transects have been established in rehabilitated areas to provide data on tree growth, cover and floristic diversity. Future transect locations will be randomly chosen within discrete rehabilitation areas in accordance to the Rehabilitation Monitoring Programme. Monitoring results will be used to determine if rehabilitation criteria have been achieved, and if not, what remedial action is required.

- machinery operating in identified weed infested areas must wash down before being entering another location;
- weed control measures are to be applied on areas to be stripped of topsoil and on topsoil stockpiles;
- use of reputable seed merchants; and
-

4.5.4.5 Weed and Pest Management

Consistent with most of the Central Highlands, the major weed pest at the site is Parthenium (*Parthenium hysterophorus*). Other weeds of lesser significance include Rubber Vine (*Cryptostegia grandiflora*), Parkinsonia (*Parkinsonia asuleata*), Prickly acacia (*Acacia nilotica*), Castor oil plant (*Ricinus communis*) and Mother of Millions (*Bryophyllum tubiflorum*).

The exotic pasture species Buffel (*Cenchrus ciliaris*) and Red Natal (*Rhynchelytrum repens*) are well established and have become naturalised in the local area. Dingoes, feral dogs, foxes, rabbits, feral pigs and cats are common on the ML. These will be managed in accordance with the requirements of the Land Protection (Pest and Stock Route Management) Act 2002 and the Land Use Management Guideline.

Surveys will be conducted annually to identify areas of weed proliferation. Weed species to be targeted are declared weeds within the Land Protection (Pest and Stock Route Management) Act 2002. Remedial action will be taken in areas identified through the monitoring.

Several measures are used to prevent the spread of weeds on site and in rehabilitation areas namely:

establishment of sufficient ground cover to prevent weeds.

Under the Land Use Management Guideline and supporting documents, requirements are in place to ensure rehabilitation areas are monitored and remedial work undertaken to prevent weed infestations has been developed. The plan includes:

- monitoring of rehabilitation areas for presence of declared weeds;
- mapping of weed presence and prioritisation of remedial work;
- recommended control techniques for different weed species (including non-chemical methods where appropriate);
- trapping of pest animals; and
- recording of remedial work undertaken.

4.5.5 Commitments

Blair Athol is committed to the following to minimise land impacts associated with the mining activities on the ML:

- the Environmental Permit (internal permitting system) will be maintained as an assessment and reconciliation process to minimise unnecessary land disturbance and impacts to flora, fauna and cultural heritage;
- topsoil will be managed to prevent sterilisation and degradation;
- a weed eradication programme will be maintained in accordance with the site's Weed and Pest Management Procedure;
- substances that have the potential to cause environmental harm to land will be handled, stored and disposed in accordance with relevant standards and EA conditions;
- contaminated land will be listed on DEHP's Contaminated Land Environment Register and remediated, when operationally practicable, in accordance with Departmental requirements;
- rehabilitation targets will be established on an annual basis, with the aim of ensuring that the at least 30% of land is rehabilitated at the end of mine life (2016);
- rehabilitation will be monitored and survey findings evaluated to determine and assess success against rehabilitation criteria; and
- upon mine surrender the rehabilitated landform will be stable, nonpolluting and self-sustaining.

4.5.6 Monitoring

To minimise land contamination weekly and monthly house keeping inspections of areas of high risk are conducted. Inspections address general cleanliness, spill kit stock, correct storage of substances and bunding integrity and spills.

Weed inspections will be conducted by a contractor on an annual basis with contractors and personnel able to also register new infestation sites (GPS recorded). The contractor treats selected infestation areas and provides a report on treatment progress.

Rehabilitation monitoring has been conducted since 1990. Early monitoring was used to evaluate results from small trial areas and more recent monitoring has been used to strategically assess rehabilitated areas across the ML. Historical monitoring methodologies have not been consistent due to specific various research interests and are not easily integrated into success criteria. Recent vegetation monitoring has established permanent transects; 13 in rehabilitation areas and two in reference sites. These sites have been monitored annually to demonstrate trends in the establishment of vegetation. The monitoring techniques have been designed to measure the following:

- species density and richness;
- ground cover;
- erosion rates;
- soil characteristics;
- establishment of volunteer species;
- extent of invasion by weed plant species; and
- spontaneous combustion.

Each component is designed to collect the necessary information to assist in decisions regarding rehabilitation success and to show development trends towards the completion criteria. Monitoring of existing rehabilitation areas has identified potential deficiencies in some of the previous rehabilitation strategies and it is Blair Athol's objective to ensure that the current programme will improve future rehabilitation techniques and success.

General fauna surveys were sporadically undertaken and are typically conducted as part of the rehabilitation monitoring or disturbance of a new mining area. Koala Venture, a cooperative research venture between Blair Athol and the UQ was conducted six times per year. Clean skin koalas found on the ML have been collared and tracked over time.

4.6 WATER MANAGEMENT

4.6.1 Water Balance

Since 1999, the site water balance at Blair Athol has changed substantially as the mining operation has progressed. The need for large scale dewatering has decreased as the operation has moved into different parts of the coal seams and the introduction of a wash plant in 1999 has resulted in increased demand for water resources on site.

To meet site demands water has been pumped, via a pipeline, from the Wolfang borefield located within the Clermont Coal Mine lease area. Supply of water from the borefield has been critical to the operation as the site has no connection to any water supply system. In 2007 after a prolonged drought, water supplies at Blair Athol became business critical the small supply from the borefield could keep the operation functioning until the January 2008 rains. In 2009, the supply from the borefield is dependent on the Clermont Coal Mine demands for water, with the supply to Blair Athol being shut off for extended periods of time in 2008 and 2009.

- protect operational areas from inundation during periods of high flow in local waterways (levees);
- contain potentially contaminated water and tailings onsite (regulated dams); and

sources at Blair Athol. As a consequence, the need to discharge water from site is predicted to remain very low as all available water will be required for mining operations at Clermont Mine in accordance with the mine water agreements.

4.6.1.1 Water Consumption

Water is considered a critical operational resource on site, with the primary source of raw water is water captured on site (refer Water Management Plan). The primary uses of water on site are:

- water trucks for dust suppression;
- potable use.

Blair Athol has implemented the following strategies to improve and promote efficient water consumption:

- dust suppression additives have been trialled on haul roads; and

- in 20082009 Blair Athol trialled a bitumen product on site to reduced water consumption for road watering.

4.6.2 Levees, Dams and Diversions

The water management system at Blair Athol consists of a number of levees, dams and diversions within the Blair Athol ML that are designed to divert waterways to allow for mining of economic reserves (diversions).

Currently there are five primary creek diversions on Blair Athol:

- **Rail Loop Diversion** (Breaker Creek Diversion) located north of the rail loop and is a diversion for Breaker Creek North. This diversion protects the rail loop infrastructure and diverts Breaker Creek North into Washpool Creek West for improved water harvesting for the West Dam;
- **Northern Boundary Drain** transfers overflow from West Dam around the north of the mining area;
- **Eastern Diversion.** Clean water entering the site from the north is diverted around the mining area by the Northern Boundary Drain, along the Eastern Diversion and Eastern Diversion Realignment where Bath Creek joins the diversion;
- **South Eastern Diversion** starts at the bottom of Eastern Diversion after the confluence of Teatree Gully, diverting flows around the Ramp 5 mining areas, and into the Environmental Dam before running off lease via the original Bath Creek Channel (if the Environmental Dam fills and spills); and
- **Western Diversion.** Clean water entering the site from Breaker Creek to the north and north west is diverted away from the mining area and the Environmental Dam and realigns with Bath Creek West.

Figure 6 illustrates the current diversions.

Breaker Creek runs around the western side of the mining operation. Breaker Creek catchment accounts for about a third of the total catchment area. This creek does not have a defined bed or banks for the majority of its course within the Blair Athol ML area and contains a number of open flood out areas to the west of the mine which inhibits the number of flows that make it to the Western Diversion. Breaker Creek receives water from the discharge at the Stockpile Dam.

All site creek diversions are licensed under the Water Act 2000 and are designed to a minimum Q100 flood event. Permanent structures located near mining operations are constructed to a Q1000.

With the development of the No. 4 Seam mining area in 2011, several changes were required to the South East and Eastern Diversions and Breaker Creek floodplain. The report by Alluvium Consulting titled – “Seam 4 Diversions – Preferred Diversion Options Concept Design and Impact Assessment” March 2010, describes that proposed changes and design components. Considerable thought has been put into the design process including liaison with DEHP Water Management Use to determine the best course for the water.

Blair Athol also has several dams within its water management system which are classified as regulated dams. All the water storages are excavated holes in the ground which are designed to capture and contain mine water and localised runoff from areas disturbed by mining.

The mine is currently using Ramp 2 TSF for co-disposal of tailings and coarse rejects. The Ramp 2 facility provides a total volume of 1.24 x $10^6 m^3$ at design height of RL302.3. Blair Athol is in the process of assessing and evaluating several options for rehabilitation of the TSF.

The elevation of the TSF is below the base of the basalt aquifer, and so does not influence the quality or elevation of the groundwater within the basalt aquifer. This is expected to remain the case in the long term, well after closure.

4.6.2.1 Acid Mine Drainage

Characterisation of mineral waste has been undertaken through various geochemical assessments and categorised in accordance with its ARD potential. The highest ARD risk on site is associated with the TSF at Ramp 2. In this area coal tailings and rejects which are known to contain sulphide are stored and consolidated in one location.

Blair Athol has developed and implemented the Blair Athol Acid and Metalliferous Drainage Management Guideline to address the management and disposal of ARD material, thus actively developing strategies to mitigate impacts of ARD on surface and groundwater. This is further discussed in Section 3.4.

4.6.2.2 Off-Site Discharges

Discharges are restricted to the authorised release point, the Stockpile Dam, and comply with the quality limits applied on the EA. Any controlled discharge will take place during wet weather

periods when the flow in Bath Creek will minimise adverse environmental impacts through further dilution.

4.6.2.3 Other

A heavy and light vehicle workshop is present on site with infrastructure designed to prevent contamination of the environment from hydrocarbons or chemicals. Runoff and small spills from the workshops are directed into an oil/water separator. The oily water is separated with the treated water discharged into the site mine water management system (refer Figure 5). Waste oil is collected in a tank for removal offsite by a licensed regulated waste operator.

Hydrocarbons and chemicals on site are stored in bunded facilities to prevent the release of these substances into the environment. Spill kits are strategically located in areas where there is potential for a spill to occur and used immediately as required to minimise the potential for contamination of the environment.

The Blair Athol sewage treatment plant, which has the capacity to treat raw sewage for up to 220 EP, is located adjacent to the industrial/administration area. Treated sewage effluent, which is quality tested daily, is pumped to a clay lined sewage effluent pond where it is allowed to evaporate. As such, the treated effluent is a low environmental risk to groundwater. Treated effluent is not irrigated or used for dust suppression on site and therefore is considered a low environmental risk to surface water.

4.6.3 Environmental Values

The environmental values of the water management system are:

- the protection of operational areas from inundation during periods of high flow in local waterways (levees);
- containment of potentially contaminated water and tailings onsite (regulated dams); and
- diversion of waterways to allow for mining of economic reserves (diversions).

4.6.4 Potential Impacts on Identified Environmental Values

The major potential impacts on environmental values which can arise because of a failure within the water management system are as follows:

- changes in flood and flow hydrology of catchments at a local scale;
- ecological changes to waterway ecosystems due to changes in flow and flood regime;
- inundation of mine operating areas in the event of failure of the levee banks in a flood event; and
- discharge of large volumes of potentially contaminated water and/or land if a regulated dam fails or spills over (including the TSF).

4.6.5 Environmental Protection Objectives

The environmental protection objectives for the water management system are:

- to ensure that the design considers and applies appropriate engineering standards;
- to maintain the structural integrity of levees, diversions and dams; and
- monitor and maintain the water management system which addresses the movement of water, tailings and rejects and the volume and contamination potential of each.

4.6.6 Management Strategies

Blair Athol is committed to the implementation of the following management strategies to minimise the potential impacts from the construction and operation of the water management system:

- model and consider flood and hydrology effects downstream of proposed diversions and levees;
- diversions designs will consider the guiding principles of the Bowen Basin River Diversion Design and Rehabilitation Criteria (ACARP 2002);
- levees, dams and diversions will be designed by suitably qualified engineer;
- design and construct new levees and regulated dams in accordance with Australian National Committee on Large Dams (ANCOLD) guidelines and DEHP requirements;
- levees, dams and diversions will be maintained in accordance with approved engineering designs and operational plans;
- mandatory reporting levels will be clearly marked on regulated dams;
- monitoring will be conducted quarterly on selected regulated dams to obtain an understanding of the contamination potential;
- offsite discharges will be controlled so that the quality of the discharge and the quality of the receiving waters (downstream of the discharge) comply with the relevant EA conditions. All discharges will be sampled in accordance with the procedure prescribed in relevant Blair Athol HSEQ Work Instructions;
- tailings and rejects from selected strata are tested for electrical conductivity, pH, net acid producing potential and exchangeable sodium percentage to identify potentially nonbenign material;
- inspections will be carried out on all levees and regulated dams on a regular basis to ensure that operation of the water management system is being undertaken in accordance with the Water Management Plan and regulated dam operational plans; and
- annual inspections will be carried out by a suitable qualified engineer to verify the integrity and suitability of all levees and regulated dams. A report of the annual inspection findings is provided to the DEHP.

Construction and operational requirements for the modification of diversions will be developed in conjunction with DEHP in accordance with guidelines stipulated by the DEHP.

Testing of coarse and fine rejects by EGi (2004) found that the materials present in Ramp 2 TSF were both were PAF and non-acid forming. The TSF is operated and maintained in accordance with Blair Athol's Tailings Storage Facility Operations and Maintenance Procedure.

The operations and maintenance procedure addresses such requirements as:

- construction works including the foundation preparation and construction tolerances, construction material, compaction and density testing;
- tailings deposition methodology;
- tailings placement;
- pipeline spills, flushing and emergency shutdowns;

- decant water management; and
- inspections and monitoring.

Impacts on groundwater and surface water from the TSF are managed through:

- construction of the TSF in accordance with design requirements;
- monitoring the placement and levels of waste material in the TSF to ensure an adequate freeboard;
- monitoring the structural integrity of the TSF; and
- monitoring the groundwater on the embankment and downstream of the TSF.

The TSF includes the operation of the decant management system. The decant management system involves: the decant pond where the bleed water from the tailings slurry is collected, in addition to rainfall runoff; the decant recovery system comprises pumps, and the decant return pipeline.

The aims of the decant water management system are as follows:

- to minimise the volume of free water on the tailings decant pond. This maximises the usable volume within the storage of the life of the TSF and ensures that the designed safety allowance is maintained;
- to minimise the loss of decant water as seepage through the main embankment and waste dump material;
- to ensure acceptable stability conditions within the main embankment and waste dumps by maintaining a low seepage surface (phreatic surface); and
- to reuse the process water in preference to evaporation losses.

4.6.7 Commitments

Blair Athol recognises the significant environmental risks which may occur from poor design, construction and operation of the water management system. Therefore, Blair Athol is committed to ensuring that appropriate engineering, modelling and operations standards are applied in all phases of the water management system.

4.6.8 Monitoring

As a requirement of the EA, Blair Athol will review the Water Management Plan on an annual basis (prior to the wet season) and ensure that the system meets the requirements of the DEHP Guideline for Preparing a Water Management Plan 2009. In addition, a review of the site water balance will be conducted prior to the wet season and following the wet season each year.

Inspections will be carried out on all regulated dams and levees on a regular basis to ensure that operation of the mine water management system is being undertaken in accordance with the Water Management Plan and regulated dam operational plans.

Inspections are conducted on a daily and weekly basis to visually observe any in construction embankments and operational matters such as seepage, pipeline failure and storage capacity.

- an annual inspection is conducted by a registered engineer regarding the TSF structural integrity and regular volume, integrity and pumping inspections throughout the year by appropriate mine personnel;
- coarse rejects density to assess the placed dry density of the coarse reject;
- embankment construction level monitoring confirms the embankment construction level is conducted fortnightly for the first year and then monthly thereafter;
- reading of water levels in monitoring bores is to check on development of seepage surfaces (water table) within the main embankment is conducted fortnightly for the first year and then monthly thereafter;

- survey of movement monuments assesses the settlement and deflection of embankments and spoil piles; this is conducted fortnightly for the first year and then monthly thereafter;
- tailings surface levels are surveyed at three points on a monthly basis to determine the rate of tailings rise;
- tailings discharge tonnage is recorded daily by the wash plant and is used to verify the tailings and decant return water volumes;
- the decant pond water level is visually inspected on a weekly basis to assess against the mandatory reporting level;
- the water levels in four monitoring bores located on the TSF embankment are monitored monthly and an additional three bores located down gradient of the TSF are monitored for water quality on a quarterly basis. (The three down gradient groundwater bores are managed in accordance with the groundwater monitoring programme (refer Section 3.2.8));
- volume reconciliation of tailings and reject material will be conducted annually; and
- geochemical characterisation of the coarse rejects and tailings to ascertain ARD potential are conducted on a six-monthly basis. Coarse rejects are collected directly from the wash plant prior to placement in the TSF and tailings are collected from the tailings discharge pipeline. Each sample event comprises of the collection of a single tailings and coarse rejects sample daily for a period of five days (a total of five samples each).

All the samples are tested for:

- total sulphur content;
- neutralization potential (NP) or Acid Neutralizing Capacity (ANC);
- pH;
- electrical conductivity;
- carbonate content based on total organic carbon.
- total metals analyses;
- Net Acid Generation (NAG) testing with hydrogen peroxide;
- Net Neutralization Potential (NNP) or Net Acid Producing Potential (NAPP); and

The volume of water used on site is monitored by water meters installed at water supply locations with metered readings recorded on a daily or monthly basis.

The sewage treatment plant is checked daily and maintained as required. Several quality characteristics are also monitored each day. Total faecal coliforms of the treated effluent are sampled from the sewage effluent dam on a quarterly basis and analysed by an external NATA registered laboratory. Results reviewed internally and recorded in the Health and Safety Department database.

ARD is monitored throughout the life of the mine, with monitoring of exploration drill holes characterising ARD potential of new mining areas, water monitoring of existing pit dams and monitoring of soil and spoil within rehabilitation. Monitoring is further discussed in Section 3.4.

4.7 SOCIAL AND CULTURAL HERITAGE

Blair Athol used to be the largest employer in Clermont and has therefore developed and implemented a plan for community relations. The purpose of the community plan is to assist in improving community relations through:

- understanding the needs of the local community;
- developing programmes that assist the community either directly through supporting specific programmes, or by training individuals and upgrading their skills;

- establishing objectives and targets for these programmes and measuring their success; and
- reporting back to the community on the effectiveness of the strategy.

While Blair Athol has significantly reduced its number of employees since the cessation of coal mining in 2012, a robust relationship with the community is still desirable. On implementation of the Closure plan, a revised community relations plan will be developed and implemented.

4.7.1 European Heritage

Blair Athol is located within the boundary of the 'Blair Athol' run, a large pastoral station dating from the late 1850s. Coal mining has been conducted within and near ML1804 for more than 120 years. Coal was first discovered in the district at Blair Athol in 1864 during well sinking operations. Several small scale underground mining operations were established during the 1880s and 1890s to service the Central Railway and copper smelting activities. The site of the former township of Blair Athol is located on ML1804. There are other remnants of past mining, timber getting and occupation scattered about ML1804 which will be subject to formal historic heritage assessment to inform the closure planning process.

4.7.2 Aboriginal Cultural Heritage

Aboriginal rights have been established through the Native Title Act (Commonwealth) 1992 and the Aboriginal Cultural Heritage Act 2003 (Qld). There is currently a native title claim over the

area that includes Blair Athol and the Clermont deposit. The claim is under review to an extent that an expanded claim may include the RTCA Kestrel Mine, to the south, but will have no substantial effect on Blair Athol. The overall RTCA aim was to have an indigenous land use agreement (ILUA) to cover the whole area. An agreement was finalised in May 2008.

The Aboriginal Cultural Heritage Act 2003 (Qld) introduces a duty of care on land users and developers such that it is illegal to 'harm' any Aboriginal cultural heritage without prior approval. Such approval can arise either by way of agreement or by an approved cultural heritage management plan (CHMP). Mining operations are exposed to the extent of cultural heritage values on previously 'undisturbed' land.

In cooperation with RTCA, the Wangan & Jagalingou Parties have prepared a State CHMP for Blair Athol and the Clermont Mine project. The plan sets out protocols for site surveys, site evaluation, salvage and safekeeping, restriction of access and communication with Traditional Owners. All impacts on Aboriginal cultural heritage will be managed in the context of this plan.

4.7.3 Environmental Values

An archaeological survey of the lease areas was conducted in 1981 by Dr Helen Brayshaw. The survey reported no aboriginal artefacts of heritage value were detected.

Further surveys were conducted in 2006 though only areas known to be disturbed by mining were surveyed.

The Blair Athol Township, which dates back approximately 100 years, was in the latter stages of decline from a population of approximately 530 to about 70 at the time of commencement of current mining operations. The township's remaining amenities included a general store, post office, recreation hall, bowling club, cemetery and sports ground. The hospital closed in 1972 and the school closed in 1974. The township was decommissioned during the late 1970s and all remaining residents were moved to Clermont. Today, the only substantial historical site remaining within ML1804 is the Blair Athol cemetery, which is located east of the Environmental Dam with public access from the Blair Athol mine access road. Measures will be taken to protect the cemetery from mining activities.

4.7.4 Potential Impacts on Identified Environmental/Social Values

Mining activities could result in the destruction or burial of artefacts, disturbance of significant sites, and impacts on culturally significant settings.

Removal of participation and support of community matters may impact on the sustainability of the social infrastructure of the community.

4.7.5 Environmental Protection Objectives

Blair Athol recognises the cultural values of the land and artefacts on the ML. Blair Athol's objective is to protect the heritage and cultural values working with the Traditional Owners and the local community to ensure that planning and operations consider the cultural issues and values.

As a prominent influence of the socioeconomic structure of the local community of Clermont and at a less degree within the Central Queensland region, Blair Athol holds social responsibility for the

integrity of the social conditions within the community. As such Blair Athol places a high emphasis on being an accepted and on being a constructive member of the local community. The objectives for the management of social issues include:

- active participation in programmes which preserve or enhance the well-being of the community;
- minimisation of the exposure of the public to environmental risks and impacts from the mining operations and postmining landforms; and
- ensuring that postmining strategies developed for the closure of the mine consider a sustainable vision for the community.

4.7.6 Management Strategies

RTCA and the Wangan Jagalingou working group entered a Queensland Government approved CHMP for the Clermont Mine project in October 2004. In cooperation with RTCA, the Wangan & Jagalingou Parties have prepared a State CHMP for Blair Athol and the Clermont Mines.

The CHMP details the general and specific management measures to be implemented for the area subject to the agreement between RTCA and Wangan Jagalingou Working Group. The management plan for cultural heritage sets the terms and conditions to be applied to each area. RTCA and the Wangan Jagalingou Working Group (native title claimants) have also entered Cultural Heritage Investigation and Management Agreements (CHIMA). These agreements guide cultural heritage work around Blair Athol. Cultural heritage assessments include one or more of the following:

- archaeological survey (aboriginal and/or historic);
- anthropological and/or ethnographic survey;
- desktop document research; and
- a study report identifying significant cultural heritage sites, areas and values and management recommendations.

Aboriginal and historic cultural heritage values and significance are assessed using an agreed assessment process and methodology detailed in a terms of reference (ToR). ToRs are developed and authorised by the RTCAWangan & Jagalingou Cultural Heritage Coordinating Committee (CHCC). The CHCC is the sole entity for dealing with all matters associated with cultural heritage on Blair Athol and RTCA lands. The Wangan & Jagalingou (technical advisors) and RTCA Cultural Heritage Unit jointly conduct assessments and other activities as directed by ToRs. ToRs are written and agreed scopes of work which also provide authorisation for cultural heritage work (e.g. archaeological surveys and site mitigation). A ToR will detail the area, scope and scale of the assessment work, assessment methodology, and composition of assessment team, timelines,

duration of work and hours, payment, safety and all other technical and procedural aspects of the cultural heritage assessment work programme. A ToR, once agreed upon, are only be modified or altered by the agreement of those who approved them that is the Wangan & Jagalingou and RTCA CHCC.

Cultural and European heritage assessments, where required, have been completed for all designated mining development areas for the life of mine at Blair Athol. A cultural and European heritage place impact mitigation process is aligned with the annual mine planning process to implement all necessary cultural heritage mitigation requirements as a precursor to any development ground disturbance activities commencing.

Areas identified as holding significant cultural value have been marked or fenced off to exclude mining activities. For the protection of the cemetery values and aesthetics, Blair Athol has maintained a 30 metre native vegetation screen to buffer mining impacts.

A register is maintained to record the location of identified heritage sites or artefacts discovered. Any artefacts that are removed from the mine site are stored in a shed located at Clermont Coal Mine. The Traditional Owners will decide if the artefacts will be returned to the land post mining or taken and located elsewhere.

An Environmental Permit (internal permitting system) is required to be obtained before entering undisturbed areas as a strategy to protect cultural heritage values. The permit which is applied for all exploration drilling, test pitting and other mobile or limited disturbance activities specifies management requirements such as operational zoning, fencing, collection and relocation of artefacts as defined by the RTCA Cultural Heritage Specialist. Collection of cultural artefacts is only carried out where places cannot be avoided, such as mining blocks, spoil dumps and other areas subject to significant ground disturbance.

Closure rehabilitation will occur on previously disturbed lands, and there is not expected to be any legal or regulatory issues associated with Traditional Owners, however, there is an opportunity for consultation through the site closure planning process regarding final land forms and land uses.

Site inductions include cultural heritage protection principles and disturbance requirements to ensure that all personnel working on site are aware of the general procedures.

As an active member of the community, Blair Athol:

- is a member of the Community Consultative Committee which provides a forum for the site and the Clermont community to share information and provide on the mining operation and closure discussions; and
- participates in regular stakeholder meetings with the DEHP.

4.7.7 Commitments

Blair Athol commits to:

- the management of aboriginal cultural values on the mine site under the requirements of the CHMP; and
- to participating in ongoing community and relevant stakeholder consultations in relation to the operation and closure of the mine, and will evaluate feedback from such meetings.

Blair Athol will continue to support selected programmes which preserve or enhance the well-being of the community.

Blair Athol will maintain a complaint register and investigate complaints with the objective of addressing/mitigating the concerns.

4.7.8 Monitoring

Cultural and European heritage assessments are undertaken for all areas proposed to be disturbed.

Complaints are recorded through the complaints register and communicated to the relevant regulatory authority.

5 GLOSSARY

ACARP	Australian Coal Association Research Programme
ACMER	Australian Centre for Mining Environmental Research
ANC	acid neutralizing capacity
ARD	acid rock drainage
BACM	Blair Athol Coal Mine
CCC	Community Consultative Committee
CCJV	Clermont Coal Joint Venture
CHCC	Cultural Heritage Coordinating Committee
CHIMA	Cultural Heritage Investigation and Management Agreements
CHMP	Cultural Heritage Management Plan
CHPP	coal handling and preparation plant
CMLR	University of Queensland Centre for Mined Land Rehabilitation
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEHP	Department of Environment and Heritage Protection
EA	Environmental Authority
EDMS	Environmental Data Management System
EIS	Environmental Impact Statement
EM Plan	Environmental Management Plan
EMS	Environmental Management System
EP	equivalent persons
EPBC	environmental protection and biodiversity conservation
ERA	environmentally relevant activity
ERE	endangered regional ecosystem
GHG	greenhouse gas emissions
GPS	global positioning system
HSEQ	health safety environment and quality
ILUA	Indigenous Land Use Agreement
IUCN	International Union for Conservation of Nature
ML	Mining Lease
ToR	Terms of Reference

6 REFERENCES

AARC 20013. Vegetation Monitoring Report for BAC. ACARP, 2002. Bowen Basin River Diversion Design and Rehabilitation Criteria. ANCOLD. Australian National Committee on Large Dams Guidelines (Various).

AS 19402004 The storage and handling of flammable and combustible liquids. AS/NZ ISO14001 Environmental Management Requirements with Guidance for Use.

Emmerton B. and Elsol J. June 2005 – Blair Athol Mine Rehabilitation Review Central Queensland University, 2000. Comparison of vegetation and invertebrate assemblages of a naturally revegetated spoil heap and an active rehabilitation site with native habitats at Blair Athol, Central Queensland.

Coffey & Partners Pty Ltd, 1983. Stage 2 Groundwater Assessment at Blair Athol Coal Mine.

Dames and Moore, 1983. BAC Waste Management and Rehabilitation Program. Department of Natural Resources and Water. Water Quality Database Sandy Creek and Wolfgang Creek, 19622001.

EGi 2004. Testing of Coarse and Fine Rejects

EGi (Environmental Geochemistry International), 2004. Geochemical Assessment of Coal Washery Wastes.

EGi (Environmental Geochemistry International), 2006. Geochemical Assessment of Overburden from Blair Athol Mine.

EGi (Environmental Geochemistry International), 2006. Geochemical Assessment of Overburden from 4 Drill Holes Blair Athol Mine.

EGi (Environmental Geochemistry International), 2009. Column Leach Test Results for Rejects and Tailings from the Blair Athol Coal Washery Plant.

Department of Environment and Resource Management, 2010. Environmental Authority (Mining Activities) Non Code Compliant Level 1, Mining Project, Permit Number MIN100930009 – Blair Athol Coal Mine.

Department of Environment and Resource Management. Guideline – Preparing Environmental Management Plans.

Department of Environment and Resource Management, 2009. Guideline for Preparing a Water Management Plan 2009.

Environsciences Pty Ltd, 1993. Blair Athol Coal Project Soil Survey.

International Union for Conservation of Nature, 2009. Species of Conservation Value Listing.

Kamst and Simpson, 1996. Noise Survey Report, Blair Athol Coal.

Kamst and Simpson, 1998. Noise Survey Report, Blair Athol Coal.

Matrixplus Consulting, 2004. Annual Report to DNRM On the Taking of Groundwater (Water Licences 84527F & 84530F).

Matrixplus Consulting, 2005. Annual Report to DNRM On the Taking of Groundwater (Water Licences 84527F & 84530F).

Peter Hollingsworth and Associated Consultants 1974/76. BAC Environmental Impact Study for an Expanded Mining Operation (Vol I and II).

Queensland Herbarium. Regional Ecosystem Mapping. Rio Tinto Coal Australia, August 2004.

Clermont Coal Mine Project, Environmental Impact Statement. Rio Tinto Coal Australia, December 2004.

Clermont Coal Mine Project, Environmental Impact Statement – Supplementary Report. Rio Tinto Coal Australia, 2009.

Blair Athol Plan of Operations: 1 January 2010 – 31 December 2010.

Rosser J, Swartz GL, Dawson NM, Briggs HS, 1974. Land Capability Classification for Agricultural Purposes. Qld Department of Primary Industries, Department of Land Utilisation, Technical Bulletin No. 14.

SKM, August 2004. Clermont Coal Project Environmental Impact Statement.

Terrenus 2009 Groundwater Review – Blair Athol Mine

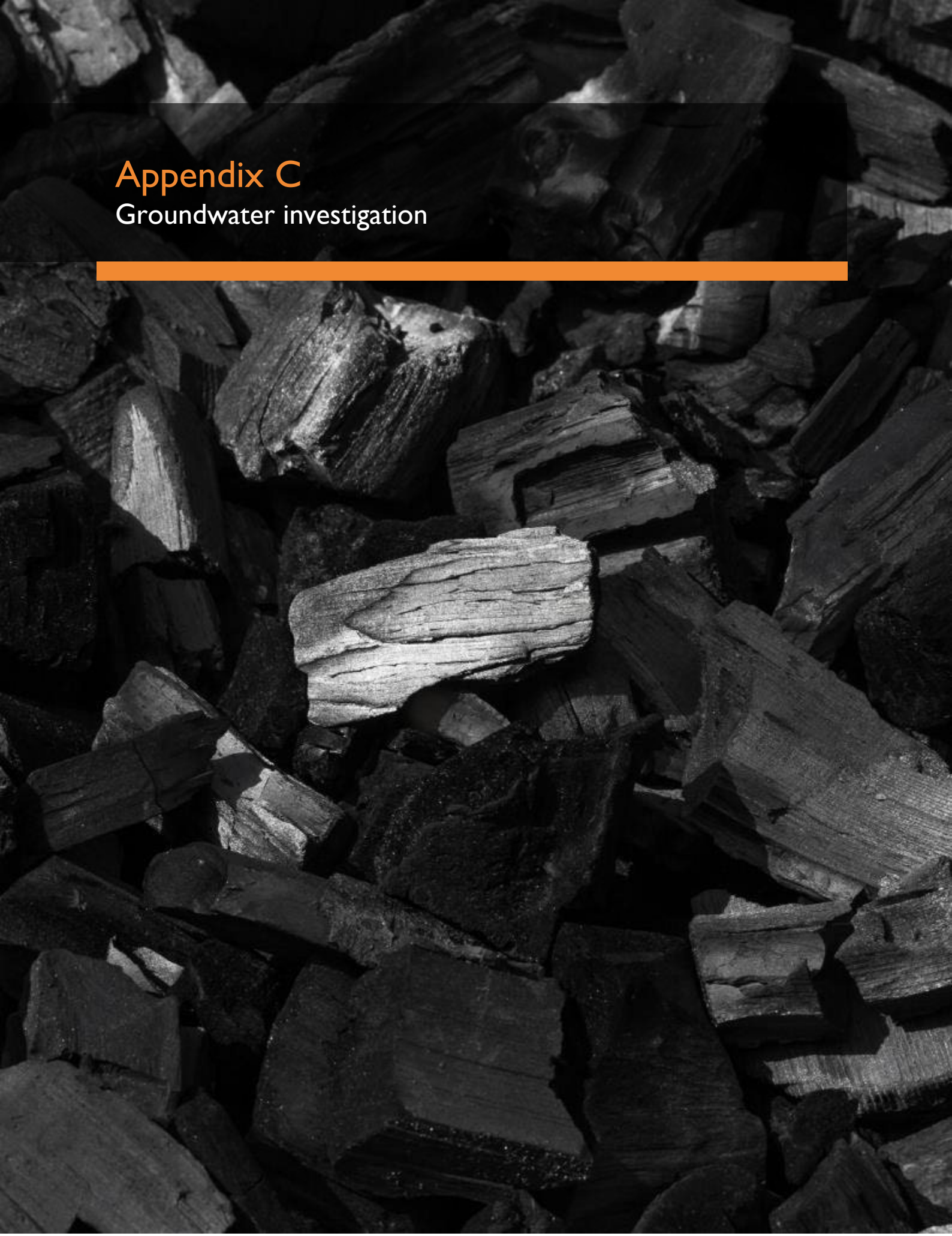
University of Queensland, 19962005. Various fauna site survey reports.

URS, 2006. Site History and Limited Phase 2 Environmental Site Assessment.

URS, 2008. Post Phase 2 Environmental Site Assessment June 2008.

Legislation

- Aboriginal Cultural Heritage Act 2003
- Environmental Protection Act 1994
- Environmental Protection Air Policy 2008
- Environmental Protection Regulation 2008
- Environmental Protection (Waste Management) Policy 2000
- Environmental Protection (Waste Management) Regulation 2000
- Explosives Act 1999
- Land Protection (Pest and Stock Route Management) Act 2002
- Native Title Act 1992 (Commonwealth)
- Water Act 2000
- Wild River Act 2005



Appendix C
Groundwater investigation

This page is intentionally blank.

RIO TINTO COAL AUSTRALIA

BLAIR ATHOL MINE

BLAIR ATHOL MINE CLOSURE
GROUNDWATER INVESTIGATION

December 2012

JBT01-018-002

RECORD OF ISSUE

File Name	Description	Issued to:	Date Issued	Method of Delivery
JBT-018-002	Draft 1	S Diggles B Rickard	22/8/2012	email
JBT-018-002	Draft 2	S Diggles B Rickard	3/9/2012	email
JBT-018-002	Draft 3	S Diggles B Rickard	24/12/2012	email
JBT-018-002	Final	S Diggles B Rickard	24/12/2012	email

TABLE OF CONTENTS

SECTION **PAGE**

1.0 INTRODUCTION 1
2.0 SCOPE OF WORK 2
3.0 HISTORY OF MINING 2
4.0 AVAILABLE DATA 3
4.1 Existing Reports 3
4.2 Bore Construction Records 5
4.3 Groundwater Level Data 6
4.4 Water Chemistry 6
4.5 Other Data 6
5.0 CLIMATIC DATA 6
5.1 Clermont Climatograph 6
5.2 Rainfall Analysis 7
6.0 GEOLOGY 9
6.1 Regional Geology 9
6.2 Site Geology 13
7.0 HYDROGEOLOGY 16
7.1 Introduction 16
7.2 Description of Hydrostratigraphic Units 16
7.2.1 Basement Rocks 16
7.2.2 Permian Sediments 16
7.2.3 Tertiary Basalt Aquifer 16
7.2.4 Tertiary/ Quaternary Alluvium 17
7.2.5 Tailings and Spoil 17
7.3 Groundwater Recharge and Flow Direction 17
7.3.1 Basement Rocks 17
7.3.2 Permian Sediments 18
7.3.3 Tertiary Basalt Aquifer 18
7.3.4 Tertiary/ Quaternary Alluvium 18
7.3.5 Tailings and Spoil 18
8.0 REVIEW OF MONITORING DATA 18
8.1 Groundwater Monitoring Bores 18
8.2 Groundwater Level Data 21
8.3 Water Chemistry 24
8.3.1 Major Ion Chemistry 24
8.3.2 Comparison of Site Water Quality with Australian Guidelines 30
9.0 FINAL VOID 32
9.1 Final Void (Pit Lake) Water Levels and Water Quality 32
9.2 Potential Groundwater Inflow Rates to Final Void 35
10.0 CONCEPTUAL GROUNDWATER MODEL 37
10.1 Pre-Mining Conceptual Groundwater Model 37
10.2 During Mining Conceptual Groundwater Model 39
10.3 Post-Closure Conceptual Groundwater Model 40
11.0 CONCLUSIONS 42
11.1 Hydrostratigraphy 42
11.2 Groundwater Levels 43
11.3 Water Chemistry 43
11.4 Final Void 45
11.4.1 Final Void Water Levels and Water Quality 45
11.4.2 Groundwater inflow to Final Void 45
11.5 Conceptual Groundwater Model 46
12.0 RECOMMENDATIONS 46
13.0 REFERENCES 47

LIST OF TABLES

Table 5-1: Clermont Rainfall (Clermont Post Office) 9
Table 8-2: Water Type Analysis 25
Table 9-1: Potential Groundwater Inflow Rates to Final Void 36

LIST OF FIGURES

Figure 1-1: Site Location 1
Figure 3-1: Blair Athol Mining Areas 3
Figure 5-1: Climatograph for Clermont (BOM Station No. 035019 – Clermont Post Office) 7
Figure 5-2: Clermont Monthly Rainfall and Residual Mass Curve 7
Figure 6-1: Location of Permian Basins in the Clermont Area 11
Figure 6-2: Pre-Tertiary Land Surface and Basement and Permian Outcrop Areas 11
Figure 6-3: Surface Geology 12
Figure 6-4: Mine Area Stratigraphy (Source: RTCA 2011) 14
Figure 6-5: Schematic Cross Sections Showing Coal Seams (Source: RTCA 2011) 15
Figure 8-1: Location of Bores and Surface Water Dams 20
Figure 8-2: Groundwater Hydrographs 23
Figure 8-3: Piper Diagram – Blair Athol Surface Water and Groundwater Samples 26
Figure 9-1: Modelled Water Level in Final Pit Lake (Source: WBM 2012) 33
Figure 9-2: Modelled Final Void Water Levels Compared to Current Groundwater Levels 34
Figure 10-1: Location of Conceptual Sections (modified from RTCA 2011) 37
Figure 10-2: Pre-Mining Conceptual Groundwater Model (Modified from RTCA 2011) 39
Figure 10-3: During-Mining Conceptual Groundwater Model 40
Figure 10-4: Post-Closure Conceptual Groundwater Model 42

LIST OF APPENDICES

Appendix A Groundwater Level Data

Appendix B Water Type Analysis

Appendix C Comparison of Site Water Quality to Australian Guidelines

1.0 INTRODUCTION

Rio Tinto Coal Australia (RTCA) operates the Blair Athol Mine (BA), which is located in central Queensland, approximately 20 km north-west of the town of Clermont (Figure 1-1).

RTCA are planning for closure of BA and are currently undertaking a number of mine closure studies. RTCA have commissioned JBT Consulting (JBT) to undertake groundwater studies to support the closure of BA.

The scope of work for undertaking the assessment is outlined in Section 2.

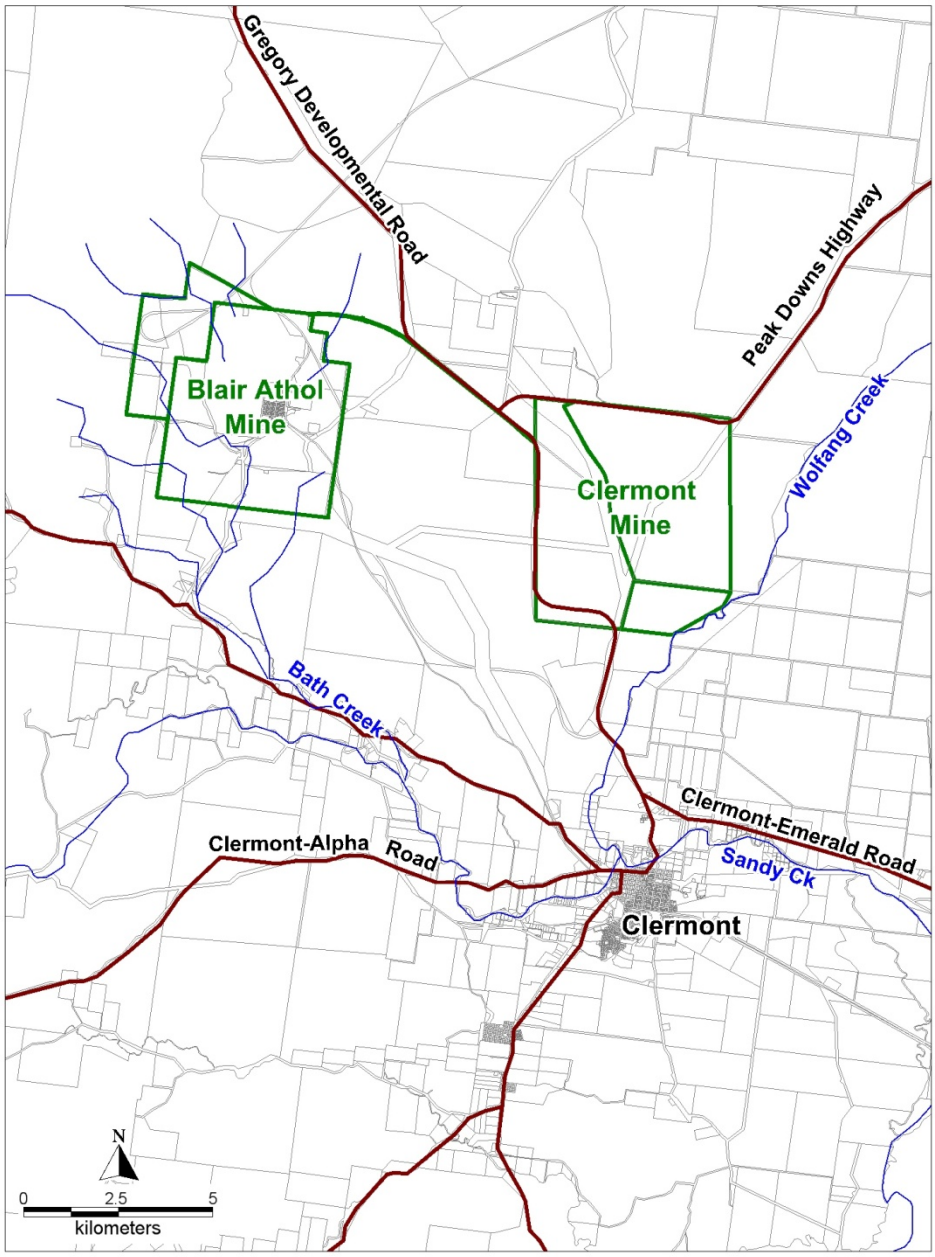


Figure 1-1: Site Location

2.0 SCOPE OF WORK

The scope of work for this groundwater study includes:

- Review groundwater data for the BA site, including previous reports, groundwater level data, surface water and groundwater quality data;
- Prepare an updated conceptual groundwater model for the site;
- Undertake a gap analysis with respect to the suitability of existing groundwater monitoring installations and monitoring/ sampling program for mine closure and post-closure;
- Make recommendations as appropriate for mine closure and post-closure groundwater monitoring/sampling, or other investigations if required; and,
- Prepare a report providing:
    - Detail of data available and reviewed for the study;
    - Presentation and discussion of groundwater level data
    - Presentation and discussion of water quality data from surface water and groundwater sources
    - An updated conceptual groundwater model for the site (pre-mining, during mining, and post-closure)
    - Data gap analysis; and,
    - Conclusions and Recommendations

3.0 HISTORY OF MINING

The Blair Athol Mine has been operating at large scale since 1984; prior to 1984 there was a history of small scale open cut and underground mining operations dating back to the 1890's.

There are four mining and rehabilitation areas at site, which are shown on Figure 3-1 and include:

- Ramp 1 (comprising Ramp 1 South Lower and Ramp 1 South East);
- Ramp 3 (comprising Ramp 3 North and Ramp 3 South);
- Ramp 4 (comprising Ramp 4 West and Ramp 4 East); and,
- Ramp 5 (comprising Ramp 5 North).

Since 1984 mining has focussed on Seam 3, which is up to 30 m thick, and the thinner (up to 5 m thick) Seam 4.

Mining has occurred at a typical production rate of 9-10 Mta (million tonnes per annum), with a maximum capacity of 12 Mta, and a recent production rate (for mining of Seam 4 reserves in the Ramp 1 area) of approximately 3.5 Mta.

Mining has been undertaken on site using the strip mining method, utilising a dragline for overburden removal, and truck and shovel operations for mining of coal and interburden. Mining areas have been progressively backfilled with spoil material (overburden and interburden material) leaving a final void at each mined-out area.

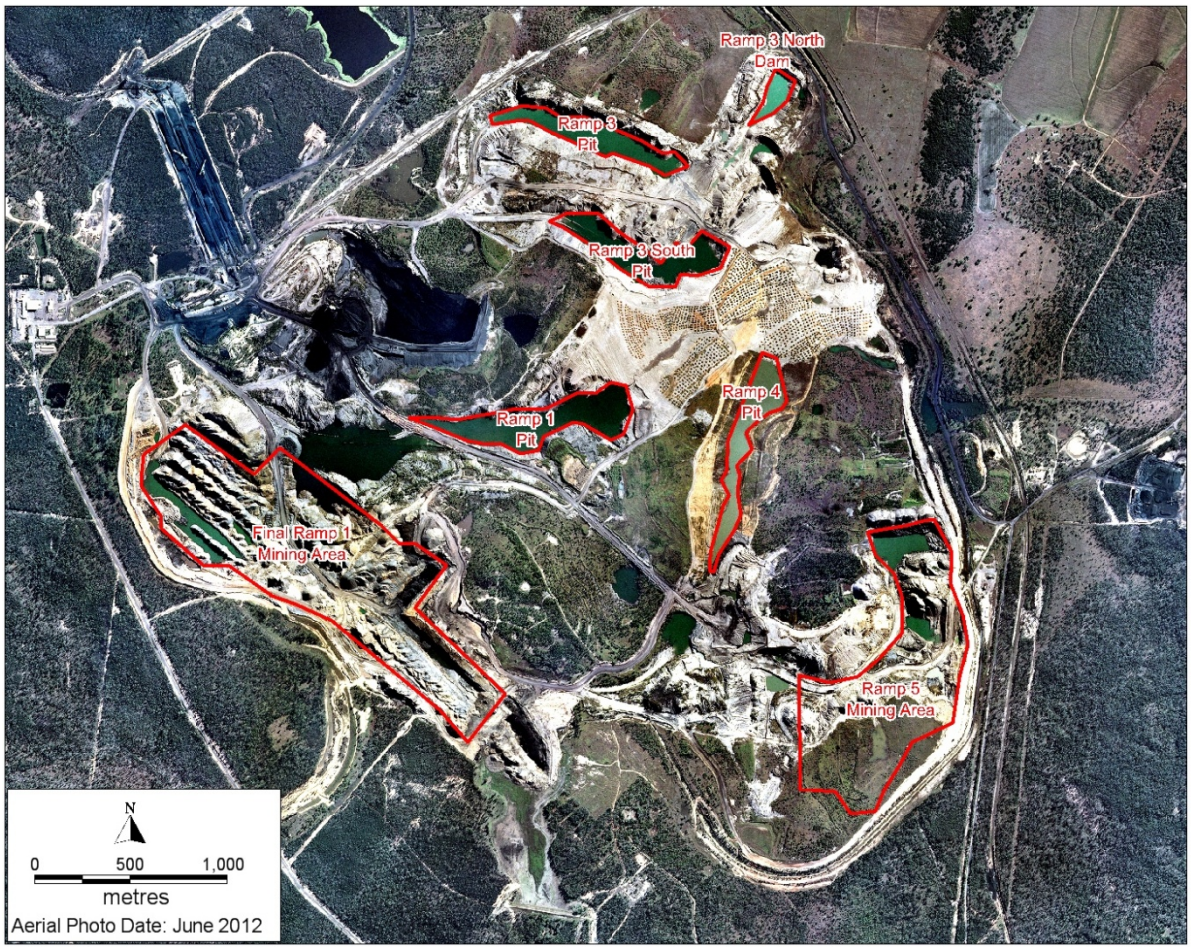


Figure 3-1: Blair Athol Mining Areas

4.0 AVAILABLE DATA

4.1 Existing Reports

Reports made available for review include:

- BMT-WBM (2012) BAC Final Landform Water Study. Report to Rio Tinto by BMT WBM, November 2012

  Summary: The report presents a summary of water modelling of the pit lake within the final landform, and contains predictions of pit lake water level and salinity for two options: one where existing diversions around the operation are maintained, and another where the existing diversions are removed.

- Matrix+ (2007) *Groundwater Monitoring Bore Installation.* Report to Rio Tinto Coal Australia Blair Athol Coal Mine by Matrix + Consulting, July 2007.

  Summary: The report contains a brief overview of regional and site hydrogeology, followed by a description of the drilling and installation of a number of groundwater monitoring bores and geotechnical monitoring bores (GW-series and GT-series bores). Information in the report includes bore locations, construction information (summary table and bore construction logs), and recommendations that:

  o Monthly water level monitoring be undertaken at each groundwater and geotechnical bore; and,

- Quarterly water quality sampling be undertaken from each groundwater and geotechnical bore.

- RTCA (2011) *The Coal Resources and Coal Reserves of the Blair Athol Mine – 2010.* Report prepared to support 2010 year end statements by Rio Tinto Coal Australia (RTCA), February 2011.

  Summary: The report provides detail of:

  - Regional geology (structure and stratigraphy);
  - Local geology (structure, stratigraphy, description of coal seams, location of alluvium, influence of igneous activity at site (basalt flows and intrusive dykes);
  - Coal exploration status;
  - Current status of the geological database, geological model, and coal quality model;
  - Geotechnical characteristics of the site;
  - The status of coal resources;
  - Overview of the mining method, mining equipment, coal handling and processing, and site infrastructure;
  - Mine design (layout and constraints); and,
  - Economic information, including economic ranking, reserves statement, and stakeholder signoff.

- Terranus (2009) *Groundwater Review – Blair Athol Coal Mine.* Report to Blair Athol Coal Mine by Terranus Earth Sciences, May 2009.

  Summary: The report was prepared to provide a summary of the understanding of groundwater conditions at site, in response to the findings of an internal RTCA environmental audit that the current understanding of groundwater conditions could be improved upon. The report includes:

  - A summary of available reports and data;
  - Description of the geological environment
  - Description of the groundwater environment
  - Summary of groundwater bores at site
  - Review of data integrity (bore construction standards and monitoring data)
  - Review of groundwater chemistry data
  - Presentation of a conceptual hydrogeological model for the site;
  - Data gap analysis, including statements as to the adequacy of:
    - Data coverage (bore distribution
    - Data capture (water level and water quality data)
    - Data quality
    - Data assessment
  - Review of available site data in comparison to Rio Tinto environmental standards; and,
  - Recommended corrective actions, with recommendations that:
    - Water quality samples be collected from water bores every 4 months, but preferably quarterly;

  - Water quality and water level data be collected from key storage dams on site;
  - EDMS (site environmental database) be updated to improve water quality reporting (this recommendation was mainly related to recording of sample QA/QC documentation);
  - Two new monitoring bores be installed, with one adjacent to the wash plant and one to the north of the TSF; and,
  - A detailed groundwater assessment be undertaken, including generation of hydrogeological cross sections through the site.

- Water Solutions (1999) *Report to RTCA Clermont Mine/ Blair Athol Coal on Permanent Waterworks Options Overview Investigations.* Water Solutions Document No. WS990292.

  Summary: The report presents a review and hydrologic assessment of a number of options for controlling surface water runoff and diversion of surface water flow around the mined area as part of mine closure operations.

- Water Solutions (2012) *Report to RTCA Clermont Mine/ Blair Athol Coal on OPSIM Water Management Metered Data Review.* Water Solutions Document No. WS120175 (Draft) 3 May 2012.

  Summary: The report presents an update of the OPSIM model (site water balance model) for the Blair Athol and Clermont Mine sites. The report includes a summary of surface water storage volumes, catchment areas, site water demands, water inputs (rainfall, groundwater, other), and transfer of water between the two mine sites.

- URS (2006) Assessment of water and sediment quality of Stockpile Dam and Environment Dam for EPA Hazardous Dam Classification. Letter report from URS to Blair Athol Coal Mine, Document No. 311006, 31 October 2006.

  Summary: The report presents an assessment of water and sediment from the Environmental Dam, Stockpile Dam, and West Dam, in comparison to EPA acceptance criteria for hazardous dams.

- A number of other reports prepared for the nearby RTCA Clermont Mine, which provide information on the regional groundwater system, groundwater levels, and groundwater chemistry in the Clermont region. The reports include information on groundwater occurrence within the Clermont Mining lease boundary. The reports to not make reference to Blair Athol Mine, but are useful for placing the regional groundwater system into context. Relevant reports include:
  - JBT (2009) *Regional Groundwater Model Update.* Report by JBT Consulting to Rio Tinto Coal Australia, Clermont Mine Project. JBT report No. JBT01-001-008, June 2009
  - JBT (2012) Clermont Mine – 5th Annual Aquifer Performance Review - 2011/2012 Water Year. Report by JBT Consulting to Rio Tinto Coal Australia, Clermont Mine. JBT report No. JBT01-001-061, August 2012.

4.2 Bore Construction Records

Details of site monitoring bores, including bore name, location, elevation, depth, screened interval, formation monitored, operational status, were available from:

- A summary spreadsheet provided by BAC;
- Bore construction records contained in Matrix+ (2007);
- Additional bore location and elevation (GPS) data provided by 4T consultants.

A summary of bore data is provided in Table 8-1.

4.3 Groundwater Level Data

Groundwater Level data available in Excel spreadsheet format included:

- Data downloaded from the site EDMS database covering the period March 2008 to August 2011;
- Data provided by 4T Consultants (site environmental sampling consultants) that included groundwater level data collected by them between May 2011 and August 2012; and,
- Additional water level data from Curtis Bore between January 2007 and May 2009, provided by BA site personnel

4.4 Water Chemistry

Water chemistry data was provided in Excel spreadsheet format, and included:

- Data downloaded from the site EDMS database covering the period March 2008 to August 2011;
- Data provided by 4T Consultants that included water quality data collected by them between May 2011 and August 2012; and,
- Water quality data from monitoring of site surface water storage facilities between May 1985 and July 2012.

4.5 Other Data

Other data provided for review/ report preparation includes:

- A geo-registered aerial photograph of the site, current to June 2012; and,
- Data generated from the site geological model, including:
  - Cross sections through the mining area; and,
  - A dxf file showing the mined-out area at end of mining.

5.0 CLIMATIC DATA

5.1 Clermont Climatograph

This climatic description of the region in which the project site is located has been compiled using data from the Bureau of Meteorology (BOM) weather station at Clermont Post Office (Station No. 035019) from August 2012.

Figure 5-1 presents a climatograph for the region. Annual average rainfall for Clermont is 666.7 mm, with the dry season peaking between July and September, and the wet season peaking from December through to March.

The coldest mean daily temperatures occur in July, with a mean minimum of 6.7ºC and a mean maximum of 23ºC. The hottest months occur in December (mean minimum of 20.8ºC and a mean maximum of 34.9ºC) and January (mean minimum of 21.6ºC and a mean maximum of 34.3ºC), with January also the highest rainfall month (average rainfall 117.9 mm).

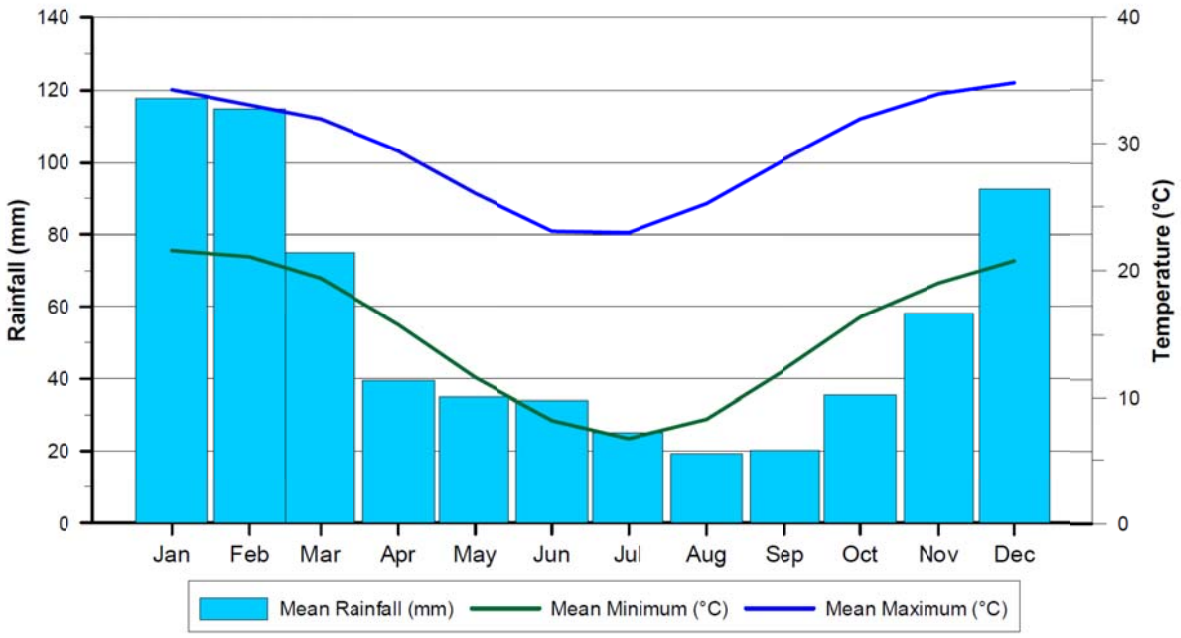


Figure 5-1: Climatograph for Clermont (BOM Station No. 035019 – Clermont Post Office)

5.2 Rainfall Analysis

Monthly rainfall for the period January 2002 to June 2012 is shown in Figure 5-2 (data recorded from the Bureau of Meteorology (BOM) Clermont Post Office weather station no. 035019).

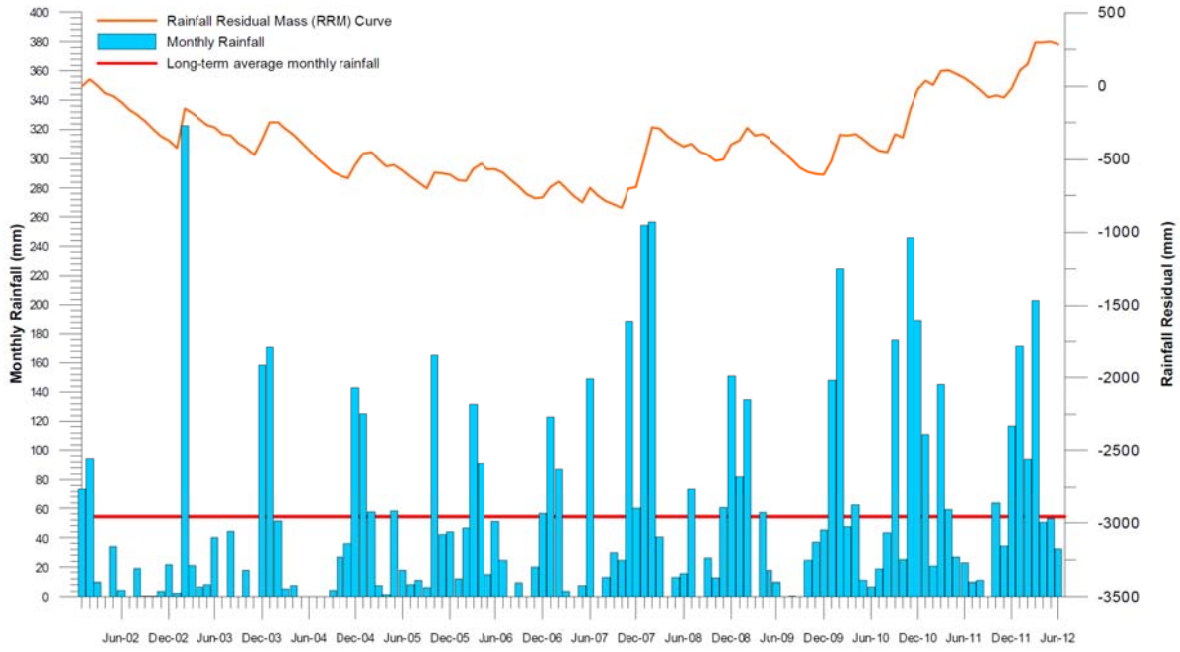


Figure 5-2: Clermont Monthly Rainfall and Residual Mass Curve

Table 5-1 shows monthly data for the Clermont Post Office weather station for each water year from 2007/2008 to 2011/2012. The long-term average data shown in Table 5-1 is for the full period of record from the Clermont Post Office weather station (1871 to present).

The wet season total (November to March) for each year is also shown on Table 5-1. The following observations are made with respect to rainfall data:

- The 2007/2008 wet season was one of the wettest on record. A total of 799.4 mm of rainfall was recorded between November 2007 and March 2008, out of a total of 894.4 mm for the entire 2007/2008 water year. The 2007/2008 wet season rainfall had a significant effect on groundwater levels in the Clermont region (JBT 2012). This effect is observed in the water level record for Curtis bore (landholder bore used for water level monitoring – discussed further in Section 8.2);
- The 2008/2009 wet season was slightly below average, however the following three wet seasons were all above average;
- The 2010/2011 year was also significant in terms of groundwater recharge. The wet season (November to March) rainfall of 695.2 mm was above average, but most significantly the wet season started early, with an additional 175.8 mm of rainfall recorded in September (compared to a September average of 19.3 mm). This meant that the above average wet season rainfall occurred when the ground was already saturated, providing enhanced conditions for groundwater recharge; and
- The 2011/2012 wet season was also above average, due mainly to high rainfall recorded during January and March 2012.

Figure 5-2 also shows the Rainfall Residual Mass (RRM) curve for the period of data between January 2002 and December 2011.

The RRM is calculated by subtracting the long-term average monthly rainfall from the actual monthly rainfall, to provide a monthly "departure" from average conditions. If the monthly rainfall is above average the resulting rainfall departure number is positive, whereas if rainfall is below average, the number is negative. The monthly rainfall departures are summed cumulatively to provide the RRM. A number of below-average rainfall months will result in a falling RRM curve, while a number of above average rainfall months will result in a rising RRM curve. The RRM curve is used extensively in groundwater investigations due to the strong correlation in many locations between the RRM and groundwater level trends, especially for shallow aquifers. This relationship is discussed further in Section 8.2.

The overall trend from early 2002 to mid-2007 has been a reducing RRM curve, followed by a rising RRM curve from mid-2007 to present. The 2007/2008 wet season is especially significant in that it marked a reversal from a trend for static or reducing groundwater levels, to a trend towards rising groundwater levels following wet season rainfall. In the Clermont region this trend has been especially evident in the basalt aquifer and other shallow aquifers including alluvium, Permian sediments where they occur close to surface, and areas of bedrock outcrop (JBT, 2012).

Table 5-1: Clermont Rainfall (Clermont Post Office)

Rainfall (mm)	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
2007-2008	0	13	29.6	24.4	188.4	60	254.2	256.4	40.4	0	12.8	15.2	**894.4**
					Total Nov to Mar - 799.4 mm								
2008-2009	73.4	0	26.4	12.2	60.4	150.8	82.1	134.8	0	57.2	17	9.6	**623.9**
					Total Nov to Mar - 428.6 mm								
2009-2010	0	0	0.4	24.2	36.8	45	148.2	231.8	47.6	63.4	12.4	6.6	**616.4**
					Total Nov to Mar - 509.4 mm								
2010-2011	18.5	43.4	175.8	25	225.6	192.6	111	20.6	145.4	79.6	26.8	22.7	**1087.0**
					Total Nov to Mar - 695.2								
2011-2012	9.5	10.9	0	63.8	34.2	99.4	165.8	77	193.2	49.4	51	32.4	**786.6**
					Total Nov to Mar - 569.6 mm								
Long-term average	24.8	19.1	20.2	35.5	58.1	92.5	117.5	115.1	74.2	39.1	34.8	34	**663.5**
					Total Nov to Mar – 457.4 mm								

* The table has been divided to provide a summary of rainfall over the wet season months (November to March).

6.0 GEOLOGY

6.1 Regional Geology

The Blair Athol Mine is located in the Blair Athol Basin, an isolated Permian basin near the western edge of the northern Bowen Basin, on the northern extension of the Dennison Trough.

The Denison Trough formed in the early Permian as an elongate depositional downwarp that developed as a half-graben (RTCA 2011). The Blair Athol Basin is an early Permian half graben lying unconformably on rocks of the Proterozoic to Cambrian Anakie Metamorphic Group (RTCA 2011).

The Permian coal basins in the Clermont area (including the Blair Athol Basin, which hosts the Blair Athol Mine, and the Wolfang Basin which hosts the Clermont Coal – refer Figure 6-1) contain Lower Permian Blair Athol Coal Measures, which overly the Proterozoic/ Cambrian Anakie Metamorphic Group (tightly folded mica, quartz-mica and quartz-chlorite schist, with phyllite, slate and quartzite.

The Permian sequence comprises a lower basal conglomerate, which is a quartzose and lithic pebble to cobble conglomerate, thought to be of glacial origin[1]. The basal conglomerate is overlain by the Permian coal-bearing sequence, which includes laminated sandstone and siltstone, coal seams, carbonaceous siltstone and mudstone, and minor conglomerate (refer stratigraphic section, Figure 6-4).

Vertical movement along faults has brought the basal conglomerates to the surface at various locations, so that the deposits occur at or near surface (with the overlying coal measures eroded away at these locations). This has occurred in the western area of the Clermont Mine, as well as in the vicinity of the Cement Hill and Black Ridge gold mines which are developed within Permian conglomerate (refer Figure 6-3).

The location of Permian coal basins within, and to the north and south of the lease area, can be seen in Figure 6-1, which shows the thickness of sediment within Permian basins in the Clermont area

[1] Herbert, H.K. (1989) Geology and Gold Potential, Black Ridge Area, Clermont Qld. Report to Southern Aurora Joint Venture, June 1989.

(including the Blair Athol Basin in which the BA Mine is developed, and the Wolfang Basin in which the Clermont Mine is developed).

The top of Permian (pre-Tertiary) surface is shown in Figure 6-2. From this figure it can be seen that pre-Tertiary drainage in the northern part of the BA lease area was to the north-east and east, via a channel system incised into the pre-Tertiary surface. The area of Permian outcrop to the north of this valley (Figure 6-2) contains the host rocks for the Cement Hill and Black Ridge gold mines. The location of these mining areas is shown on Figure 6-3.

During the Tertiary (Late Eocene to Middle Oligocene) basalt filled the area from east to west, with initial deposition focused on a deep paleochannel that can be seen to the east of Figure 6-2. The basalt is derived from nearby volcanoes, the remnants of which are still visible today as andesitic plugs including Mt Oscar and Wolfang Peak.

As deposition of basalt continued, the flows progressed further west and eventually infilled the pre-Tertiary channel that can be seen to the north of the BA and Clermont leases on Figure 6-2. The extent of basalt can be seen on the surface geology map shown as Figure 6-3.

Therefore the basalt encountered in the north and north east of the site (Figure 6-3) represents the marginal extent of basalt. Basalt thickens to the north and north-east of the site, with the greatest thickness (locally) within the pre-Tertiary channel shown on Figure 6-2. The basalt progressively thickens to the east of BA; at Clermont Mine the basalt maximum thickness of basalt is in the order of 70-80 m, and in the deepest part of the paleochannel (to the east of the extent shown on Figure 6-2) the basalt thickness exceeds 170 m (JBT 2009).

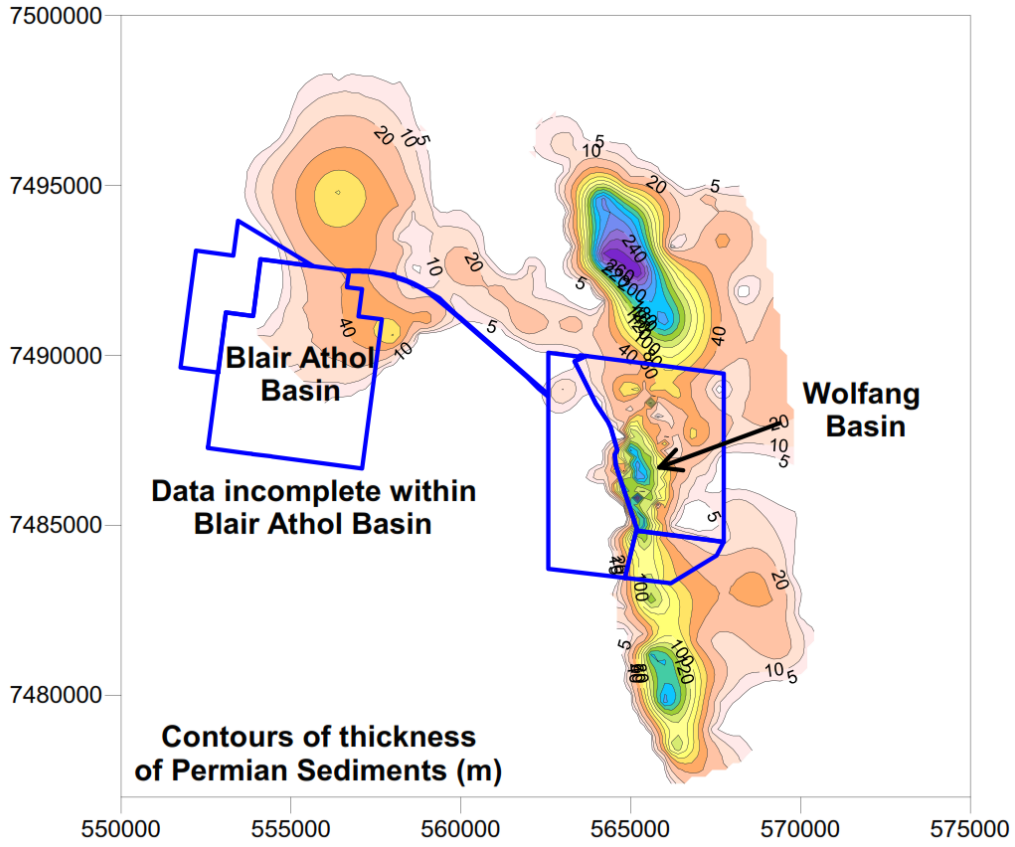


Figure 6-1: Location of Permian Basins in the Clermont Area

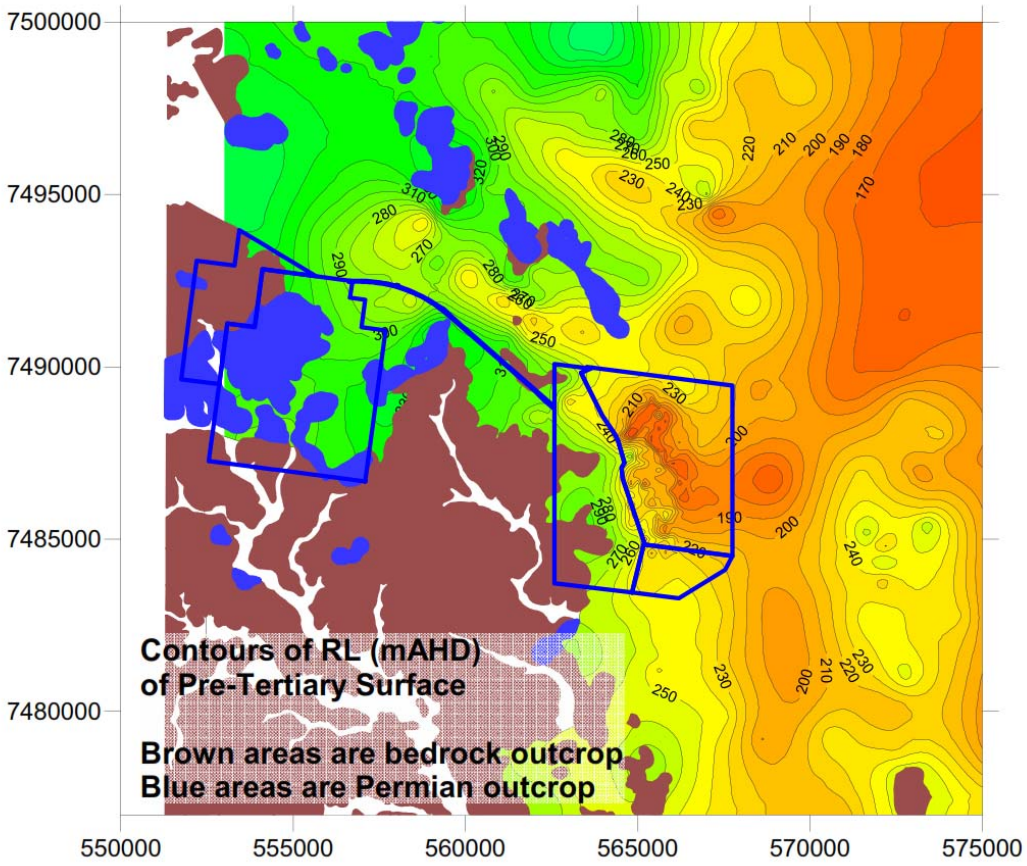


Figure 6-2: Pre-Tertiary Land Surface and Basement and Permian Outcrop Areas

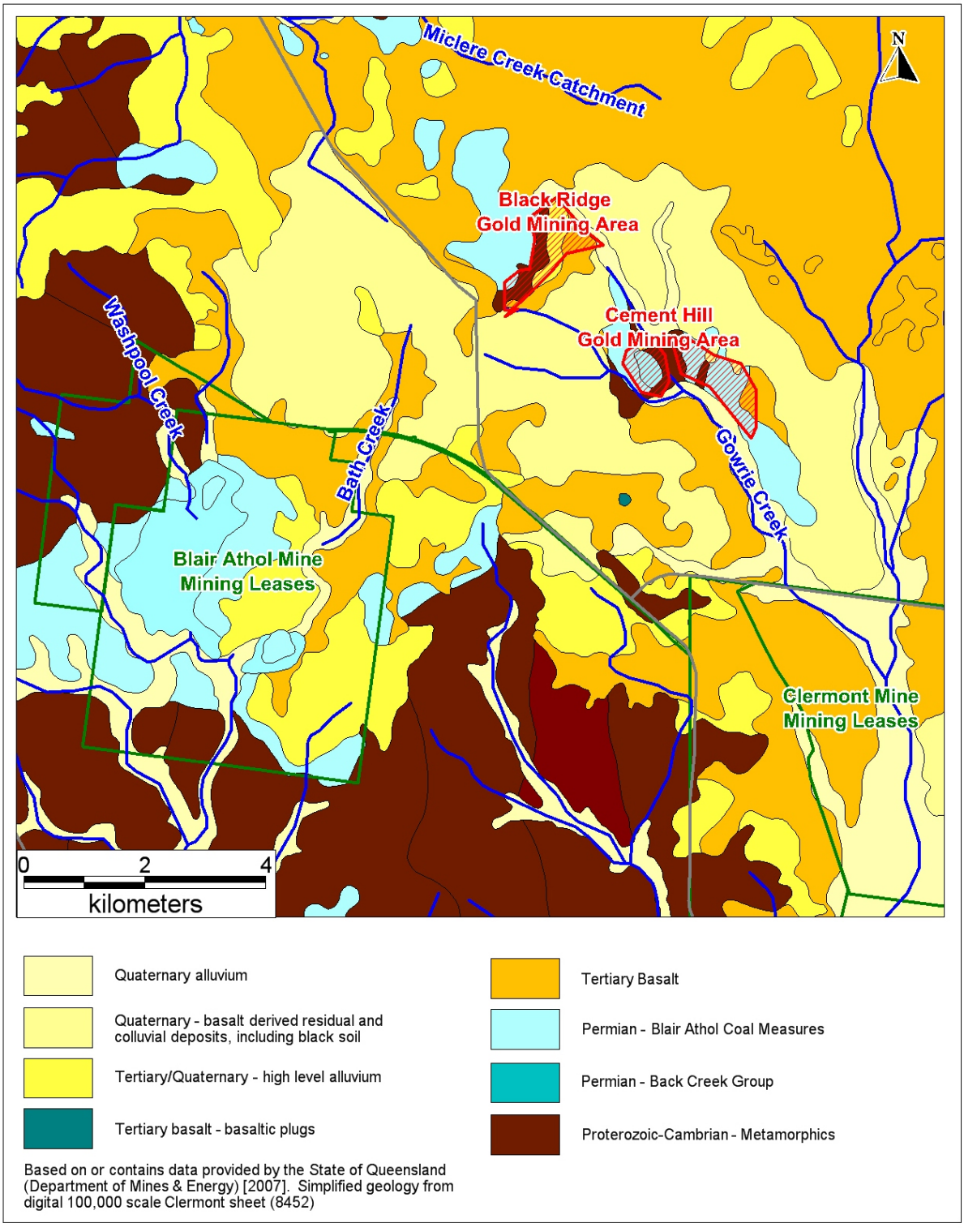


Figure 6-3: Surface Geology

6.2 Site Geology

The stratigraphic sequence in the Blair Athol Basin comprises five lithological units (RTCA 2011). These are, from stratigraphically lowest to highest:

- Proterozoic/ Cambrian Anakie Metamorphic Group, comprising schist, phyllite, metabasalt;
- Early to Middle Devonian arenites, occupying a small basement trough in the southern part of the basin;
- Permian-age Blair Athol Coal Measures, comprising:
  - The lower Coal Measures, which include basal conglomerate, sandstone, siltstone, and mudstone with an estimated maximum thickness of 130-150 m; and,
  - The upper Coal Measures, which include sandstone, siltstone, mudstone, conglomerate, as well as the four main coal seams of the basin (Seams 1, 2, 3, and 4)
- Tertiary basalt, which only occurs in the north and east of the lease area (Figure 6-3), with an average thickness within the lease area of 18-22 m; and,
- Tertiary and Quaternary (recent) alluvial deposits developed within the ephemeral streams that drain the site, including Bath Creek and Washpool Creek.

The stratigraphy outlined above is shown as a stratigraphic section in Figure 6-4.

Schematic sections through the basin, showing the general basin geometry and the relationship of the coal seams, are shown as Figure 6-5.

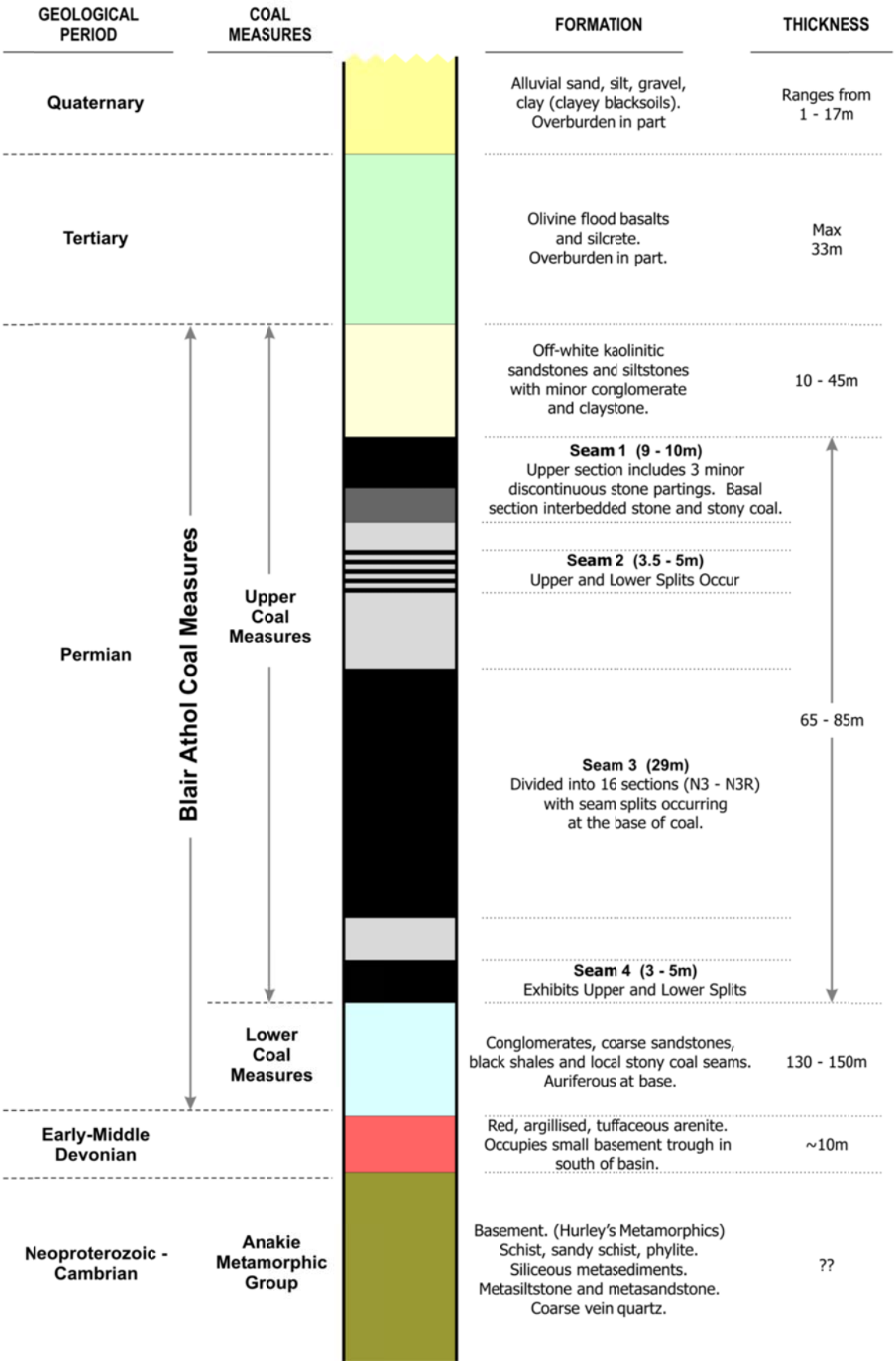


Figure 6-4: Mine Area Stratigraphy (Source: RTCA 2011)

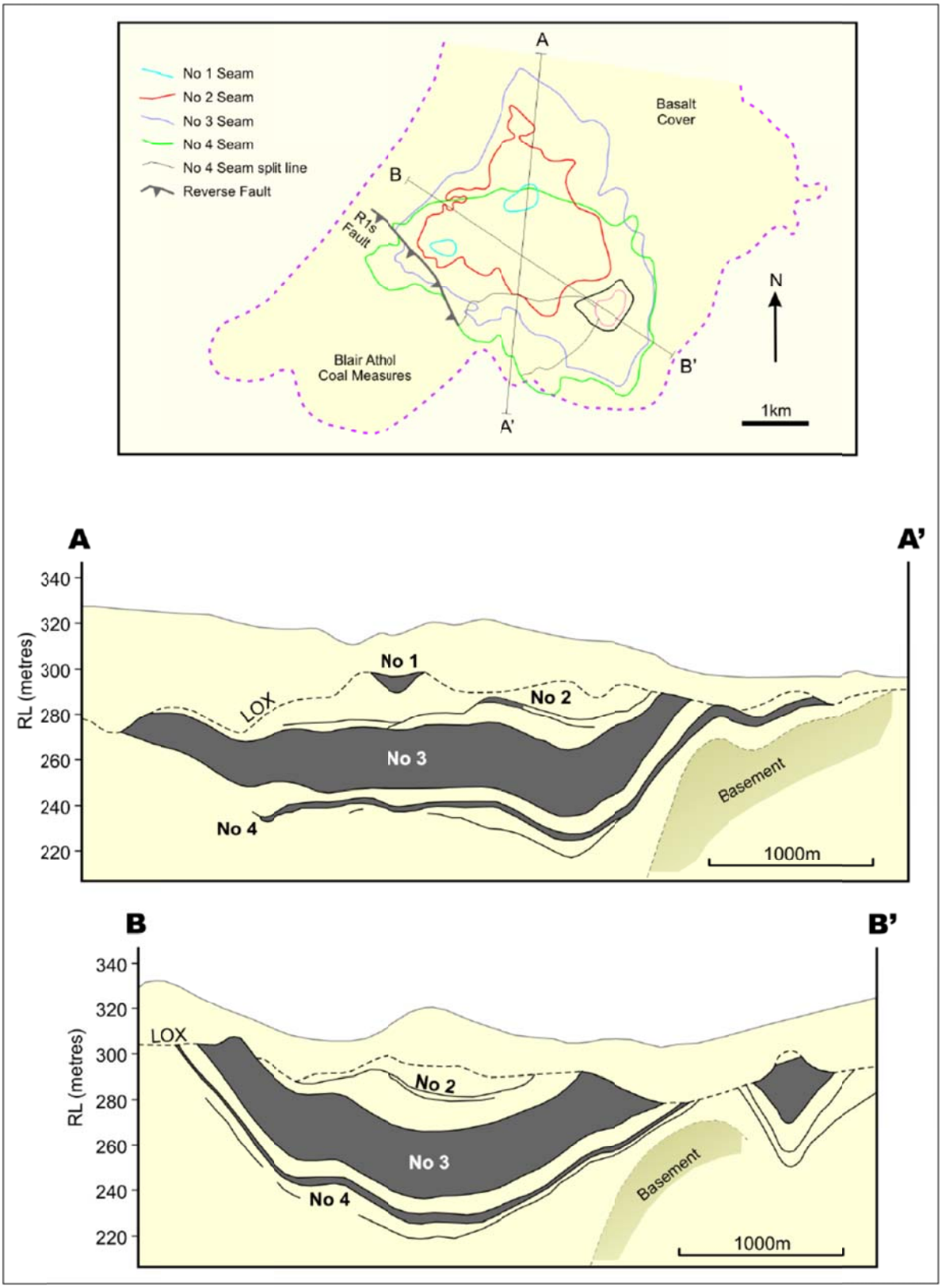


Figure 6-5: Schematic Cross Sections Showing Coal Seams (Source: RTCA 2011)

7.0 HYDROGEOLOGY

7.1 Introduction

Complex subsurface geology is generally simplified for groundwater studies by defining distinct hydrostratigraphic units. Hydrostratigraphic units comprise geological units grouped together on the basis of similar hydraulic properties, generally hydraulic conductivity (Fetter, 1994). Hydrostratigraphic units may incorporate a number of separate geological units if the hydraulic properties of those units are similar (e.g. a number of different rock types may be treated as one hydrostratigraphic unit if the rocks are similarly fractured, and store and transmit groundwater in the same way). In the Clermont area the distinct geological units are also distinct hydrostratigraphic units (JBT 2009), as discussed further below.

7.2 Description of Hydrostratigraphic Units

7.2.1 Basement Rocks

Proterozoic-Cambrian metamorphics occur at surface or close to surface at a number of locations in the Clermont area, including the western and southern portions of the Blair Athol Mining Lease, and to the east between the BA and Clermont Mining Lease areas (refer Figure 6-3).

A number of regional groundwater monitoring bores are screened within basement metamorphics at shallow depth (for a detailed discussion of regional water level data, refer JBT 2012). In these bores, the weathered metamorphics show a response to rainfall recharge that is similar to other watertable bores. However the bore yields within the metamorphics are low and the unit is not regarded as an aquifer. The Proterozoic-Cambrian metamorphics are regarded as the hydraulic basement to other groundwater units in the region (JBT 2009).

7.2.2 Permian Sediments

Groundwater has been encountered in all coal seams during exploration drilling, but groundwater occurrence is more pervasive in Seams 3 and 4 (Terranus 2009).

The coal seams are water-bearing units but are not aquifers as the yields are too low and too short-lived (generally hours, based on air-lift data (Terranus 2009)).

The coal seams have not been observed to provide significant rates of seepage to the open pits during mining, and generally the seepage rates encountered were insufficient to provide a reliable water supply to the mining operation (Terranus 2009).

7.2.3 Tertiary Basalt Aquifer

The Tertiary Basalt aquifer is the most significant regional aquifer in the Clermont area as it is the main aquifer from which landholders in the region draw stock and domestic water supplies. The basalt is known to comprise a number of distinct flows, though these have not been mapped in a regional sense.

Regionally, groundwater in the basalt has been observed to occur within discrete, isolated fractures, so that pumping from one fracture system can have little or no impact on water levels within adjacent fracture systems (JBT 2009).

Basalt is encountered in the northern and eastern areas of the site, where basalt flows have infilled depressions in the pre-Tertiary land surface (as described in Section 6.1).

Seepage water from the basalt aquifer to the pits in the vicinity of Ramp 3 and Ramp 4 is understood to have provided reasonable supplies of non-potable water to the operation over the course of many years (Terranus 2009). However, the average rate of seepage is unknown.

7.2.4 Tertiary/ Quaternary Alluvium

Unconsolidated alluvial deposits occur along Bath Creek and Washpool Creek, which drain through the lease area from the north and north-east (Figure 6-3). The creeks are ephemeral and groundwater occurrence within the alluvium is sporadic and related to rainfall recharge events when the streams briefly flow.

Following 2010/2011 wet season rainfall the alluvium in the Ramp 1 mining area became sufficiently saturated that engineering measures were required to control the rate of groundwater inflow to the mining operation. Therefore, potential exists for the alluvium to provide groundwater seepage to the final void particularly following above-average wet season rainfall, with the rate of seepage is dependent on the degree of saturation of the alluvium, as well as the degree to which alluvial channels are hydraulically connected to the final void.

7.2.5 Tailings and Spoil

The following section is taken from Terranus (2009), in discussion of URS (2008) (which was not reviewed for this report)

> *The TSF is currently an artificial source of locally perched groundwater. The tailings are deposited as a slurry (about 40 - 60% solids). Seepage modelling undertaken by URS (2008a) indicatively suggests (due to limited data) that most seepage from the TSF will be through the TSF embankments in the early and middle stages of construction and that seepage rates through the embankments will be minimal in the latter stages and moving into closure.*
>
> *The long-term prediction from the URS (2008a) report is that most seepage (latter stages and post-closure) will be through the floor of the TSF into the underlying spoil, and thence into the sandstone/conglomerate aquifer. The flux (i.e. the rate of water movement) through the floor of the TSF is expected to decrease post-closure as the tailings dewater and the TSF cap reduces rainfall recharge (URS, 2008a).*
>
> *As mentioned above, the fate of the basal conglomerate/sandstone aquifer on and immediately outside the site is difficult to predict.*
>
> *The elevation of the TSF is below the base of the basalt aquifer, and so does not influence the quality or elevation of groundwater within the basalt aquifer. This is expected to remain the case in the long term well after closure.*

The spoil comprises overburden and interburden that has been removed to access the coal seams, and progressively back-filled into pits as the coal is removed. The hydraulic properties of the spoil will therefore be dependent on the properties of the parent material, dumping method, degree to which the spoil has been consolidated by traffic, and degree to which the spoil as settled and consolidated over time.

The final landform should be shaped to control runoff and prevent ponding (i.e. to prevent conditions which could lead to enhanced recharge of the spoil).

7.3 Groundwater Recharge and Flow Direction

7.3.1 Basement Rocks

Water level response in regional basement monitoring bores indicates that the basement rocks, especially where they occur at surface, are recharged via direct rainfall infiltration. However, the storage of the rocks is low relative to other groundwater units in the area, so much rainfall in basement outcrop areas will report as runoff (i.e. rejected recharge) to surface drainage systems.

7.3.2 Permian Sediments

The Blair Athol Basin is a relatively isolated groundwater system, at least in the sense of groundwater within the coal seams. Recharge mechanisms are unknown, however based on recharge mechanisms observed at other Bowen Basin coal mines it is speculated that recharge to the coal seams occurs in marginal areas of the basin where the coal seams subcrop, or via downward drainage from overlying groundwater units.

There is no natural outlet for water in the coal seams (refer schematic cross sections, Figure 6-5), so groundwater movement within the coal seams could be expected to be minimal.

7.3.3 Tertiary Basalt Aquifer

The basalt aquifer is the uppermost aquifer in the groundwater system, and receives recharge directly from rainfall. Regionally, the water level in the basalt aquifer has risen in many bores due to a succession of above average wet seasons since 2007/2008. Therefore water levels in the basalt aquifer are currently elevated relative to historic levels.

Groundwater flow direction within the basalt aquifer is topographically controlled, with movement of water from topographically higher regions to topographically lower regions. Based on surface drainage evident from Figure 6-3, it is judged that the aquifer to the north of the site (within the Bath Creek catchment) will flow toward the mine, and that further north groundwater within the basalt aquifer will flow towards either the Gowrie Creek or Miclere Creek catchments..

7.3.4 Tertiary/ Quaternary Alluvium

Groundwater recharge to the alluvium is via direct rainfall infiltration, with groundwater movement in the direction of surface drainage.

7.3.5 Tailings and Spoil

Recharge to the tailings and spoil is via direct rainfall recharge, and in the north of the lease area the spoil may receive recharge vial lateral flow from the basalt aquifer.

Groundwater flow direction will be dependent on the degree to which a mounded water table develops in the spoil, and on the shape of the final landform relative to surrounding natural material.

The degree of recharge and the water table height (and hence groundwater flow direction) is difficult to predict at this stage, though it is considered likely (based on surrounding topography) that flow direction will continue to be a reflection of topography, and that the ultimate flow direction will be to the south in the direction of Bath Creek drainage.

8.0 REVIEW OF MONITORING DATA

8.1 Groundwater Monitoring Bores

Groundwater monitoring is currently undertaken on 24 bores at 20 sites. Details of the monitoring bores are provided in Table 8-1, and the bore locations are shown on Figure 8-1. The information contained in Table 8-1 is based on information provided from site, as well as review of previous reports (Matrix+ (2007) and Terranus (2009)).

Table 8-1: Groundwater Monitoring Bore Summary Data

Bore Name	Easting (AGD84)	Northing (AGD84)	RL (mAHD)	Total Depth (m)	Casing Diameter (mm)	Screen From (mbgl)	Screen To (mbgl)	Lithology Monitored	Comment
BP3	556021	7492053	327					Tertiary Basalt	Located at same site as GW01
Curtis Bore	557350	7491750	325					Tertiary Basalt	Landholder bore on Blair Athol Station
GT01A	556584	7491258	318	54	50	36	39	Coal - Seam 3	Dry when drilled – bores no longer monitored. Site comprises two 50 mm standpipes within one borehole
GT01B	556584	7491258	318	54	50	44	46	Coal - Seam 4	
GT02	555631	7488834	318	24	50			Coal - Seam 4	
GT03	554768	7489108	318		50			Coal - Seam 4	
GT04	556584	7491258	314	72	50	41	44	Coal - Seam 4	
GW01B	556026	7492049	327	57	50	33	39	Permian Conglomerate	
GW02A	555293	7492702	329	60	50	21	27	Tertiary Basalt	
GW02B	555287	7492696	329	60.3	50	53	59	Permian Conglomerate	
GW03A	556581	7491265	318	17	50	11	14	Tertiary Basalt	
GW03B	556581	7491265	318	54.9	50	43	46	Permian Conglomerate	
GW04A	557071	7490417	314	16	50	11	14	Tertiary Basalt	
GW04B	557073	7490412	314	48	50	39	45	Permian Conglomerate	
GW05	557330	7489460	318	40.1	50	25	28	Permian Conglomerate	Dry when drilled – bore no longer monitored
GW06	553976	7491409	318	36	50	28	34	Permian Conglomerate	
GW07	554172	7490244	310		50			Spoil	
GW08	554834	7490684	307		50			Spoil	
GW10	555711	7489930	328	72	100			Spoil	
Mayes Bore	558120	7493142	324					Tertiary Basalt	Landholder bore on Blair Athol Station
MB02	554215	7490409	313		50	Screened for entire length of bore		TSF Embankment	Construction details for individual bores unknown, but bore depths are understood to be between 7.88 and 17.60 m (Terranus 2009).
MB03	554254	7490402	312		50			TSF Embankment	
MB04	554672	7490544	308		50			TSF Embankment	
MB05	554657	7490493	307		50			TSF Embankment	
SP(3279C)	555431	7488557	310	40	50	30?	?	Coal - Seam 4	Comprises 2 x 50 mm standpipes within one borehole. Upper piezo (20 m depth in sandstone) is dry

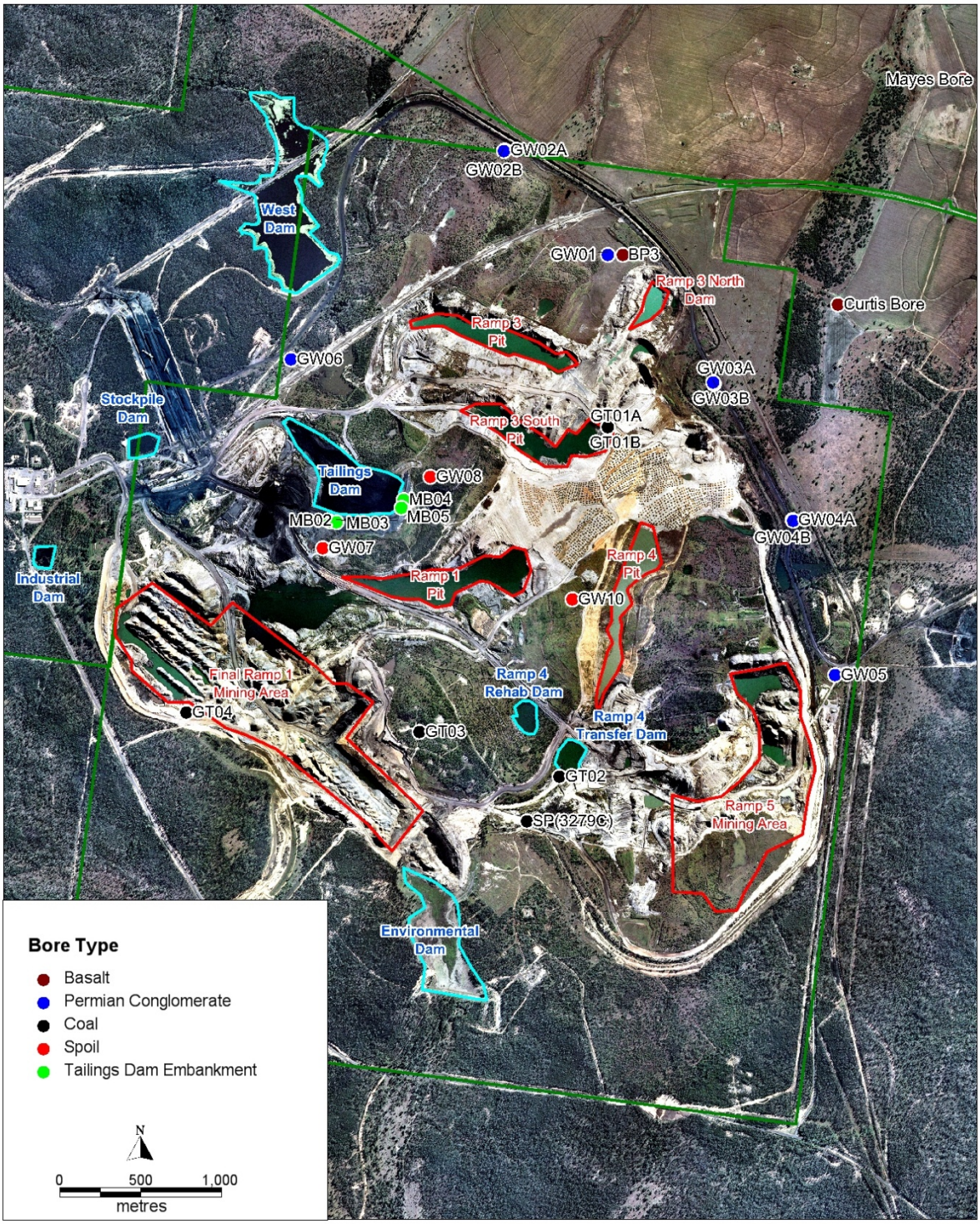


Figure 8-1: Location of Bores and Surface Water Dams

8.2 Groundwater Level Data

Groundwater level data (as water level below top of casing (TOC)) is shown in Appendix A. The data has been converted to reduced water level (relative to Australian Height Datum, AHD) with the resultant hydrographs shown as Figure 8-2. Observations from review of the hydrographs include:

Tertiary Basalt Aquifer

- Only one bore (Curtis Bore) has water level readings that date prior to January 2008 (prior to the 2007/2008 wet season). The impact of 2007/2008 wet season rainfall is evident at this site, where the water level rise in the bore matches the rise in the residual rainfall mass (RRM) curve. In response to 2007/2008 wet season rainfall the water level in the bore rose from 10.16 m below top of casing (mTOC) (November 2007) to 4.55 mTOC (March 2008). The water level has continued to rise in this bore, and in August 2012 the water level was above ground level (i.e. the bore is flowing).
- Other basalt bores display a relatively steady water level trend, with a slight overall rise in water level evident between March 2008 and August 2012 (refer also Appendix A).

Coal Seam

- Monitoring bores at site are screened in either Seam 3 or Seam 4 (lower coal seams) as the seams above (Seam 1 and Seam 2) tend to be dry when drilled;
- Bore GT01 is located adjacent to the Ramp 3 South pit (Figure 8-1). Both GT01A (Seam 3) and GT01B (Seam 4) are dry, indicating that water within the coal seams has drained to the pit at this location;
- The impact of mining on water levels in the coal seam can be seen from the hydrograph for bore GT03 (Seam 4). The bore is located adjacent to the Ramp 1 mining area, and the water level has reduced significantly at this site between May 2011 and May 2012 (7.38 m water level reduction) compared to a water level reduction of 0.11 m between March 2009 and May 2011. It is assumed that the water level reduction is related to mining in the adjacent Ramp 1 area.

Permian Conglomerate

- Water levels in bores monitoring the Permian conglomerate have tended to increase in response to rainfall recharge, i.e. water levels tend to conform to the overall trend of the RRM curve, which has displayed a rising trend since December 2007. Between May 2008 and May 2012 the water level has increased by 6.01 m in GW03B, 9.98 m in GW04B, and 1.36 m in GW06 (i.e. the greatest rate of water level increase has been in bores that are overlain by Tertiary basalt);
- At sites where the conglomerate is overlain by basalt (GW02B, GW03B, GW04B) the water level in the basalt aquifer is higher than the water level in the conglomerate, indicating a potential for the basalt aquifer to recharge the underlying Permian sediments. Recharge from the basalt aquifer to the underlying Permian sediments is noted from water quality data, as discussed in Section 8.3;
- At the site of GW04B the water level trend matches the trend displayed in adjacent basalt aquifer bore GW04A, though the rate of water level increase in GW04B is greater than observed in the basalt bore. The hydrographs have now almost converged (i.e. the hydrographs are almost reading the same water level) indicating a high degree of hydraulic connection, and a strong recharge potential, between the Tertiary basalt and the underlying Permian sediments.

Spoil

- Bores screened in spoil (GW08, GW10) show a rise in water level between July 2008 and August 2012 of between 8.06 m (GW10) and 12.32 m (GW08). This matches the overall rise in the RRM curve, indicating that groundwater levels within the spoil are directly impacted by rainfall recharge events.

Tailings Storage Facility (TSF)

- Bores screened within the TSF embankment (MB02, MB03, MB04, MB05) display relatively consistent water levels, suggesting that water levels in the bores are dominated by the water level within the TSF rather than by rainfall recharge (as is the case with bores in the surrounding spoil);
- Site sampling records indicate that all of the TSF bores are difficult to sample as the water level in all bores is just above the base of screens, and the water that is able to be bailed from the bores is generally turbid and often black in colour (reported as coal fines within the samples).

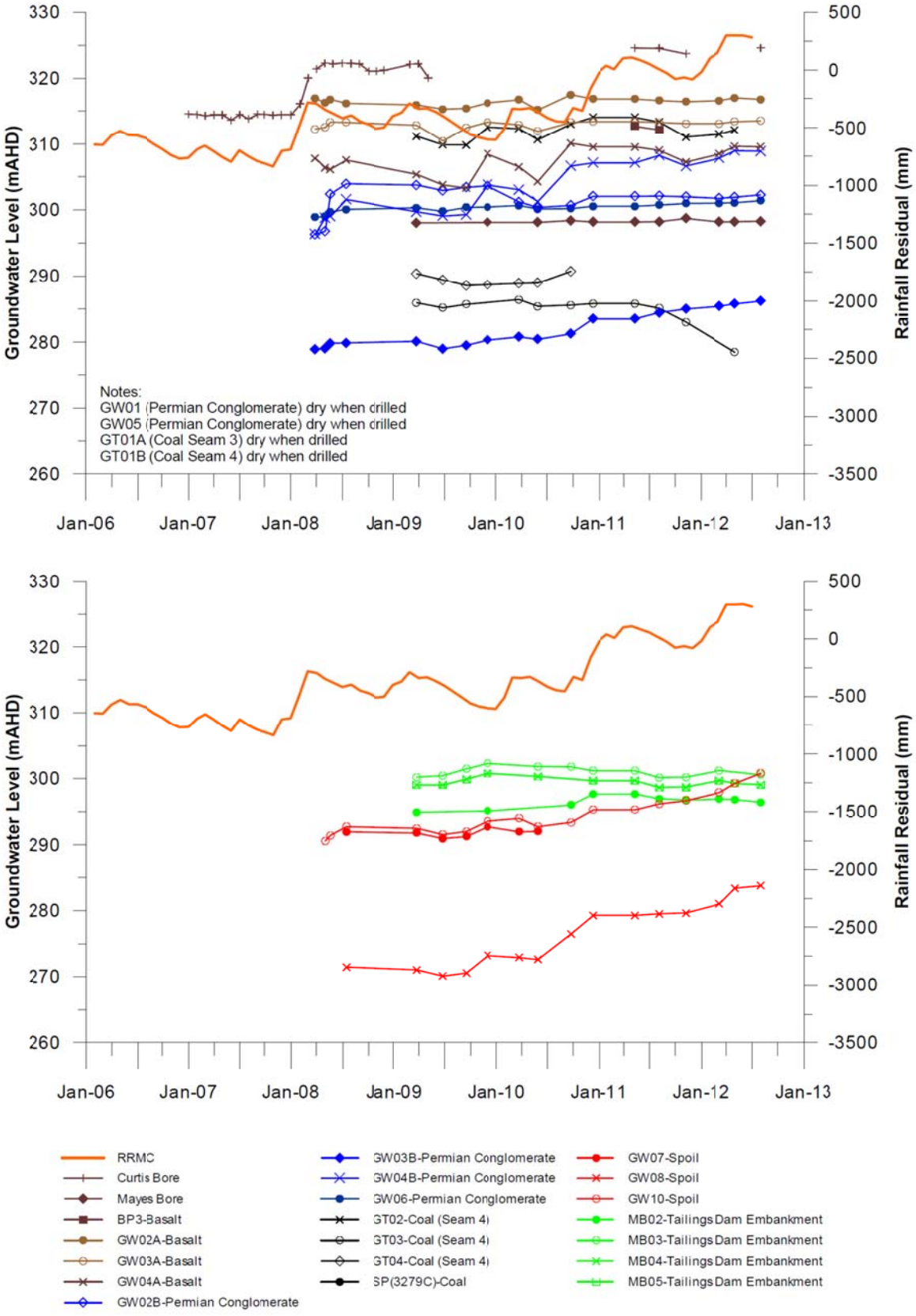


Figure 8-2: Groundwater Hydrographs

8.3 Water Chemistry

The following section presents an analysis of chemistry data from groundwater bores as well as site water storages.

Section 8.3.1 presents an analysis of major ion chemistry, which is used to differentiate water types at the site, and to describe the evolution of water at site from one water type to another (which is evident at a number of surface water storages).

Section 8.3.2 presents a comparison of historic and current site water quality data for major and minor ions, as well as for a number of metals/metalloids, against a range of Australian guidelines.

8.3.1 Major Ion Chemistry

8.3.1.1 Data Analysis

Major ion chemistry includes concentration data for cations (sodium (Na), potassium (K), magnesium (Mg), calcium (Ca)) and anions (chloride (Cl), carbonate (CO_3), bicarbonate (HCO_3), and sulphate (SO_4)). These data have been analysed to determine the water type at each groundwater bore location, as well as for surface water storages.

To undertake a water type analysis the relative concentration of each parameter (converted to milliequivalents per litre) is determined, so that the relative percentage of each anion adds up to 100%, and the relative percentage of each anion adds up to 100%.

Water type is then determined based on the dominant cation and anion in water samples from each site. For example, water classified as a sodium-chloride (Na-Cl) type water contains more than 50 percent of the total cation milliequivalents as sodium and more than 50 percent of the total anion milliequivalents as chloride. If no cation or anion is dominant (i.e. more than 50%) then the water is a mixed type and the most common cations and ions, in decreasing order of abundance, are used to describe the water type.

The water type for each site is presented in Table 8-2.

The major ion analyses for each water source has also been plotted on a Piper diagram (Figure 8-3). Piper diagrams are a useful visual indicator of the range of water types present in a particular area. Piper diagrams plot the percentage concentration of three cation types (i.e. the concentrations of Ca, Mg, and the sum of Na+K are expressed as a percentage, so that the sum of the cations is 100%) and three anion types (Cl, SO_4, and the sum of CO_3+HCO_3) on separate ternary diagrams. The data points for the top diamond plot are derived as the intersection point of lines drawn from the cation and anion plots.

Water that is dominated by Na and Cl ions will plot in the bottom right corner of the cation and anion plots, while water that is dominated by Ca and CO_3+HCO_3 will plot in the bottom left corner of the cation/anion plots. As water from one source mixes with water from another source (e.g. with further distance along a groundwater flow line) this can be seen as the plot symbols for different dates move from one part of the graph to another.

Raw data used as the basis for the analysis presented in this section (i.e. major ion concentration converted from mg/L to meq/L, in preparation for plotting on a Piper diagram, and for performing water-type analysis) is presented in Appendix B.

Table 8-2: Water Type Analysis

Sample Point	Type	Water Source	Water Type
BP3	Groundwater bore	Tertiary Basalt	Mg-Ca-HCO_3
Curtis Bore	Groundwater bore	Tertiary Basalt	Mg-HCO_3
GW02A	Groundwater bore	Tertiary Basalt	Mg-Ca-HCO_3
GW03A	Groundwater bore	Tertiary Basalt	Mg-Ca-HCO_3
GW04A	Groundwater bore	Tertiary Basalt	Mg-Ca-HCO_3
Mayes Bore	Groundwater bore	Tertiary Basalt	Na-Ca-HCO_3
GW01	Groundwater bore	Permian Conglomerate	Mg-Ca-Na-HCO_3
GW02B	Groundwater bore	Permian Conglomerate	Mg-Ca-Na-HCO_3
GW03B	Groundwater bore	Permian Conglomerate	Mg-Ca-Na-HCO_3
GW04B	Groundwater bore	Permian Conglomerate	Mg-Ca-HCO_3
GW05	Groundwater bore	Permian Conglomerate	Dry
GW06	Groundwater bore	Permian Conglomerate	Na-Cl
GT02	Groundwater bore	Coal - Seam 4	Na-Cl
GT03	Groundwater bore	Coal - Seam 4	Na-Cl
GT04	Groundwater bore	Coal - Seam 4	Na-Cl
SP(3279C)	Groundwater bore	Coal - Seam 4	Na-SO4
GW07	Groundwater bore	Spoil	Na-Cl
GW08	Groundwater bore	Spoil	Na-Mg-SO_4-Cl
GW10	Groundwater bore	Spoil	Na-Mg-HCO_3
MB02	Groundwater bore	TSF Embankment	Ca-Na-Mg-SO_4
MB03	Groundwater bore	TSF Embankment	Mg-Na-SO_4
MB04	Groundwater bore	TSF Embankment	Mg-Ca-Na-SO_4
MB05	Groundwater bore	TSF Embankment	Mg-Ca-SO_4
TSF	Surface Water		Mg-Ca-SO_4
East Dam	Surface Water		Na-Mg-HCO_3
West Dam	Surface Water		Na-Mg-Cl-HCO_3 (1986-1994) Na-Ca-Mg-HCO_3 (2011-2012)
Industrial Dam	Surface Water		Na-Cl (1995-1998) Na-Mg-Cl-SO_4 (2011-2012)
No. 2 Pit	Surface Water		Na-Cl (1984-1989) Na-Mg-Cl-HCO_3-SO_4 (1990-1992)
Ramp 1 Pond	Surface Water		Na-Mg-Cl-SO_4
Ramp 3 North	Surface Water		Na-Mg-SO_4-Cl
Ramp 4 Pond	Surface Water		Na-Mg-SO_4
Transfer Dam 1	Surface Water		Na-Mg-SO_4
Environmental Dam	Surface Water		Na-Cl (1985-1993) Na-Mg-Cl-SO_4 (2012)

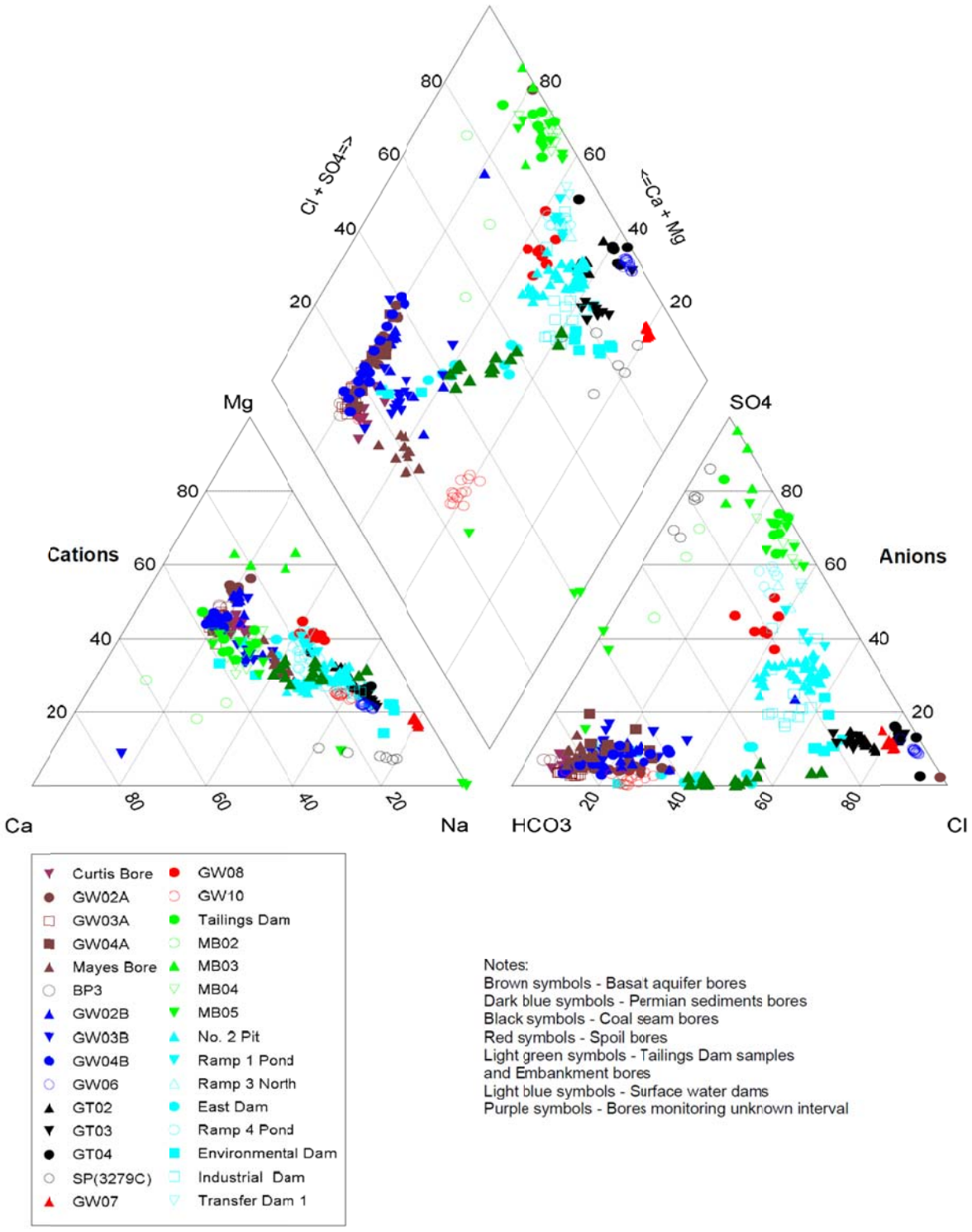


Figure 8-3: Piper Diagram – Blair Athol Surface Water and Groundwater Samples

8.3.1.2 Discussion

The following observations are made with respect to water type analysis and the Piper diagram:

Basalt Aquifer

- Basalt water samples are of magnesium-calcium-bicarbonate (Mg-Ca,HCO_3) type (Table 8-2). The cation mineralogy is interpreted to be related to the weathering products of basalt minerals, (e.g. Na, Ca, Mg, K silicates). The bicarbonate is interpreted to be present due to the interaction of recharge water with CO_2 from the atmosphere and the root zone of plants (H_2O and CO_2 combining to form carbonic acid (H_2CO_3), which dissociates to bicarbonate (HCO_3-) and carbonate (CO_3)
- On the Piper diagram (Figure 8-3) the basalt water plots to the lower left of the anion plot, indicating that the samples are low in chloride and sulphate, and high in HCO_3.
- The samples plot to the middle left of the cation plot, in a region that indicates a slight domination of magnesium (40-50 %) over sodium and calcium, which each comprise 20 – 30% of the equivalent weight.
- On the combined graph the plots cluster in the middle left corner of the plot, in a region that indicates high calcium + magnesium (60-80% of the equivalent weight) and low chloride + sulphate (between 10 and 40% of the equivalent weight).

Permian Conglomerate

- Water samples from bores screened in the Permian conglomerates are of two distinct water types, including:
    - Mg-Ca-Na,HCO_3 water in areas where the Permian conglomerates are overlain by basalt. At these sites (GW02B, GW03B, GW04B) the water level in the corresponding basalt bore (GW02A, GW03A, GW04A) is higher, indicting a potential for downward leakage of water from the basalt aquifer to the underlying Permian sediments; and,
    - Sodium-Chloride (Na-Cl) water, in areas where basalt is absent (e.g. GW06).
- On the Piper diagram (Figure 8-3) the groundwater samples from the Permian conglomerate bores plot in two distinct clusters:
    - For water samples from bores where the Permian conglomerate underlies the basalt (GW02B, GW03B, GW04B) the data points for the anions, cations, and combined plots are all in the same region as the basalt aquifer, indicating that the water in the Permian sediments at these locations is derived from downward leakage from the overlying basalt aquifer;
    - For water samples from the bore where the Permian conglomerates are not overlain by basalt (GW06) the data plots in a distinctly different area of each plot, i.e. towards the lower right of the cation plot (sodium dominated), to the lower right of the anion plot (chloride dominated) and in a region of the combined plot that indicates over 90% chloride + sodium, and less than 40% calcium + magnesium.

Spoil

- Water samples from bores that screen spoil show distinctly different chemical types, including Na-Cl (GW07), Na-Mg-SO_4-Cl (GW08) and Na-Mg-HCO_3 (GW10)
- On the Piper diagram the samples plot relatively close together , though GW07 plots to the lower right of the plot, indicating the strong dominance of the sodium ion. However, the

samples plot in markedly different regions of the anion plots, with GW07 strongly dominated by chloride, GW08 dominated by sulphate, and GW10 dominated by bicarbonate.

- On the combined graph indicates high chloride and relatively low calcium + magnesium at GW07; low chloride + sulphate and 50-60% calcium + magnesium at GW08, and low chloride + sulphur (~30%) and moderate calcium + magnesium (~40%) at GW10.

Tailings Storage Facility

- Water quality in the area of the tailings storage facility (TSF), including TSF water samples as well as groundwater samples from embankment monitoring bores MB1, MB03, MB04, and MB05, are strongly sulphate dominated. The water samples have a relatively even mix of cations (calcium magnesium and sodium all ~30%) indicated by the clustering of sample points towards the middle of the cation plot.
- On the combined graph the cluster towards the top of the graph indicates a dominance of chloride + sulphate (more than 90% of cations, with sulphate accounting for ~70% and chloride 20%) and calcium + magnesium (60-80% of anions).

Surface Water Storages

- Surface water sources plot over a relatively wide area of each graph, indicating variability and mixing from different water sources. The following observations are made with respect to surface water major ion chemistry:
    - The early major ion chemistry appears to be dominated by the geological environment in which the dam is developed, as the initial major ion chemistry matches the groundwater chemistry. However, over time the major ion chemistry of the surface water bodies has evolved in all cases to a mixed water type. Examples include:
        - The industrial dam, where:
            - Early data (between May 1995 and February 1998) indicates a sodium-chloride (Na-Cl) water type. The industrial dam is located in an area where basalt does not exist, on an area of outcropping basement metamorphics and Permian sediments. Groundwater samples from the closest monitoring bore (GW06 – Permian conglomerate) are Na-Cl type water.

              In terms of cations, sodium was dominant over magnesium, with calcium the least dominant cation. In terms of anions, chloride was dominant over bicarbonate, with sulphate the least dominant anion.

            - Later data (November 2011 to April 2012) indicates an evolution in water type from Na-Cl to Na-Mg,Cl-SO_4. In terms of cations, the percentage of magnesium has increased relative to sodium, with the percentage of calcium relatively unchanged. In terms of anions, the relative concentrations of both chloride and bicarbonate have decreased, and sulphate has increased.
        - The environmental dam, where:
            - Early data (between March 1985 and December 1993) indicates a sodium-chloride (Na-Cl) type water, with sodium dominant over magnesium, with calcium the least dominant anion. In terms of anions, chloride was dominant over bicarbonate, with sulphate a relatively minor ion (approximately 10% of the anion total – refer also Appendix B)

- Later data (January to April 2012) indicates an evolution in water type from Na-Cl to Ca-Mg-Cl-HCO_3. In terms of cations, the relative concentration of sodium has more than halved (from ~65% to ~30%), and the relative concentration of calcium has more than doubled (from ~12% to ~32%). In terms of anions, the relative concentration of chloride has reduced by approximately one-third (from ~60% to ~20%) and the concentration of bicarbonate has trebled (from ~25% to ~75%). The concentration of sulphate is relatively unchanged.

▪ West Dam, where:

- Early data (January 1986 to November 1994) indicates a Na-Mg-Cl-HCO_3 type water. Unlike the dams mentioned above, the west dam is located in an area where the catchment includes basaltic rocks, so the early chemistry of the dam is similar to the groundwater chemistry of the basalt aquifer (as seen in bores such as GW02A, GW03A, and GW04A – refer
- Later data (November 2011 to January 2012) indicates an evolution towards Na-Ca-Mg-HCO_3 water, with a relatively lower percentage of sodium, higher percentage of calcium, and a slight increase in the bicarbonate ion relative to chloride.

  The chemistry of the west dam has altered only slightly compared to other dams at site. The current major ion chemistry is now similar to other storages on site, but the west dam started with similar chemistry, whereas other dams evolved to this chemistry type

8.3.1.3 Summary

The major ion chemistry at site is summarised as:

- Cation chemistry:
  - Water samples from the coal seam, the Permian conglomerate (in areas where basalt does not exist), and some spoil bores (e.g. GW07) is sodium dominated;
  - Cation chemistry for the basalt aquifer, and for the Permian conglomerate underlying basalt, is calcium-magnesium dominated; and,
  - A number of surface water (industrial dam, environmental dam) were initially sodium dominated, but evolved to calcium-magnesium dominated over time. West Dam, which is in a catchment containing basalt outcrop as well as bedrock outcrop, has consistently displayed a mixed water chemistry dominated by sodium, calcium, and magnesium cations.
- Anion chemistry is more diverse, with water samples from different sources tending to be dominated by either chloride, bicarbonate, or sulphate. This manifests as a clusters of data towards the three corners of the anion plot (for groundwater samples), with surface water samples reflecting a mixing of water types; and,
- When plotted together on the combined plot, samples for the basalt aquifer, as well as the Permian sediments underlying basalt, display a dominance of calcium and magnesium over chloride and sulphate. All other sites (surface water (except the TSF) and groundwater) are more dominated by a combination of chloride + sulphate, and less dominated by calcium + magnesium. Water samples from the TSF show a similar relative concentration of calcium + magnesium as basalt aquifer samples, but a much higher concentration of chloride + sulphate, reflecting a dominance of the sulphate ion in ash dam samples).

8.3.2 Comparison of Site Water Quality with Australian Guidelines

Available surface water and groundwater data has been compared to a number of environmental standards, including:

- Stock Watering Guidelines (ANZECC 2000)
- Freshwater Ecosystem Protection (value for slightly disturbed systems) (ANZECC 2000); and,
- Australian drinking water guidelines (ADWG 6, 2011)

Available groundwater data is included from the bores listed in Table 8-1.

Available surface water data is included from the following sample points:

- Transfer Dam 1
- Ramp 3 South
- Ramp 3 North
- Environmental Dam
- East Dam
- West Dam
- Industrial Dam
- Bath Creek – EPA Licence Point
- No 2 Pit
- No 1 Pit
- Ramp 4 Pond
- Ramp 1 Pond
- Tailings Storage Facility

Table 8-3: Comparison of Site Water Quality to Australian Guidelines

Parameter	No. of Samples	No. of Samples exceeding Guideline Limits[1]			
		Stock Watering[2]	Freshwater Ecosystem[3]	Drinking Water[4]	
				Health	Aesthetic
pH – GW[5]	243	n/a	n/a	n/a	25
pH – SW[6]	340	n/a	n/a	n/a	2
TDS – GW	279	50	n/a	n/a	144
TDS – SW	340	2	n/a	n/a	258
Sodium (Na) – GW	281	n/a	n/a	n/a	56
Sodium (Na) – GW	281	n/a	n/a	n/a	2
Chloride (Cl) – GW	280	n/a	n/a	n/a	54
Chloride (Cl) – SW	454	n/a	n/a	n/a	26
Sulphate (SO4) – GW	279	n/a	n/a	68	53
Sulphate (SO4) – SW	483	n/a	n/a	59	44
Fluoride (F) – GW	71	0	n/a	0	n/a
Fluoride (F) – SW	154	0	n/a	0	n/a
Aluminium (Al) – GW	71	2	13	n/a	0
Aluminium (Al) – SW	154	0	12	n/a	0
Arsenic (As) – GW	71	0	5	8	n/a
Arsenic (As) – SW	62	0	0	0	n/a
Cadmium (Cd) – GW	71	0	6	3	n/a
Cadmium (Cd) – SW	62	0	1	1	n/a
Copper (Cu) – GW	71	0	31	0	0
Copper (Cu) – SW	62	0	8	0	0
Chromium (Cr) – GW	71	0	1	0	n/a
Chromium (Cr) – SW	39	0	0	0	n/a
Iron (Fe) – GW	71	n/a	n/a	n/a	21
Iron (Fe) – SW	139	n/a	n/a	n/a	12

Parameter	No. of Samples	No. of Samples exceeding Guideline Limits[1]			
		Stock Watering[2]	Freshwater Ecosystem[3]	Drinking Water[4]	
				Health	Aesthetic
Mercury (Hg) – GW	71	0	0	0	n/a
Mercury (Hg) – SW	39	0	0	0	n/a
Manganese (Mn) – GW	71	n/a	2	16	30
Manganese (Mn) – SW	73	n/a	1	7	16
Molybdenum (Mo) – GW	71	0	(a)	0	n/a
Molybdenum (Mo) – SW	39	0	(a)	0	n/a
Lead (Pb) – GW	71	0	0	0	n/a
Lead (Pb) – SW	64	0	1	1	n/a
Antimony (Sb) – GW	71	n/a	n/a	0	n/a
Antimony (Sb) – SW	21	n/a	n/a	0	n/a
Zinc (Zn) – GW	71	0	62	(a)	2
Zinc (Zn) – SW	62	0	18	(a)	0

* Notes
1 - Exceedences for metals/metalloids are for dissolved metals. A comparison for both total and dissolved metals is included in Appendix C.
2 – ANZECC (2000) Livestock Watering Guideline Values
3 – ANZECC (2000) Freshwater ecosystem protection – guideline limits for *slightly to moderately disturbed systems*
4 - Australian Drinking Water Guidelines (ADWG 6, 2011)
5 – GW = Groundwater Samples
6 – SW = Surface Water Samples
n/a - No standard exists

Observations from review of data in Table 8-3 include:

Stock water guideline limits

- Groundwater samples do not exceed stock water quality guidelines, with the exception of TDS, where 50 out of 279 samples exceed 4,000 mg/L, and aluminium, where 2 out of 71 samples exceed guideline limits
- Surface water samples exceed stock water guideline limits for TDS, but only 2 out of 340 samples exceed 4,000 mg/L;

Freshwater ecosystem protection guideline limits (slightly to moderately disturbed systems)

- Groundwater samples exceed guideline limits for a number of parameters, including aluminium, arsenic, cadmium, copper, chromium, manganese, and zinc
- Surface water samples exceed guideline limits for aluminium, cadmium, manganese, lead, and zinc

Drinking water guideline limits

- Groundwater samples exceed guideline limits (health-based) for sulphate, arsenic, cadmium, manganese
- Groundwater samples exceed guideline limits (aesthetic-based criteria) for pH, TDS, sodium, chloride, sulphate, iron, manganese, and zinc
- Surface water samples exceed guideline limits (health-based) for sulphate, cadmium, manganese, and lead
- Surface water samples exceed guideline limits (aesthetic-based criteria) for pH, TDS, sodium, chloride, sulphate, iron, and manganese.

The results from site groundwater sampling are consistent with previous investigations have concluded that the beneficial use for groundwater in the Clermont region is stock watering. Groundwater within the Tertiary basalt aquifer is, in some instances, suitable for potable use based on TDS criteria alone, however a number of other parameters may make groundwater in the area unsuitable for potable consumption without treatment to a potable standard.

Parameters that occur above drinking water guideline levels in regional groundwater samples include (JBT 2012):

- antimony, arsenic, lead, manganese and molybdenum (health-based criteria); and,
- aluminium, iron, and manganese (aesthetic-based criteria).

9.0 FINAL VOID

9.1 Final Void (Pit Lake) Water Levels and Water Quality

A water balance study has been undertaken for prediction of the water level and salinity of the pit lake that will be developed within the final landform (BMT-WBM 2012). The report notes that the site has a large external catchment, but the majority of flows from the catchment are directed around the site by two perimeter diversions, which are likely to remain in place after mine closure.

Two water balance scenarios were modelled:

1. With the exiting diversions in place; and,
2. With the diversions removed.

The modelled water level in the final pit lake (final void) for both scenarios is shown in Figure 9-1. The maximum water level for each simulation (279.6 mAHD for the “diversions” scenarios and 286.8 mAHD for the “no diversions” scenario) has been plotted on the hydrographs showing current and historic groundwater levels (Figure 9-2).

With respect to the modelled water level of the final void relative to historic and current groundwater levels it is noted that:

- For the majority of aquifers the current groundwater level in site monitoring bores is above the predicted final void water level, for both water balance scenarios;
- The bores for which water levels are close to or below predicted final void water levels (Figure 9-2) are generally close to the existing pit voids (refer Figure 8-1 for bore locations), and therefore affected by mining operations (including GT03 (monitoring Seam 4) and GW08 (monitoring spoil adjacent to the tailings dam);
- One bore (GW03B) monitors water levels in the Permian sediments close to the eastern boundary of the site. Water levels in this bore have been rising since the 2010/2011 wet season in response to downward leakage from the overlying basalt aquifer. The current water level at this site is now close to the maximum modelled water level for the “no diversions” scenario. Therefore this bore is well placed to monitor for potential offsite discharge of water from the pit void, via the groundwater system. This site represents the only monitored location to the west, north, or east of the site at which groundwater levels are close to the predicted maximum water level in the final void (with the groundwater level at all other sites being higher than modelled pit lake water levels – refer Figure 9-2).

The results of final void modelling therefore predict that for both scenarios modelled, the pit lake is likely to act as a groundwater sink, limiting the potential for offsite movement of water from the pit lake via the groundwater system,

With respect to water quality, final void modelling predicts that the pit lake will become progressively more saline to a level that is significantly greater than the salinity of surrounding groundwater system.

Therefore, maintenance of the existing groundwater monitoring network, and extension of the network (discussed further below) is recommended to enable monitoring of the impact of the final

landform pit lake on groundwater. With respect to offsite movement of groundwater, it is judged that a useful indicator parameter of interaction between the pit lake and the groundwater system will be chloride. This is because:

- Final void modelling predicts that that the salinity of the pit lake will be significantly higher than the salinity of surrounding groundwater, providing a contrast between the pit lake and the groundwater system; and,
- Chloride is a conservative parameter, i.e. it moves freely in the groundwater system at the rate of groundwater flow, and with little retardation along the flow-path.

Based on historic and current groundwater levels, and the results of final void water level monitoring, it is judged that the most likely pathway for offsite movement of impacted groundwater is in the area of current surface water discharge from site, i.e. the southern boundary and particularly down-gradient of the existing environmental dam. Therefore it is recommended that additional groundwater monitoring bores be placed down-gradient of the environmental dam, monitoring water levels and water quality in the alluvium, as well as the shallow bedrock at this location.

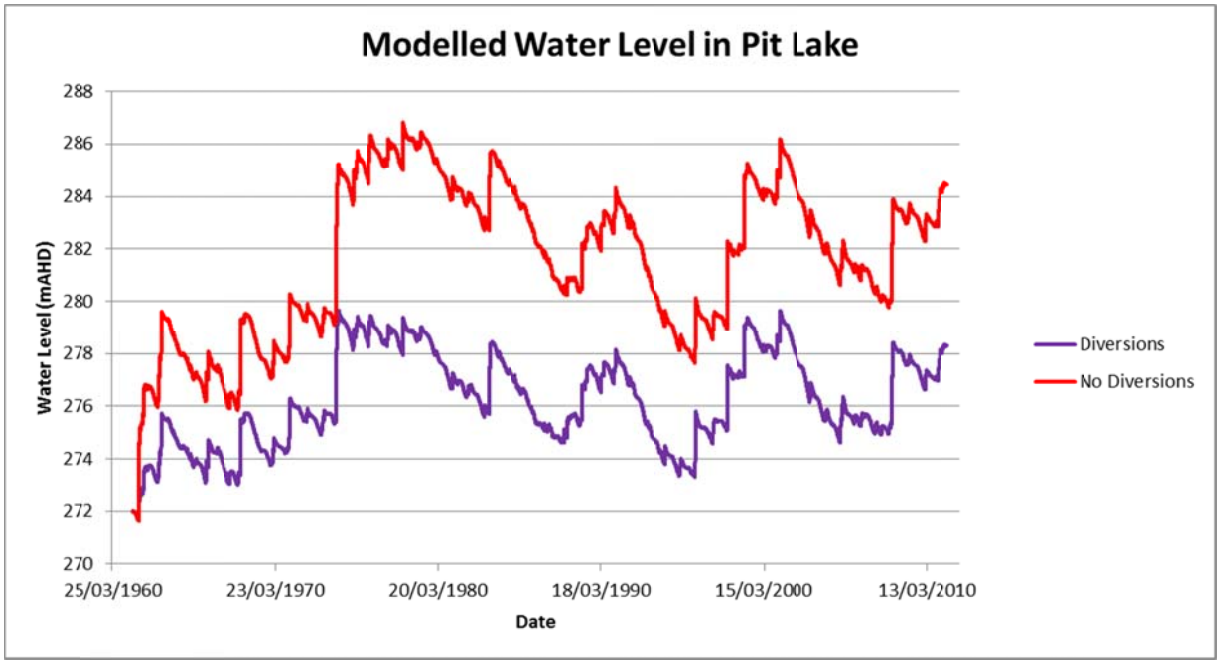


Figure 9-1: Modelled Water Level in Final Pit Lake (Source: BMT-WBM 2012)

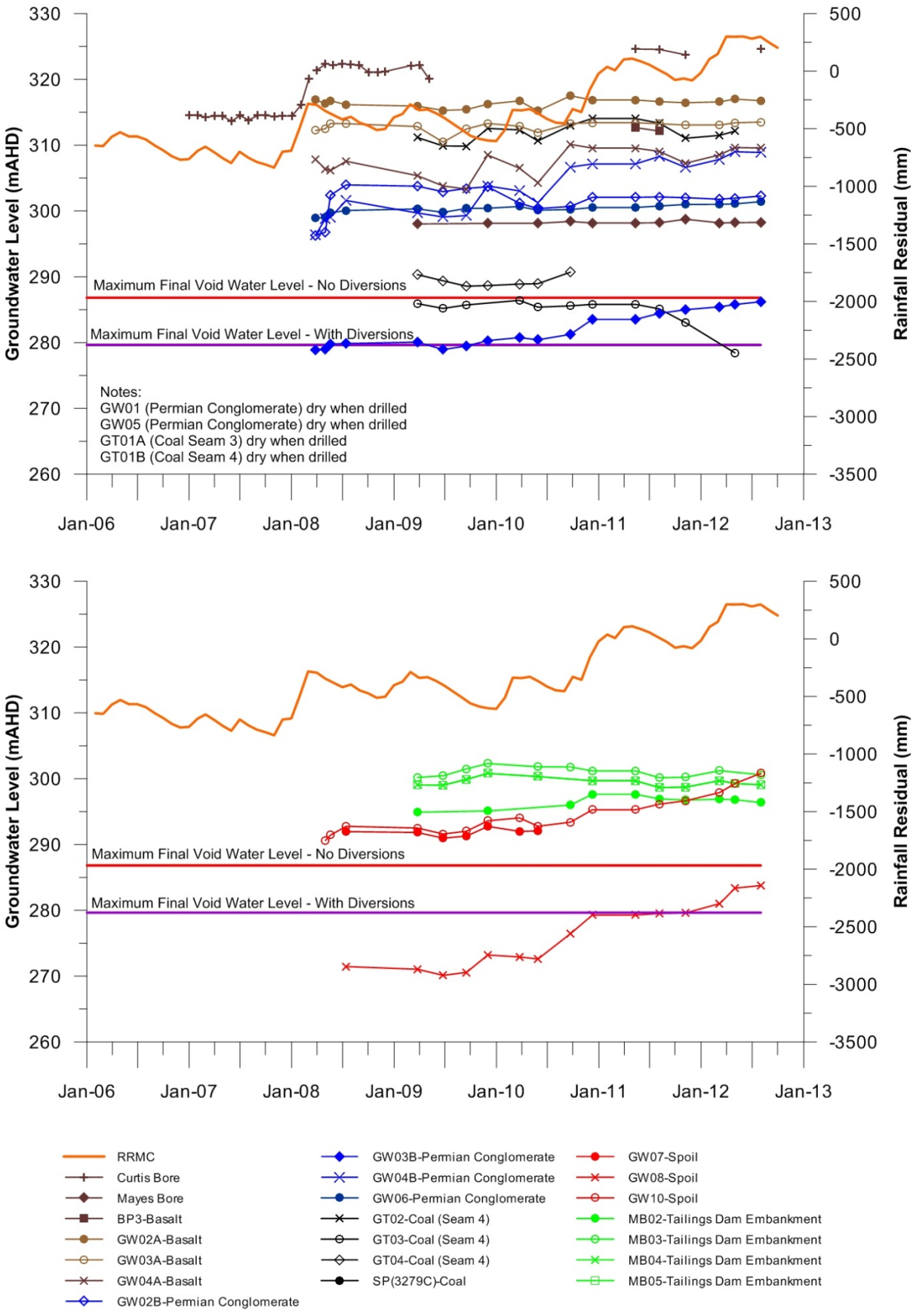


Figure 9-2: Modelled Final Void Water Levels Compared to Current Groundwater Levels

9.2 Potential Groundwater Inflow Rates to Final Void

The following section presents a summary of potential long-term yields of the groundwater units at the Blair Athol site. The inflow rates presented in this section were used by BMT-WBM as input to final landform water study modelling (BMT-WBM 2012).

Observations related to potential inflow rates to the final void from groundwater units at site are presented below in Table 9-1. The potential inflow rates are based on anecdotal information from site and professional judgement. Current inflow rates (i.e. to the operating mine) have not been quantified, and no groundwater modelling has been undertaken.

Rates of groundwater inflow to the final void are likely to be highly dependent on climatic variation, as follows:

- During periods of higher than average rainfall the water level in the basalt, alluvium, and spoil can be expected to rise, and the rate of inflow to the final void from these groundwater units will increase. It is noted that the more transmissive units of the coal measures (the coal seams) have been largely removed by mining. Therefore it is judged that the Permian coal measures will not provide significant rates of inflow to the pit void; and,
- During periods of lower than average rainfall the water level in groundwater units at site can be expected to decrease and the rate of inflow to the final void to decrease over time. In particular:
    - Within the basalt aquifer groundwater occurs within discrete fractures. Over time the rate of inflow from fractures connected to the final void could be expected to decrease, unless recharge (via rainfall) is maintained; and,
    - The alluvium tends to become saturated during high rainfall events (for example as occurred during the 2010/2011 wet season), however the volume of water contained within the alluvium will decrease over time as contained water is dissipated down-gradient.

Based on the indicative inflow rates presented in Table 9-1, the total groundwater contribution to the final void is predicted to be in the order of 3-5 L/s, though the actual rate will be dependent on factors such as seasonal rainfall, the overall shape of the final landform, and the hydraulic characteristics of groundwater units (such as spoil) that occur adjacent to or within the final void.

Table 9-1: Potential Groundwater Inflow Rates to Final Void

Unit	Predicted Inflow (L/s)	Comment
Permian coal measures	0	• The Permian coal measures are recharged in areas where the units subcrop (Figure6-4), and via diffuse downward recharge. • The coal seams occur in an isolated basin, and the catchment area for recharge to the coal measures is small (refer Figure 6-4). • The permeability of the coal seams and interburden is low, therefore the capacity of the coal seam to transmit water is relatively low • Observations from site are that inflow rates from the coal seams during production were low • The coal seams (which are the most transmissive unit of the Permian coal measures) have been largely removed by mining. • Based on the above observations, it is concluded (for the purpose of pit void studies) that the inflow rate from the coal seams is nil
Permian conglomerate	0-2	• The Permian basal conglomerate generally only provides significant yields in areas where the unit has been remobilized. This is because the fine matrix material tends to be removed during remobilization, leaving behind the coarse clastic material which can form an aquifer (e.g. Tertiary gravels beneath Clermont Mine – refer JBT (2012). When the unit remains in-situ (i.e. in original position) the matrix remains, so that the permeability of the unit is dictated by the fine material of the matrix • At Blair Athol the basal conglomerate is saturated at depth. Where the unit exists close to surface it may contain water in areas where the unit receives recharge from direct rainfall, or via downward leakage where the unit underlies Tertiary basalt. • The Permian basal conglomerate does not form an extensive aquifer across the mine site, and the rate of inflow to the final void from this unit is expected to be low.
Tertiary basalt	1-5 (dependent on degree of rainfall recharge)	• Tertiary basalt exists only in the northern and north-eastern areas of the lease (Figure xx) • The basalt has been the main unit to contribute inflow to the pit voids during the life of the mine. Inflow rates are uncertain, but anecdotally it is believed that total flow rates are in the order of several litres per second • Inflow rates will be dependent on the position of the final void relative to the basalt aquifer.
Spoil	1-5 (dependant on spoil geometry relative to final void)	• The spoil will potentially become the most significant aquifer on site, however it is also noted that the extent of the spoil is limited, and the aerial extent (over which direct rainfall recharge will occur) is also limited; • Over time, it is judged that the spoil will be in continuous hydraulic connection with the pit lake, with the water level rising and falling in response to seasonal rainfall, as well as lake levels. • The greatest significance of the spoil aquifer to the final void is therefore likely to be geochemical, i.e. the extent to which rainfall recharge occurs through unsaturated spoil, and the extent to which the water level in the lake (and hence the spoil) rises and falls, will influence the chemistry of groundwater within the spoil, and hence within the pit lake. • The degree to which a water table develops in the spoil will be dependent on the shaping and cover of the final landform (i.e. whether rainfall recharge is enhanced or reduced) • The inflow rates to the final void will be dependent on factors such as: o The height of the water table in the spoil relative to the final void (and the hydraulic gradient available to drive groundwater flow); o The hydraulic properties of the spoil; and, o The geometry of the spoil relative to the final void
Alluvium	1-2 (dependent on degree of rainfall recharge)	• The alluvium tends to carry significant water only following periods of high rainfall, where the alluvium is directly recharged. • In periods of lower than average rainfall the groundwater level in the alluvium could be expected to continually decrease, with a corresponding decrease in inflow rate to the final void • The degree to which groundwater in alluvium could provide seepage to the pit void will be dependent on the degree of hydraulic connection between the pit void and alluvium. For example, if a significant thickness of alluvium is in hydraulic connection with the final void, and if a high rainfall period such as the 2010/2011 wet season re-occurs, the rate of groundwater inflow could be significantly in excess of the rate presented in the column to the left

10.0 CONCEPTUAL GROUNDWATER MODEL

Conceptual groundwater models are presented below for pre-mining, mining, and post-closure scenarios. Each scenario is discussed with reference to conceptual cross sections. The location of the sections, sub-crop area of each coal seam, and general extent of basalt cover, is shown schematically in Figure 10-1.

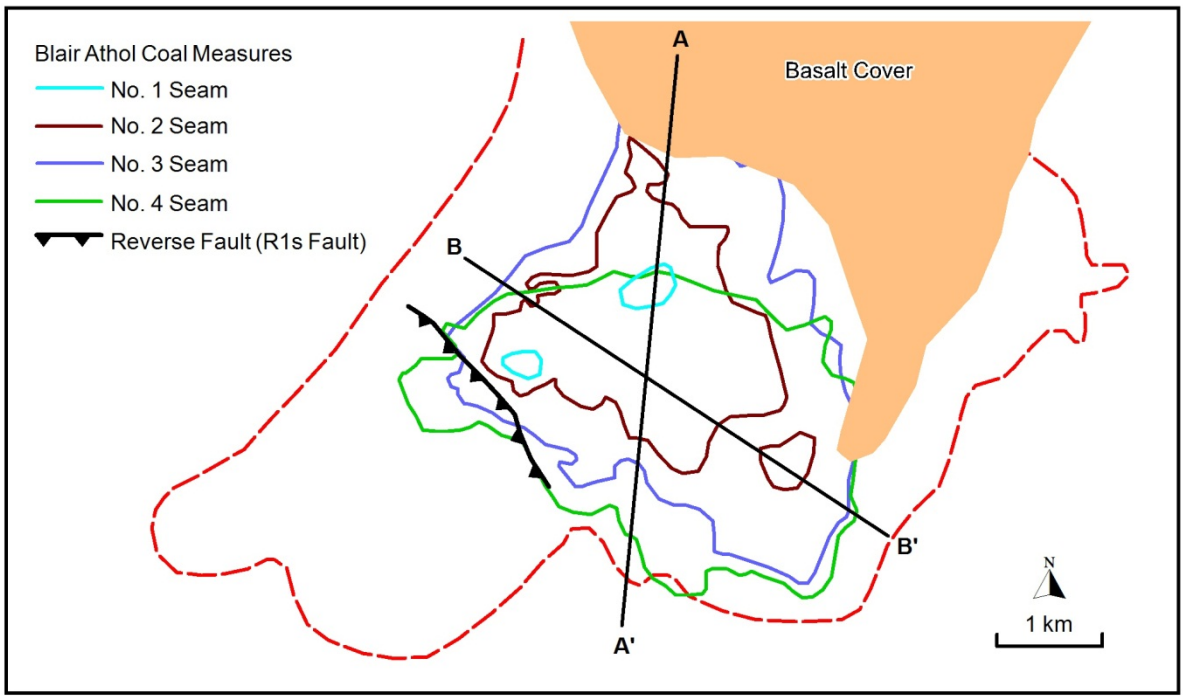


Figure 10-1: Location of Conceptual Sections (modified from RTCA 2011)

10.1 Pre-Mining Conceptual Groundwater Model

No groundwater data exists prior to commencement of mining, therefore the pre-mining conceptual model is based on observations from available monitoring data at site (water level and water quality), as well as observations from ongoing reviews by JBT of regional groundwater data for the Clermont Mine, and professional judgement. The pre-mining conceptual model (Figure 10-2) is summarised as:

- The basement metamorphics, Permian sediments, Tertiary basalt, and Quaternary alluvium all occur at surface in different areas of the Blair Athol Mining Lease (refer Figure 6-3);
- Groundwater occurs in all groundwater units at site, though available data relating to groundwater yields suggests that the units are not aquifers[1] (with the exception of the Tertiary Basalt) but rather water-bearing units, as the rate at which the units are capable of yielding water to a bore would not allow the units to be classified as aquifers. Exceptions may occur locally where faulting or fracturing has increased the secondary porosity of the unit;
- Pre-Tertiary (pre-basalt deposition) surface drainage was from the northern part of the lease area to the north-east and east, along a drainage channel incised into the Permian surface (Figure 6-2). During deposition the basalt flowed up the drainage channel and into the northern area of the lease. The basalt on site represents the marginal extent of the basalt flow, and the

[1] An aquifer is defined as "rock or sediment in a formation, group of formations, or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs". (Fetter, 1994)

basalt cover on site is therefore thin in areas where it occurs on lease, thickening to the north and north-east;

- Within the basalt aquifer groundwater occurs primarily within fractures that are generally poorly connected to adjacent fractures (i.e. pumping from one fracture system may have little impact on adjacent fracture systems). This has implications for potential long-term inflow rates from the basalt aquifer to the final void (refer Sections 10.1 and 10.2);
- The Blair Athol Basin is a relatively isolated groundwater system, and the coal seams drain towards the centre of the basin. The groundwater flow paths within the coal seams are relatively short as it can be observed from Figure 10-1 that the subcrop boundaries of the individual coal seams are only several kilometres apart (i.e. the distance from one side of the basin to the other);
- Recharge to the coal seams occurs in marginal areas of the basin where the coal seams subcrop (refer Figure 10-1 for coal seam subcrop areas), or via downward drainage from overlying groundwater units;
- Recharge to other groundwater units is via direct rainfall recharge, and groundwater flow direction is topgraphically controlled. A groundwater divide exists in the basalt aquifer to the north of the mine area, at the catchment boundary between the north-west draining Miclere Creek, the south-east draining Gowrie Creek, and Bath and Washpool Creeks, which drain in a southerly direction through the mining area (refer Figure 6-3);
- All creeks in the area are ephemeral, and groundwater exists within unconsolidated alluvial deposits following rainfall recharge events; and,
- Major ion chemistry/ water types are different in different regions of the site, reflecting the chemistry of the rock units that host the groundwater (i.e. Mg-Ca-HCO3 in areas where basalt exists, Na-Cl in other areas).

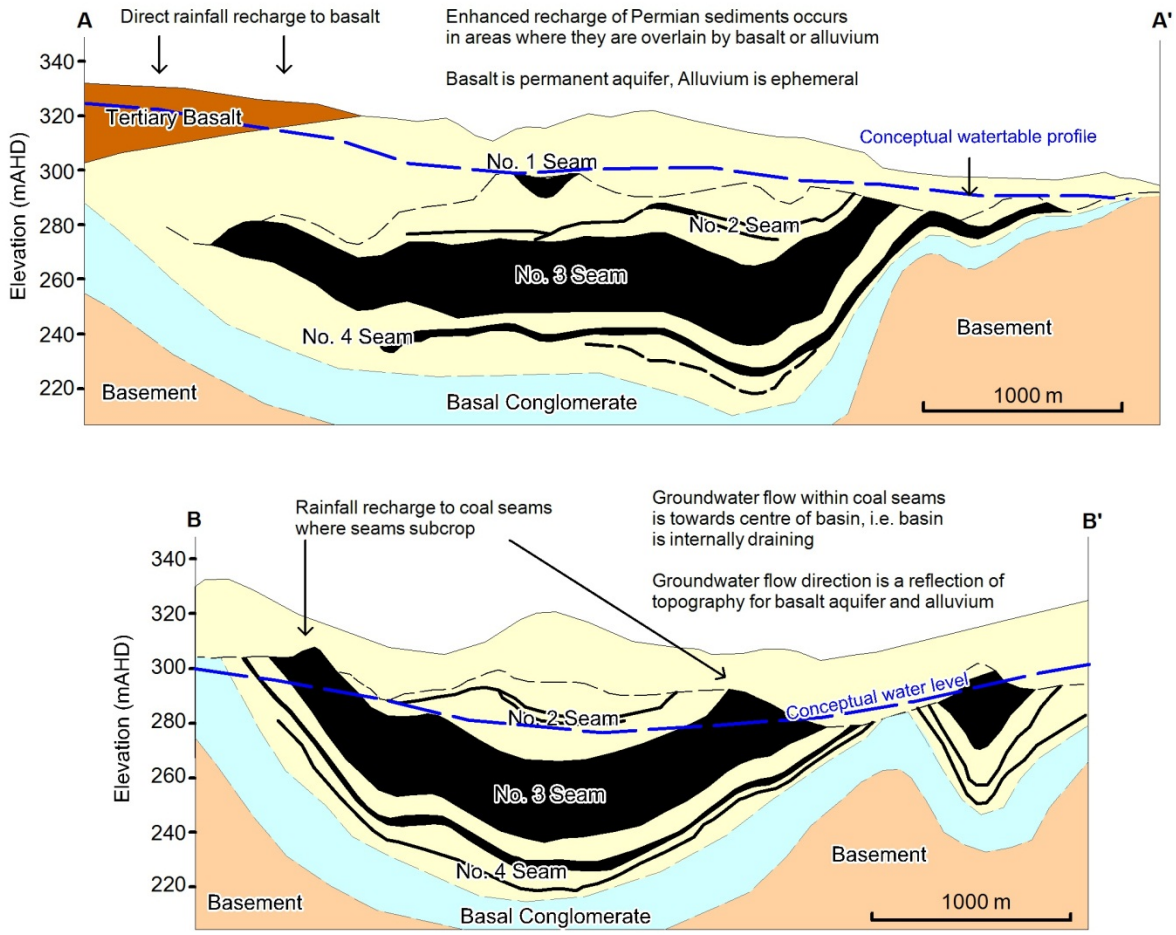


Figure 10-2: Pre-Mining Conceptual Groundwater Model (Modified from RTCA 2011)

10.2 During Mining Conceptual Groundwater Model

The conceptual model for groundwater conditions during mining is shown in Figure 10-3, and is summarised as:

- Excavation of the pit voids creates groundwater sinks, which locally dewater the coal seams;
- Flow toward the pit voids is also induced from the basalt aquifer, with seepage occurring from the base of basalt (predominantly at the contact between the basalt and underlying units);
- Inflow to the pits may also occur through Permian conglomerates, especially in areas where the unit underlies (and is recharged by) the basalt aquifer;
- A localised aquifer is created within the spoil which backfills the mined-out pit voids. The hydraulic properties of the spoil aquifer are likely to be highly variable, dependant on factors such as the permeability of the original material, the dumping pattern, degree of compaction due to traffic, and variability in the rate of compaction and settlement with time. One study of groundwater conditions within spoil aquifers across a number of mining regions in the United States[2] noted a 6-order of magnitude variability in the permeability of spoil;
- The spoil aquifer is directly recharged by rainfall, as evidenced by bore hydrographs which show a correlation between rainfall and water level rise in the spoil (Section 8.2);

[2] Rehm, B.R, Groenewold, G.H. & Morin, K.A. (1980) Hydraulic Properties of Coal and Related Materials, Northern Great Plains. Groundwater Vol 18, No. 6, November-December 1980.

- Water quality has evolved from a number of distinct types (Na-Cl in areas distant from the basalt aquifer, and Ca-Mg-HCO3 within the basalt aquifer, as well as within units that underlie basalt) to mixed water types as mixing occurs between different groundwater units (Section 8.3.1).

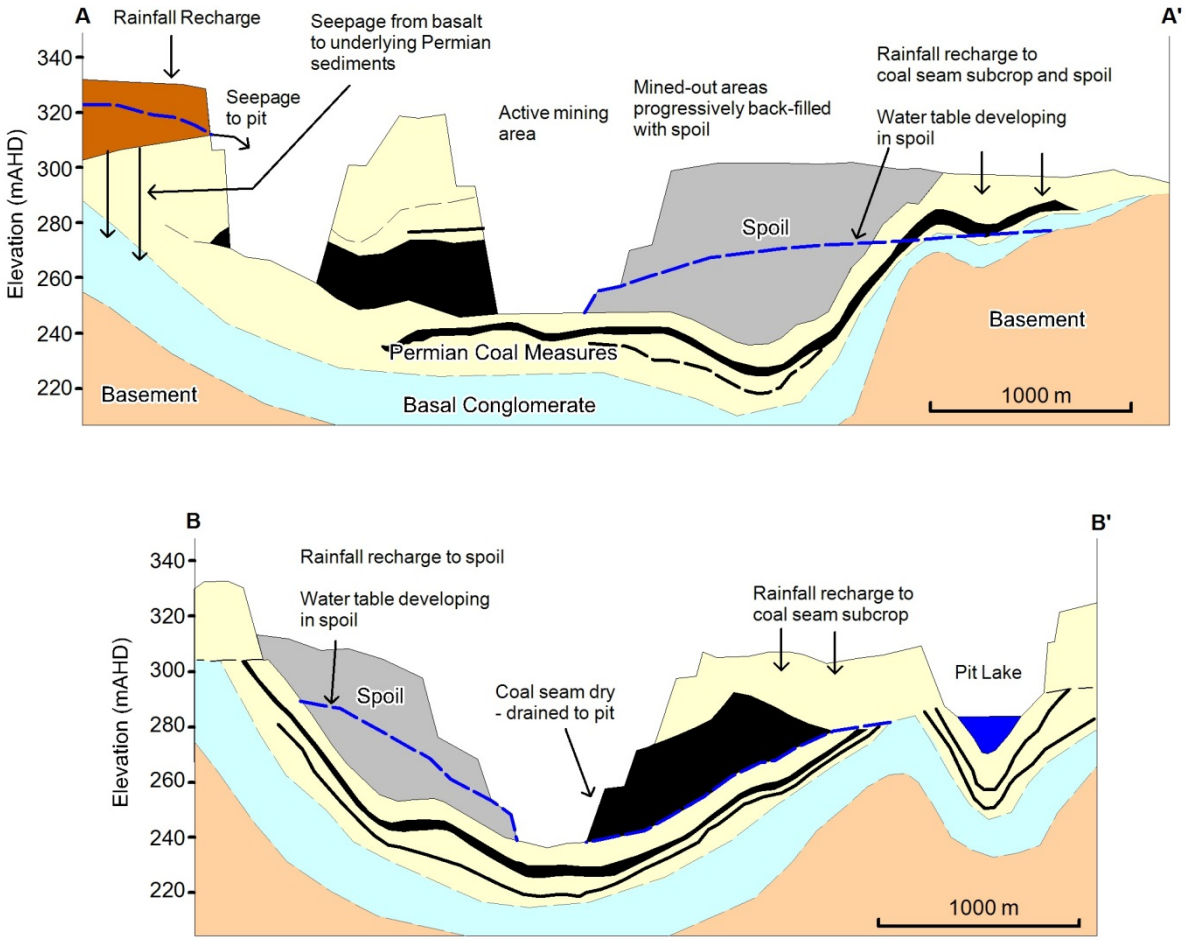


Figure 10-3: During-Mining Conceptual Groundwater Model

10.3 Post-Closure Conceptual Groundwater Model

Based on review of available geological, water level, and water quality data, the post closure conceptual groundwater model (Figure 10-4) is summarised as:

- A water table will develop within the spoil, with the water level in the spoil influenced by rainfall recharge;
- The spoil will potentially become the most significant aquifer on site, however it is also noted that the extent of the spoil is limited, and the aerial extent (over which direct rainfall recharge will occur) is also limited;
- Over time, it is judged that the spoil will be in continuous hydraulic connection with the pit lake, with the water level rising and falling in response to seasonal rainfall, as well as lake levels;
- The greatest significance of the spoil aquifer to the final void is therefore likely to be geochemical, i.e. the extent to which rainfall recharge occurs through unsaturated spoil, and the extent to which the water level in the lake (and hence the spoil) rises and falls, will influence the chemistry of groundwater within the spoil, and hence within the pit lake.
- The degree to which a water table develops in the spoil will be dependent on the shaping and cover of the final landform (i.e. whether rainfall recharge is enhanced or reduced);

- The inflow rates to the final void will therefore be dependent on:
  - The height of the water table in the spoil relative to the final void, and therefore the hydraulic gradient available to drive groundwater flow;
  - The hydraulic properties of the spoil; and,
  - The geometry of the spoil relative to the final void
- Groundwater quality within the spoil aquifer will be dependent on spoil chemistry and groundwater residence times. Based on analysis of existing water quality data, it is predicted that water at the site (surface water and groundwater) will evolve to a mixed water type (dominated by Mg, Ca, and Na cations, and SO_4 and HCO_3 anions);
- Water within the basalt aquifer occurs within discrete fracture systems. Ongoing seepage from the basalt aquifer towards pit voids can be expected in areas where water-bearing fractures have been exposed by mining. The individual fractures store a finite volume of water, so the seepage rates could be expected to decrease over time, with increases in seepage rates evident following periods of rainfall recharge. Wet season rainfall has generally been above average since the 2007/2008 wet season, therefore the water level in most aquifers in the region are currently higher than has historically been the case (i.e. since prior to 2007, refer JBT 2012). Therefore it could be expected that seepage rates to the pit voids from the basalt aquifer would reduce during sustained periods of below average rainfall as the finite volume of water within the fractures discharges to the pit voids without being replenished by rainfall recharge; and,
- Groundwater levels for the majority of aquifers at site are currently higher than the predicted maximum water level in the final landform (pit lake). Therefore, it is predicted that the final landform pit lake will act as a groundwater sink, which will limit the potential for off-site discharge of water from the final void.

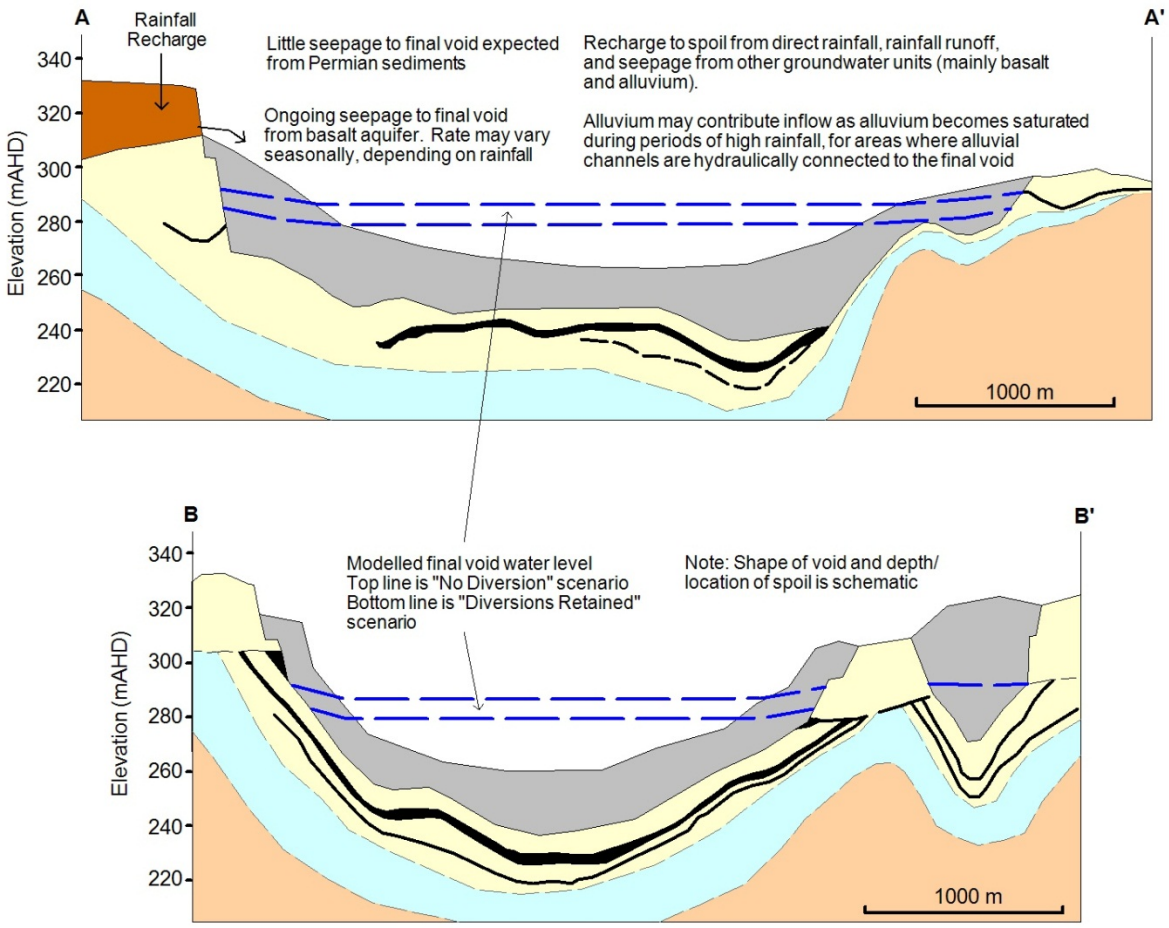


Figure 10-4: Post-Closure Conceptual Groundwater Model

11.0 CONCLUSIONS

11.1 Hydrostratigraphy

The stratigraphic sequence in the Blair Athol Basin comprises five lithological units; these are, from stratigraphically lowest to highest:

- Proterozoic/ Cambrian Anakie Metamorphic Group, comprising schist, phyllite, metabasalt;
- Early to Middle Devonian arenites, occupying a small basement trough in the southern part of the basin;
- Permian-age Blair Athol Coal Measures, comprising:
  - The lower Coal Measures, which include basal conglomerate, sandstone, siltstone, and mudstone; and,
  - The upper Coal Measures, which include sandstone, siltstone, mudstone, conglomerate, as well as the four main coal seams of the basin (Seams 1, 2, 3, and 4)
- Tertiary basalt, which only occurs in the north and east of the lease area (Figure 6-3); and,
- Tertiary and Quaternary (recent) alluvial deposits developed within the ephemeral streams that drain the site, including Bath Creek and Washpool Creek.

11.2 Groundwater Levels

Groundwater level data is summarised and analysed in Section 8.0. Observations from review of the hydrographs include:

Tertiary Basalt

- Only one bore (Curtis Bore) has water level readings that date prior to January 2008 (prior to the 2007/2008 wet season). The impact of 2007/2008 wet season rainfall is evident at this site, where the water level rise in the bore matches the rise in the residual rainfall mass (RRM) curve;
- Other basalt bores display a relatively steady water level trend, with a slight overall rise in water level evident between March 2008 and August 2012;

Coal Seam

- Monitoring bores at site are screened in either Seam 3 or Seam 4 (lower coal seams) as the seams above (Seam 1 and Seam 2) tend to be dry when drilled;
- Bore GT01 is located adjacent to the Ramp 3 South pit (Figure 8-1). Both GT01A (Seam 3) and GT01B (Seam 4) are dry, indicating that water within the coal seams has drained to the pit at this location;
- The impact of mining on water levels in the coal seam can be seen from the hydrograph for bore GT03 (Seam 4), the water level has reduced significantly at this site (7.38 m water level reduction) between May 2011 and May 2012.

Permian Conglomerate

- Water levels in bores monitoring the Permian conglomerate have tended to increase in response to rainfall recharge, i.e. water levels tend to conform to the overall trend of the RRM curve, which has displayed a rising trend since December 2007.
- Between May 2008 and May 2012 the water level has increased by 6.01 m in GW03B, 9.98 m in GW04B, and 1.36 m in GW06 (i.e. the greatest rate of water level increase has been in bores that are overlain by Tertiary basalt);
- At sites where the conglomerate is overlain by basalt (GW02B, GW03B, GW04B) the water level in the basalt aquifer is higher than the water level in the conglomerate, indicating a potential for the basalt aquifer to recharge the underlying Permian sediments.

Spoil

- Bores screened in spoil (GW08, GW10) show a rise in water level between July 2008 and August 2012 of between 8.06 m (GW10) and 12.32 m (GW08). This matches the overall rise in the RRM curve, indicating that groundwater levels within the spoil are directly impacted by rainfall recharge events.

Tailings Storage Facility (TSF)

- Bores screened within the TSF embankment (MB02, MB03, MB04, MB05) display relatively consistent water levels, suggesting that water levels in the bores are dominated by the water level within the TSF rather than by rainfall recharge (as is the case with bores in the surrounding spoil);

11.3 Water Chemistry

The major ion chemistry at site is summarised as:

- Water samples from the coal seam, the Permian conglomerate (in areas where basalt does not exist), and some spoil bores (e.g. GW07) is sodium dominated;
- Cation chemistry for the basalt aquifer, and for the Permian conglomerate underlying basalt, is calcium-magnesium dominated; and,
- A number of surface water (industrial dam, environmental dam) were initially sodium dominated, but evolved to calcium-magnesium dominated over time. West Dam, which is in a catchment containing basalt outcrop as well as bedrock outcrop, has consistently displayed a mixed water chemistry dominated by sodium, calcium, and magnesium cations.
- Anion chemistry is more diverse, with water samples from different sources tending to be dominated by either chloride, bicarbonate, or sulphate. However, over time the various water sources (including surface water and groundwater) that were previously chloride dominated have evolved towards being dominated by bicarbonate or sulphate anions.
- Therefore over time, the surface water and groundwater at site has evolved from distinct water types to a mixed water type, which is increasingly dominated by calcium, magnesium, bicarbonate, and sulphate.

Water quality across the site has also been compared to a number of Australian guidelines, with observations as follows:

- Stock water guideline limits (ANZECC 2000)
    - Groundwater samples do not exceed stock water quality guidelines, with the exception of TDS, where 50 out of 279 samples exceed 4,000 mg/L, and aluminium, where 2 out of 71 samples exceed guideline limits
    - Surface water samples exceed stock water guideline limits for TDS, but only 2 out of 340 samples exceed 4,000 mg/L;
- Freshwater ecosystem protection guideline limits (ANZECC 2000 - slightly to moderately disturbed systems)
    - Groundwater samples exceed guideline limits for a number of parameters, including aluminium, arsenic, cadmium, copper, chromium, manganese, and zinc
    - Surface water samples exceed guideline limits for aluminium, cadmium, manganese, lead, and zinc
- Drinking water guideline limits (ADWG 2011)
    - Groundwater samples exceed guideline limits (health-based) for sulphate, arsenic, cadmium, manganese
    - Groundwater samples exceed guideline limits (aesthetic-based criteria) for pH, TDS, sodium, chloride, sulphate, iron, manganese, and zinc
    - Surface water samples exceed guideline limits (health-based) for sulphate, cadmium, manganese, and lead
    - Surface water samples exceed guideline limits (aesthetic-based criteria) for pH, TDS, sodium, chloride, sulphate, iron, and manganese.

In summary, the results from site groundwater sampling are consistent with previous investigations have concluded that the beneficial use for groundwater in the Clermont region is stock watering. Groundwater within the Tertiary basalt aquifer is, in some instances, suitable for potable use based

on TDS criteria alone, however a number of other parameters may make groundwater in the area unsuitable for potable consumption without treatment to a potable standard.

11.4 Final Void

11.4.1 Final Void Water Levels and Water Quality

A summary of final void modelling undertaken by BMT-WBM (2012) with respect to groundwater implications, is presented in Section 9.1 and is summarised as follows:

- Comparison of final void modelling with current and historic groundwater levels indicates that, for the majority of cases, groundwater levels are higher than the water level in the final void. This suggests that the final landform pit lake will act as a groundwater sink, limiting the potential for off-site movement of water from the pit lake via the groundwater system;
- It is concluded that the existing groundwater monitoring network (north, east and west of the site) is sufficient to monitor for offsite impacts from the final void lake;
- The groundwater monitoring network should be supplemented with:
    - Monitoring bores around the pit lake, drilled to intersect the water table and to monitor for changes in water level and water quality; and,
    - Monitoring bores to the south of the site, in the area where offsite groundwater movement is most likely to occur (i.e. down-gradient of the existing environmental dam, with bores placed too monitor water level/ water quality in the alluvium as well as adjacent/ underlying units (shallow bedrock)).

11.4.2 Groundwater inflow to Final Void

The potential for groundwater to provide inflow to the final void is presented in Section 9-2 and Table 9-1, and is summarised as follows:

- Rates of groundwater inflow to the final void are likely to be highly dependent on climatic variation, as follows:
- During periods of higher than average rainfall the water level in the basalt, alluvium, and spoil can be expected to rise, and the rate of inflow to the final void from these groundwater units will increase. It is noted that the more transmissive units of the coal measures (the coal seams) have been largely removed by mining. Therefore it is judged that the Permian coal measures will not provide significant rates of inflow to the pit void; and,
- During periods of lower than average rainfall the water level in groundwater units at site can be expected to decrease and the rate of inflow to the final void to decrease over time. In particular:
    - Within the basalt aquifer groundwater occurs within discrete fractures. Over time the rate of inflow from fractures connected to the final void could be expected to decrease, unless recharge (via rainfall) is maintained; and,
    - The alluvium tends to become saturated during high rainfall events (for example as occurred during the 2010/2011 wet season), however the volume of water contained within the alluvium will decrease over time as contained water is dissipated down-gradient.
- Based on the indicative inflow rates presented in Table 9-1, the total groundwater contribution to the final void is predicted to be in the order of 3-5 L/s, though the actual rate will be dependent on factors such as seasonal rainfall, the overall shape of the final landform, and the hydraulic characteristics of groundwater units (such as spoil) that occur adjacent to or within the final void.

11.5 Conceptual Groundwater Model

Conceptual groundwater models for pre-mining, mining, and post-mining (closure) scenarios are presented in Section 10. The conceptual models are presented in summary form, so they will not be further summarised in this section.

12.0 RECOMMENDATIONS

Following review of groundwater conditions at site, as well as data from the existing groundwater monitoring network and results of final landform water study modelling, the final recommendations are made:

- Following development of the final landform, groundwater monitoring bores should be constructed around the perimeter of the lake (final number to be established once the landform is complete). Bores should be drilled to intersect the watertable, and monitored for change in water level and water quality;
- Additional groundwater monitoring bores should also be constructed at the southern end of the site (between the environmental dam and the southern boundary of the lease) to monitor for potential offsite movement of contaminants from site, particularly from the final landform pit lake;
- Following final design of the post-closure groundwater monitoring network, a plan and schedule for ongoing monitoring/sampling of water levels and water quality should be developed. Initial recommendations for monitoring include:
    - Monitoring of water levels within key bores (to be determined) via down-hole data loggers, with data loggers to be downloaded at a maximum interval of 3-monthly. For other sites water levels should be recorded manually at 3-monthy intervals. Following each data download the data should be reviewed for data integrity, and a report on groundwater levels and trends prepared on an annual basis;
    - Water quality should be monitored quarterly for a minimum of 2 years to establish a base-line data set for closure conditions, for a minimum of the following parameters:
        - Total Dissolved Solids
        - EC, pH (field)
        - Major Ions - sodium, calcium, magnesium, potassium, chloride, sulphate, alkalinity (hydroxide, carbonate, bicarbonate, total)
        - Fluoride
        - Total + dissolved metals, via ICPMS/FIMS (aluminium, arsenic, boron, cadmium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, vanadium, zinc)
    - It is recommenced that water quality data be reviewed each quarter, and a report prepared on an annual basis to present and discuss results and trends. The frequency of data collection should be reviewed following 2 years of data collection, with recommendations then made as to the frequency of ongoing data collection.
- It is acknowledged that different monitoring/reporting conditions may be required by DEHP, therefore the post-closure groundwater monitoring plan will need to be reviewed and approved by DEHP.

13.0 REFERENCES

BMT-WBM (2012) BAC Final Landform Water Study. Report to Rio Tinto Coal Australia, November 2012.

Fetter (1994). Applied Hydrogeology, Third Edition. Prentice Hall Publishers, 691 pp.

Herbert, H.K. (1989) Geology and Gold Potential, Black Ridge Area, Clermont Qld. Report to Southern Aurora Joint Venture, June 1989.

JBT (2009) Regional Groundwater Model Update. Report by JBT Consulting to Rio Tinto Coal Australia, Clermont Mine Project. JBT report No. JBT01-001-008, June 2009

JBT (2012) Clermont Mine – 5th Annual Aquifer Performance Review - 2011/2012 Water Year. Report by JBT Consulting to Rio Tinto Coal Australia, Clermont Mine. JBT report No. JBT01-001-061, August 2012.

Matrix+ (2007) Groundwater Monitoring Bore Installation. Report to Riotinto Coal Australia Blair Athol Coal Mine by Matrix + Consulting, July 2007

Rehm, B.R, Groenewold, G.H. & Morin, K.A. (1980). *Hydraulic Properties of Coal and Related Materials, Northern Great Plains.* Groundwater Vol 18, No. 6, November-December 1980

RTCA (2011) The Coal Resources and Coal Reserves of the Blair Athol Mine – 2010. Report prepared to support 2010 year end statements by Rio Tinto Coal Australia (RTCA), February 2011.

Terranus (2009) Groundwater Review – Blair Athol Coal Mine. Report to Blair Athol Coal Mine by Terranus Earth Sciences, May 2009.

URS (2006) Assessment of water and sediment quality of Stockpile Dam and Environment Dam for EPA Hazardous Dam Classification. Letter report from URS to Blair Athol Coal Mine, Document No. 311006, 31 October 2006.

Water Solutions (1999) Report to RTCA Clermont Mine/ Blair Athol Coal on Permanent Waterworks Options Overview Investigations. Water Solutions Document No. WS990292.

Water Solutions (2012) Report to RTCA Clermont Mine/ Blair Athol Coal on OPSIM Water Management Metered Data Review. Water Solutions Document No. WS120175 (Draft) 3 May 2012.

APPENDIX A

GROUNDWATER LEVEL DATA

Appendix A - Groundwater Levels

All measurements as metres below top of casing (mTOC)

Date	BP3	Curtis Bore	GT02	GT03	GT04	GW02A	GW02B	GW03A	GW03B	GW04A	GW04B	GW05	GW06	GW07	GW08	GW10	Mayes Bore	MB02	MB03	MB04	MB05	SP(3279C)
02-Jan-07	-	10.06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31-Jan-07	-	10.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
01-Mar-07	-	10.32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
02-Apr-07	-	10.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
01-May-07	-	10.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
01-Jun-07	-	10.98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-07	-	10.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-07	-	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-07	-	10.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
01-Oct-07	-	10.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
01-Nov-07	-	10.22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30-Nov-07	-	10.16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03-Jan-08	-	10.17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04-Feb-08	-	8.51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03-Mar-08	-	4.55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27-Mar-08	-	-	-	-	-	12.08	32.73	5.77	39.11	6.17	17.67	Dry	19.09	-	-	-	-	-	-	-	-	21.82
01-Apr-08	-	3.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
01-May-08	-	2.3	-	-	-	12.7	32.21	5.5	39	7.62	15.19	Dry	18.99	-	-	37.36	-	-	-	-	-	22.21
19-May-08	-	-	-	-	-	12.24	26.62	4.7	38.22	7.86	14.98	Dry	18.28	-	-	36.54	-	-	-	-	-	21.72
29-May-08	-	2.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-08	-	2.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-08	-	-	-	-	-	12.84	25.04	4.73	38.15	6.444	12.4	Dry	17.93	26.04	35.87	35.21	-	-	-	-	-	-
31-Jul-08	-	2.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-08	-	2.42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
02-Oct-08	-	3.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04-Nov-08	-	3.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
01-Dec-08	-	3.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
02-Mar-09	-	2.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25-Mar-09	-	-	6.53	32.55	23.17	13.06	25.23	5.17	37.93	8.63	14.3	Dry	17.69	26.17	36.28	35.47	-	14.99	16.97	8.16	7.58	21.63
01-Apr-09	-	2.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06-May-09	-	4.54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25-Jun-09	-	-	7.82	33.28	24.11	13.71	26.07	7.54	39.06	10.2	14.91	-	18.2	27.03	37.21	36.38	-	-	-	7.9	7.6	22.38
16-Sep-09	-	-	7.85	32.75	24.93	13.59	25.57	5.54	38.52	10.67	14.7	-	17.61	26.72	36.75	35.95	-	-	-	6.87	6.73	21.76
01-Dec-09	-	-	5.15	-	24.84	12.76	25.33	4.7	37.7	5.5	10.2	Dry	17.58	25.25	34.11	34.37	-	14.9	16.78	6.04	5.82	21.73
24-Mar-10	-	-	5.38	32.06	24.61	12.27	27.81	5.11	37.24	7.49	10.95	Dry	17.32	26	34.41	33.93	-	-	-	-	-	-
29-May-10	-	-	7.05	33.09	24.55	13.8	28.63	6.08	37.58	9.7	12.75	-	17.88	25.94	34.72	35.2	-	14.89	-	6.54	6.3	-
22-Sep-10	-	-	4.69	32.89	22.8	11.5	28.31	4.71	36.75	3.88	7.33	Dry	17.78	-	30.87	34.58	-	14.61	15.88	6.57	-	-
09-Dec-10	-	-	3.65	32.66	-	12.13	26.93	4.59	34.48	4.44	6.85	Dry	17.47	-	28.04	32.69	2.71	14.84	14.24	7.17	6.94	-
12-May-11	14.67	0	3.65	32.66	-	12.13	26.93	4.59	34.48	4.44	6.85	-	17.47	-	28.04	32.69	2.71	14.84	14.24	7.17	6.94	-
05-Aug-11	15.2	0.05	4.35	33.35	-	12.38	26.86	4.74	33.56	4.95	5.72	-	17.24	-	27.81	31.84	3.4	14.81	14.94	8.2	7.98	-
07-Nov-11	-	0.87	6.65	35.46	-	12.55	26.98	4.94	33	6.74	7.38	-	17.01	-	27.71	31.33	4.23	14.28	15.11	8.13	7.91	-
07-Mar-12	-	-	6.21	-	-	12.42	27.22	4.94	32.57	5.48	6.16	-	16.99	-	26.3	30.07	-	14.82	14.99	7.13	6.91	-
01-May-12	-	-	5.57	40.04	-	12	27.05	4.6	32.21	4.36	5	-	16.92	-	23.95	28.7	-	14.8	15.06	-	7.36	-
01-Aug-12	-	0	-	-	-	12.24	26.73	4.49	31.79	4.43	5.11	-	16.58	-	23.55	27.15	3.55	14.75	15.5	7.76	7.55	-

APPENDIX B

WATER-TYPE ANALYSES

Appendix B - Water Type Analysis

	Basalt	PERCENTAGE meq/L OF TOTAL CATION/ANION									Water Type
		Ca	Mg	Na	K	Cl	CO3 + HCO3	SO4	Cations	Anions	
		(% meq)	(% meq)	(% meq)	(% meq)	(% meq)	(% meq)	(% meq)			
14-Jul-08	BP3	32.41	48.59	18.62	0.38	6.87	87.42	5.71	100.00	100.00	Mg-Ca-HCO3
12-May-11	BP3	32.53	48.14	18.90	0.43	4.70	89.39	5.90	100.00	100.00	
5-Aug-11	BP3	30.85	48.20	20.53	0.42	3.33	90.70	5.97	100.00	100.00	
14-Jul-08	Curtis Bore	30.36	41.51	27.75	0.38	9.72	86.85	3.43	100.00	100.00	Mg-Ca-HCO3
25-Mar-09	Curtis Bore	30.71	43.41	25.50	0.37	8.87	87.71	3.43	100.00	100.00	
25-Jun-09	Curtis Bore	30.05	45.93	23.64	0.38	8.31	88.32	3.37	100.00	100.00	
17-Sep-09	Curtis Bore	30.98	44.12	24.55	0.36	14.32	80.39	5.29	100.00	100.00	
3-Dec-09	Curtis Bore	29.86	43.77	26.03	0.34	7.50	86.64	5.86	100.00	100.00	
24-Mar-10	Curtis Bore	33.68	41.05	24.89	0.38	10.15	85.48	4.37	100.00	100.00	
27-May-10	Curtis Bore	32.20	42.48	24.95	0.37	8.16	87.63	4.21	100.00	100.00	
12-May-11	Curtis Bore	32.02	43.42	24.19	0.36	7.49	87.90	4.61	100.00	100.00	
5-Aug-11	Curtis Bore	29.76	42.07	27.80	0.36	5.84	90.16	4.00	100.00	100.00	
3-Nov-11	Curtis Bore	29.65	41.29	28.72	0.34	14.59	80.87	4.54	100.00	100.00	
1-May-12	Curtis Bore	31.10	44.45	24.10	0.35	5.76	87.04	7.20	100.00	100.00	
27-Mar-08	GW02A	26.80	52.28	20.73	0.19	16.08	80.65	3.27	100.00	100.00	Mg-HCO3
19-May-08	GW02A	27.26	53.12	19.44	0.18	24.24	72.66	3.10	100.00	100.00	
14-Jul-08	GW02A	27.40	54.22	18.21	0.18	30.20	66.04	3.77	100.00	100.00	
25-Mar-09	GW02A	26.36	52.97	20.46	0.21	13.55	81.99	4.46	100.00	100.00	
25-Jun-09	GW02A	27.34	52.60	19.86	0.19	21.37	75.00	3.63	100.00	100.00	
17-Sep-09	GW02A	26.61	52.65	20.54	0.19	98.57	0.70	0.73	100.00	100.00	
3-Dec-09	GW02A	25.78	53.62	20.40	0.20	19.74	76.41	3.85	100.00	100.00	
24-Mar-10	GW02A	27.31	52.76	19.73	0.20	17.18	78.99	3.84	100.00	100.00	
27-May-10	GW02A	27.70	51.93	20.18	0.19	19.50	76.13	4.37	100.00	100.00	
22-Sep-10	GW02A	21.73	56.03	22.04	0.20	19.31	77.21	3.48	100.00	100.00	
9-Dec-10	GW02A	28.11	50.38	21.31	0.21	14.27	81.80	3.93	100.00	100.00	
12-May-11	GW02a	27.65	52.89	19.28	0.19	22.13	73.16	4.71	100.00	100.00	
5-Aug-11	GW02a	26.31	53.36	20.15	0.18	28.34	67.34	4.33	100.00	100.00	
3-Nov-11	GW02a	26.20	52.88	20.74	0.18	23.86	72.03	4.11	100.00	100.00	
7-Mar-12	GW02a	27.33	52.68	19.80	0.18	20.30	73.92	5.78	100.00	100.00	
1-May-12	GW02a	26.24	53.11	20.45	0.20	12.33	80.29	7.38	100.00	100.00	
27-Mar-08	GW03A	34.05	46.35	19.32	0.28	12.44	81.52	6.05	100.00	100.00	Mg-Ca-HCO3
19-May-08	GW03A	34.31	44.58	20.85	0.27	12.15	83.66	4.19	100.00	100.00	
14-Jul-08	GW03A	35.79	43.79	20.13	0.30	11.53	83.85	4.62	100.00	100.00	
25-Mar-09	GW03A	34.24	44.43	21.04	0.29	8.35	88.33	3.32	100.00	100.00	
25-Jun-09	GW03A	32.99	46.89	19.83	0.29	7.62	89.45	2.93	100.00	100.00	
17-Sep-09	GW03A	32.97	45.93	20.81	0.29	7.88	88.96	3.15	100.00	100.00	
3-Dec-09	GW03A	33.05	45.98	20.71	0.26	9.12	87.89	2.99	100.00	100.00	
24-Mar-10	GW03A	34.34	43.42	21.95	0.29	7.71	89.33	2.97	100.00	100.00	
27-May-10	GW03A	37.59	42.85	19.28	0.28	10.05	87.08	2.87	100.00	100.00	
22-Sep-10	GW03A	33.20	46.40	20.11	0.29	11.22	86.58	2.19	100.00	100.00	
9-Dec-10	GW03A	35.75	44.21	19.74	0.31	10.28	86.94	2.78	100.00	100.00	
12-May-11	GW03a	35.20	45.35	19.18	0.28	11.95	85.43	2.62	100.00	100.00	
5-Aug-11	GW03a	32.93	45.26	21.53	0.28	11.59	86.04	2.38	100.00	100.00	
3-Nov-11	GW03a	38.39	38.53	22.79	0.29	10.32	87.31	2.38	100.00	100.00	
7-Mar-12	GW03a	34.72	45.62	19.39	0.28	10.36	85.01	4.63	100.00	100.00	
1-May-12	GW03a	33.93	45.94	19.87	0.26	11.71	84.48	3.81	100.00	100.00	
27-Mar-08	GW04A	34.86	45.66	19.22	0.26	25.16	68.16	6.68	100.00	100.00	Mg-Ca-HCO3
19-May-08	GW04A	34.89	43.56	21.29	0.26	17.59	73.28	9.13	100.00	100.00	
14-Jul-08	GW04A	36.29	43.84	19.61	0.26	23.81	67.73	8.46	100.00	100.00	
25-Mar-09	GW04A	34.92	45.25	19.57	0.26	14.51	77.35	8.14	100.00	100.00	
25-Jun-09	GW04A	33.01	44.24	22.48	0.26	16.51	74.46	9.03	100.00	100.00	
17-Sep-09	GW04A	36.12	41.60	21.99	0.29	11.37	83.69	4.94	100.00	100.00	
3-Dec-09	GW04A	33.11	45.19	21.40	0.29	11.55	83.22	5.23	100.00	100.00	
24-Mar-10	GW04A	36.67	42.23	20.80	0.30	9.13	85.37	5.49	100.00	100.00	
27-May-10	GW04A	35.43	43.35	20.92	0.29	11.35	84.47	4.19	100.00	100.00	
22-Sep-10	GW04A	34.93	42.71	22.05	0.31	9.07	88.09	2.83	100.00	100.00	
9-Dec-10	GW04A	37.21	41.89	20.60	0.30	9.65	86.28	4.07	100.00	100.00	
11-May-11	GW04a	36.36	44.03	19.32	0.29	7.06	76.17	16.77	100.00	100.00	
5-Aug-11	GW04a	35.18	44.42	20.12	0.28	14.16	76.27	9.56	100.00	100.00	
8-Nov-11	GW04a	34.78	41.80	23.12	0.30	9.71	86.47	3.82	100.00	100.00	
7-Mar-12	GW04a	36.45	45.27	18.05	0.23	18.16	68.43	13.40	100.00	100.00	
1-May-12	GW04a	35.46	44.72	19.55	0.27	10.65	79.59	9.76	100.00	100.00	
19-May-08	Mayes Bore	26.96	39.65	33.02	0.37	8.28	86.84	4.89	100.00	100.00	Na-Mg-HCO3
14-Jul-08	Mayes Bore	26.23	31.72	41.16	0.90	11.79	81.78	6.43	100.00	100.00	
25-Mar-09	Mayes Bore	25.09	31.03	42.96	0.92	9.16	84.08	6.76	100.00	100.00	
25-Jun-09	Mayes Bore	26.29	32.17	40.67	0.87	11.26	81.88	6.86	100.00	100.00	
17-Sep-09	Mayes Bore	25.36	28.38	45.80	0.46	11.92	81.20	6.88	100.00	100.00	
3-Dec-09	Mayes Bore	25.64	33.03	40.51	0.82	9.79	82.17	8.03	100.00	100.00	
24-Mar-10	Mayes Bore	26.87	34.62	38.07	0.43	12.92	80.38	6.71	100.00	100.00	
27-May-10	Mayes Bore	27.45	30.62	41.52	0.41	10.71	82.11	7.18	100.00	100.00	
12-May-11	Mayes Bore	27.22	33.30	39.03	0.45	8.93	81.92	9.15	100.00	100.00	
5-Aug-11	Mayes Bore	26.21	30.25	42.65	0.90	7.11	84.64	8.25	100.00	100.00	
3-Nov-11	Mayes Bore	27.73	32.86	38.52	0.89	6.96	84.96	8.07	100.00	100.00	
1-May-12	Mayes Bore	26.90	36.04	36.64	0.43	6.98	81.26	11.77	100.00	100.00	

Appendix B - Water Type Analysis

	Coal	PERCENTAGE meq/L OF TOTAL CATION/ANION									Water Type
		Ca	Mg	Na	K	Cl	CO3 + HCO3	SO4	Cations	Anions	
		(% meq)	(% meq)	(% meq)	(% meq)	(% meq)	(% meq)	(% meq)			
25-Jun-09	GT02	12.09	32.05	55.63	0.24	72.82	15.85	11.34	100.00	100.00	Na-Cl
17-Sep-09	GT02	12.20	30.64	56.94	0.21	81.91	5.96	12.12	100.00	100.00	
3-Dec-09	GT02	12.32	30.07	57.36	0.24	71.66	15.55	12.78	100.00	100.00	
24-Mar-10	GT02	13.09	30.56	56.13	0.22	76.04	13.86	10.10	100.00	100.00	
27-May-10	GT02	14.06	32.46	53.20	0.27	68.74	18.32	12.94	100.00	100.00	
22-Sep-10	GT02	12.46	31.06	56.22	0.25	72.68	15.04	12.28	100.00	100.00	
9-Dec-10	GT02	12.39	29.22	58.20	0.20	73.75	15.01	11.24	100.00	100.00	
13-May-11	GT02	13.47	30.61	55.68	0.24	76.79	13.86	9.35	100.00	100.00	
12-Aug-11	GT02	13.18	30.70	55.87	0.26	71.52	16.45	12.04	100.00	100.00	
8-Nov-11	GT02	12.85	32.34	54.62	0.19	73.39	15.90	10.71	100.00	100.00	
7-Mar-12	GT02	13.09	30.77	55.92	0.22	71.11	15.82	13.07	100.00	100.00	
1-May-12	GT02	13.77	30.76	55.29	0.19	68.16	17.52	14.32	100.00	100.00	
25-Jun-09	GT03	10.35	20.97	67.93	0.74	70.57	16.54	12.89	100.00	100.00	Na-Cl
17-Sep-09	GT03	10.45	21.67	67.19	0.69	82.93	3.26	13.81	100.00	100.00	
3-Dec-09	GT03	10.61	22.58	66.24	0.57	69.23	17.82	12.95	100.00	100.00	
27-May-10	GT03	11.70	23.93	63.82	0.55	66.05	22.96	10.99	100.00	100.00	
22-Sep-10	GT03	10.88	24.18	64.50	0.44	70.53	18.90	10.57	100.00	100.00	
9-Dec-10	GT03	10.76	23.14	65.72	0.38	70.83	19.48	9.70	100.00	100.00	
12-May-11	GT03	11.30	24.84	63.41	0.46	70.37	19.24	10.39	100.00	100.00	
8-Nov-11	GT03	12.62	25.76	61.14	0.48	68.64	20.56	10.80	100.00	100.00	
1-May-12	GT03	12.55	25.92	61.11	0.42	64.19	22.36	13.45	100.00	100.00	
25-Jun-09	GT04	8.69	26.62	63.23	1.47	82.34	5.49	12.17	100.00	100.00	Na-Cl
17-Sep-09	GT04	10.25	25.95	62.48	1.32	86.35	0.57	13.08	100.00	100.00	
3-Dec-09	GT04	12.84	26.19	59.87	1.10	79.47	4.53	16.00	100.00	100.00	
24-Mar-10	GT04	11.35	24.91	62.57	1.17	81.74	5.86	12.40	100.00	100.00	
27-May-10	GT04	12.08	24.81	31.29	31.83	91.63	5.95	2.42	100.00	100.00	
22-Sep-10	GT04	12.85	26.81	59.20	1.15	79.94	4.49	15.57	100.00	100.00	
9-Dec-10	GT04	12.96	26.53	59.60	0.91	81.27	4.73	14.00	100.00	100.00	
27-Mar-08	SP(3279C)	28.86	10.16	60.44	0.54	5.02	31.56	63.41	100.00	100.00	Na-SO4
19-May-08	SP(3279C)	22.97	8.95	67.61	0.47	3.10	22.46	74.44	100.00	100.00	
14-Jul-08	SP(3279C)	16.14	8.03	75.28	0.54	2.56	32.18	65.26	100.00	100.00	
25-Jun-09	SP(3279C)	14.98	7.65	76.87	0.51	2.75	22.86	74.39	100.00	100.00	
3-Dec-09	SP(3279C)	13.77	7.13	78.59	0.51	2.63	13.57	83.80	100.00	100.00	
24-Mar-10	SP(3279C)	12.72	7.40	79.26	0.63	3.55	22.44	74.02	100.00	100.00	

Appendix B - Water Type Analysis

	Basal	PERCENTAGE meq/L OF TOTAL CATION/ANION									
	Conglomerate										
		Ca	Mg	Na	K	Cl	CO3 + HCO3	SO4	Cations	Anions	Water Type
		(% meq)	(% meq)	(% meq)	(% meq)	(% meq)	(% meq)	(% meq)			
27-Mar-08	GW02B	26.71	30.20	41.91	1.17	19.39	76.04	4.57	100.00	100.00	Mg-Ca-Na-HCO3
19-May-08	GW02B	26.99	32.09	39.95	0.97	30.14	65.89	3.97	100.00	100.00	
14-Jul-08	GW02B	28.92	35.26	34.53	1.29	21.25	73.43	5.32	100.00	100.00	
25-Mar-09	GW02B	27.89	46.00	25.14	0.97	16.52	79.29	4.20	100.00	100.00	
25-Jun-09	GW02B	29.69	43.92	25.50	0.89	18.46	75.44	6.10	100.00	100.00	
17-Sep-09	GW02B	27.68	51.35	20.78	0.20	50.77	26.82	22.41	100.00	100.00	
3-Dec-09	GW02B	27.15	51.16	21.30	0.40	21.08	69.48	9.43	100.00	100.00	
24-Mar-10	GW02B	27.77	51.52	20.51	0.20	19.24	73.04	7.73	100.00	100.00	
27-May-10	GW02B	28.04	51.38	20.37	0.20	17.85	73.21	8.94	100.00	100.00	
22-Sep-10	GW02B	25.86	52.53	21.23	0.38	20.60	70.93	8.47	100.00	100.00	
9-Dec-10	GW02B	27.15	50.07	22.42	0.37	21.19	70.04	8.77	100.00	100.00	
12-May-11	GW02B	27.27	50.52	21.82	0.38	20.56	70.91	8.54	100.00	100.00	
5-Aug-11	GW02B	26.61	51.19	21.79	0.41	19.73	72.26	8.00	100.00	100.00	
3-Nov-11	GW02B	27.89	49.68	22.05	0.38	17.61	74.46	7.93	100.00	100.00	
7-Mar-12	GW02B	27.60	49.95	22.06	0.39	17.84	72.06	10.10	100.00	100.00	
1-May-12	GW02B	27.02	51.10	21.47	0.41	18.47	72.10	9.42	100.00	100.00	
27-Mar-08	GW03B	33.98	33.39	31.52	1.11	14.95	78.49	6.56	100.00	100.00	Mg-Ca-Na-HCO3
19-May-08	GW03B	74.13	8.61	15.93	1.34	26.45	66.73	6.81	100.00	100.00	
14-Jul-08	GW03B	33.65	33.06	31.83	1.47	14.59	77.72	7.69	100.00	100.00	
25-Mar-09	GW03B	33.54	38.20	27.85	0.41	8.87	87.71	3.43	100.00	100.00	
25-Jun-09	GW03B	27.64	32.93	38.38	1.05	22.57	64.62	12.81	100.00	100.00	
17-Sep-09	GW03B	26.36	36.11	36.61	0.92	30.74	58.48	10.78	100.00	100.00	
3-Dec-09	GW03B	31.99	36.61	30.73	0.67	13.00	76.53	10.47	100.00	100.00	
24-Mar-10	GW03B	34.21	33.18	31.58	1.03	11.01	79.42	9.57	100.00	100.00	
27-May-10	GW03B	31.95	34.09	33.31	0.64	16.71	74.70	8.58	100.00	100.00	
22-Sep-10	GW03B	24.99	50.28	23.96	0.77	16.02	76.48	7.50	100.00	100.00	
9-Dec-10	GW03B	33.14	34.01	32.10	0.75	14.03	77.49	8.47	100.00	100.00	
12-May-11	GW03b	33.11	34.85	31.32	0.72	12.93	76.95	10.12	100.00	100.00	
5-Aug-11	GW03b	31.82	33.81	33.28	1.09	13.90	78.26	7.84	100.00	100.00	
3-Nov-11	GW03b	32.34	35.17	31.79	0.71	11.49	80.62	7.89	100.00	100.00	
7-Mar-12	GW03b	32.08	36.37	30.87	0.68	11.67	74.44	13.89	100.00	100.00	
1-May-12	GW03b	31.66	35.60	31.99	0.74	12.19	74.91	12.90	100.00	100.00	
27-Mar-08	GW04B	34.75	46.70	18.33	0.22	28.31	63.75	7.93	100.00	100.00	Mg-Ca-HCO3
19-May-08	GW04B	36.19	45.12	18.47	0.23	24.35	68.05	7.60	100.00	100.00	
14-Jul-08	GW04B	36.09	43.50	20.17	0.24	27.60	63.78	8.62	100.00	100.00	
25-Mar-09	GW04B	35.27	45.33	19.17	0.23	16.71	73.90	9.40	100.00	100.00	
25-Jun-09	GW04B	35.88	44.58	19.28	0.25	16.34	76.34	7.31	100.00	100.00	
17-Sep-09	GW04B	34.04	45.44	20.25	0.28	13.69	80.16	6.15	100.00	100.00	
3-Dec-09	GW04B	32.26	45.74	21.71	0.29	10.90	84.27	4.83	100.00	100.00	
24-Mar-10	GW04B	35.88	43.93	19.91	0.28	10.75	83.18	6.07	100.00	100.00	
27-May-10	GW04B	36.57	43.46	19.69	0.28	13.32	81.54	5.14	100.00	100.00	
22-Sep-10	GW04B	34.41	43.05	22.24	0.30	8.50	88.49	3.01	100.00	100.00	
9-Dec-10	GW04B	37.82	43.85	18.03	0.30	8.96	87.22	3.82	100.00	100.00	
11-May-11	GW04b	34.58	45.02	20.10	0.31	8.67	87.24	4.09	100.00	100.00	
5-Aug-11	GW04b	34.80	43.73	21.19	0.28	16.42	79.99	3.59	100.00	100.00	
8-Nov-11	GW04b	34.85	42.44	22.43	0.27	16.26	81.12	2.62	100.00	100.00	
7-Mar-12	GW04b	35.86	44.91	18.99	0.23	23.65	70.66	5.69	100.00	100.00	
1-May-12	GW04b	35.49	44.96	19.28	0.26	14.80	80.20	5.00	100.00	100.00	
27-Mar-08	GW06	12.75	21.74	64.74	0.78	87.99	3.28	8.73	100.00	100.00	Na-Cl
19-May-08	GW06	12.98	22.54	63.63	0.85	87.14	3.37	9.49	100.00	100.00	
14-Jul-08	GW06	13.31	21.95	63.90	0.83	87.11	2.90	9.99	100.00	100.00	
25-Mar-09	GW06	12.98	21.67	64.52	0.83	87.29	3.04	9.67	100.00	100.00	
25-Jun-09	GW06	13.15	21.75	64.23	0.88	88.08	2.92	9.00	100.00	100.00	
17-Sep-09	GW06	13.44	21.79	63.91	0.86	88.54	2.69	8.77	100.00	100.00	
3-Dec-09	GW06	12.39	21.14	65.62	0.84	87.33	2.98	9.69	100.00	100.00	
24-Mar-10	GW06	12.87	21.16	65.16	0.82	88.81	2.64	8.55	100.00	100.00	
27-May-10	GW06	13.03	21.81	64.30	0.86	87.29	3.04	9.67	100.00	100.00	
22-Sep-10	GW06	13.04	21.77	64.35	0.84	87.98	2.70	9.32	100.00	100.00	
9-Dec-10	GW06	11.47	20.59	67.15	0.79	87.06	3.43	9.51	100.00	100.00	
12-May-11	GW06	11.21	20.86	66.99	0.94	87.15	3.43	9.42	100.00	100.00	
5-Aug-11	GW06	11.48	21.00	66.62	0.90	87.57	3.37	9.06	100.00	100.00	
3-Nov-11	GW06	12.34	22.16	64.38	1.12	82.40	4.98	12.62	100.00	100.00	
7-Mar-12	GW06	11.68	21.45	66.00	0.87	86.69	3.25	10.06	100.00	100.00	
1-May-12	GW06	11.84	21.50	65.83	0.82	87.21	3.29	9.50	100.00	100.00	

Appendix B - Water Type Analysis

	Spoil	PERCENTAGE meq/L OF TOTAL CATION/ANION									Water Type
		Ca	Mg	Na	K	Cl	O3 + HCO	SO4	Cations	Anions	
		(% meq)	(% meq)	(% meq)	(% meq)	(% meq)	(% meq)	(% meq)			
25-Mar-09	GW07	3.41	17.86	78.60	0.13	76.51	8.73	14.75	100.00	100.00	Na-Cl
25-Jun-09	GW07	2.92	18.45	78.52	0.11	79.43	8.37	12.20	100.00	100.00	
17-Sep-09	GW07	2.97	17.98	78.97	0.08	80.44	8.47	11.09	100.00	100.00	
3-Dec-09	GW07	2.71	18.57	78.66	0.06	80.49	7.79	11.72	100.00	100.00	
24-Mar-10	GW07	3.07	16.07	80.73	0.12	81.89	8.03	10.08	100.00	100.00	
27-May-10	GW07	2.96	16.85	80.10	0.09	79.30	9.77	10.94	100.00	100.00	
22-Sep-10	GW07	2.66	16.72	80.56	0.06	81.36	8.74	9.90	100.00	100.00	
25-Mar-09	GW08	13.04	40.76	45.74	0.47	26.68	29.64	43.68	100.00	100.00	Na-Mg-SO4-Cl
25-Jun-09	GW08	17.48	41.11	40.55	0.86	33.01	27.13	39.87	100.00	100.00	
17-Sep-09	GW08	14.35	40.00	45.25	0.40	40.07	24.48	35.45	100.00	100.00	
3-Dec-09	GW08	13.00	39.39	47.20	0.41	35.25	24.56	40.19	100.00	100.00	
24-Mar-10	GW08	14.40	41.48	43.71	0.42	36.48	23.97	39.56	100.00	100.00	
27-May-10	GW08	16.08	39.91	43.48	0.53	35.42	24.77	39.80	100.00	100.00	
7-Mar-12	GW08	13.48	40.25	45.84	0.44	37.16	18.42	44.42	100.00	100.00	
1-May-12	GW08	15.34	44.47	39.72	0.48	34.00	16.65	49.34	100.00	100.00	
27-Mar-08	GW10	16.47	24.64	58.11	0.79	20.51	76.94	2.55	100.00	100.00	Na-Mg-HCO3
19-May-08	GW10	17.27	24.50	57.41	0.82	18.15	79.02	2.84	100.00	100.00	
14-Jul-08	GW10	16.84	25.74	56.58	0.84	23.53	73.96	2.51	100.00	100.00	
25-Mar-09	GW10	30.35	44.09	25.20	0.37	8.87	87.71	3.43	100.00	100.00	
25-Jun-09	GW10	15.32	23.21	60.62	0.85	22.06	76.62	1.32	100.00	100.00	
17-Sep-09	GW10	15.85	24.86	58.30	0.99	22.59	75.50	1.91	100.00	100.00	
3-Dec-09	GW10	14.65	23.57	61.05	0.73	27.42	70.15	2.43	100.00	100.00	
24-Mar-10	GW10	17.29	24.85	57.18	0.68	21.89	77.77	0.34	100.00	100.00	
27-May-10	GW10	17.01	24.23	57.97	0.79	25.78	72.38	1.84	100.00	100.00	
23-Sep-10	GW10	15.09	24.89	59.20	0.81	24.60	74.43	0.97	100.00	100.00	
9-Dec-10	GW10	16.46	24.78	58.02	0.73	25.18	71.56	3.26	100.00	100.00	
13-May-11	GW10	17.54	24.80	56.80	0.86	22.69	77.13	0.17	100.00	100.00	
12-Aug-11	GW10	17.49	25.40	56.26	0.85	22.33	77.32	0.35	100.00	100.00	
8-Nov-11	GW10	16.89	24.29	58.15	0.67	20.99	78.52	0.49	100.00	100.00	

Appendix B - Water Type Analysis

	TSF	PERCENTAGE meq/L OF TOTAL CATION/ANION									Water Type
		Ca	Mg	Na	K	Cl	CO3 + HCO3	SO4	Cations	Anions	
		(% meq)	(% meq)	(% meq)	(% meq)	(% meq)	(% meq)	(% meq)	%	%	
25-Jun-09	MB02	37.63	19.19	28.37	14.81	9.26	49.12	41.62	100.00	100.00	Ca-Na-Mg-K-SO4
23-Sep-10	MB02	49.79	17.04	27.03	6.14	8.68	33.05	58.27	100.00	100.00	
9-Dec-10	MB02	58.98	28.45	11.54	1.03	7.92	25.61	66.47	100.00	100.00	
9-Dec-10	MB03	12.25	58.67	28.52	0.56	14.63	5.41	79.96	100.00	100.00	Mg-Na-SO4
13-May-11	MB03	19.83	59.45	20.17	0.54	8.32	0.12	91.56	100.00	100.00	
11-Aug-11	MB03	7.66	62.78	28.79	0.77	10.54	14.76	74.70	100.00	100.00	
7-Mar-12	MB03	21.90	62.65	14.90	0.55	3.62	0.03	96.36	100.00	100.00	
25-Jun-09	MB04	37.33	41.17	20.64	0.87	19.75	9.05	71.19	100.00	100.00	Mg-Ca-Na-SO4
17-Sep-09	MB04	37.93	29.92	31.38	0.77	35.29	5.43	59.28	100.00	100.00	
3-Dec-09	MB04	36.55	32.58	30.09	0.78	27.65	0.04	72.32	100.00	100.00	
24-Mar-10	MB04	34.66	31.42	33.08	0.84	35.28	5.73	59.00	100.00	100.00	
27-May-10	MB04	37.60	34.40	27.18	0.82	26.37	0.78	72.85	100.00	100.00	
23-Sep-10	MB04	31.87	35.36	31.88	0.90	27.04	1.27	71.69	100.00	100.00	
9-Dec-10	MB04	25.94	41.67	31.47	0.92	28.00	3.28	68.72	100.00	100.00	
13-May-11	MB04	29.22	37.16	32.60	1.02	31.90	3.37	64.73	100.00	100.00	
11-Aug-11	MB04	33.85	40.31	25.04	0.80	29.49	5.69	64.82	100.00	100.00	
3-Nov-11	MB04	33.20	35.81	30.18	0.81	33.60	5.82	60.58	100.00	100.00	
7-Mar-12	MB04	29.49	39.34	30.14	1.03	26.70	2.88	70.42	100.00	100.00	
25-Jun-09	MB05	0.37	0.31	44.37	54.95	1.36	85.53	13.11	100.00	100.00	Mg-Na-Ca-SO4
17-Sep-09	MB05	13.81	5.36	37.54	43.29	8.06	78.96	12.98	100.00	100.00	
3-Dec-09	MB05	31.74	35.89	31.41	0.96	25.66	4.28	70.06	100.00	100.00	
24-Mar-10	MB05	32.62	30.06	36.59	0.74	37.25	3.99	58.76	100.00	100.00	
27-May-10	MB05	36.52	33.82	28.87	0.79	28.07	2.09	69.84	100.00	100.00	
23-Sep-10	MB05	29.93	33.25	35.84	0.97	32.64	3.20	64.16	100.00	100.00	
9-Dec-10	MB05	0.21	0.05	84.08	15.65	0.02	90.01	9.97	100.00	100.00	
13-May-11	MB05	30.55	37.68	30.69	1.08	30.62	7.48	61.90	100.00	100.00	
3-Nov-11	MB05	38.97	38.06	22.15	0.83	26.18	11.41	62.41	100.00	100.00	
7-Mar-12	MB05	32.53	38.70	27.82	0.95	23.92	5.67	70.41	100.00	100.00	
1-May-12	MB05	36.14	40.74	22.33	0.78	16.05	8.71	75.25	100.00	100.00	
23-Jun-09	Tailings Dam	37.06	47.01	15.53	0.40	7.06	11.57	81.37	100.00	100.00	Mg-Ca-SO4
8-Oct-09	Tailings Dam	35.84	39.72	23.92	0.52	24.90	4.60	70.50	100.00	100.00	
30-Nov-09	Tailings Dam	36.37	36.42	26.61	0.60	27.14	5.15	67.71	100.00	100.00	
17-Mar-10	Tailings Dam	35.79	34.03	29.37	0.81	25.99	6.87	67.14	100.00	100.00	
2-Jun-10	Tailings Dam	37.62	36.18	25.50	0.70	24.59	1.88	73.53	100.00	100.00	
28-Sep-10	Tailings Dam	27.53	41.91	29.54	1.02	27.22	0.09	72.69	100.00	100.00	
7-Apr-11	Tailings Dam	29.00	38.36	31.60	1.04	29.03	9.20	61.76	100.00	100.00	

	Surface Water	PERCENTAGE meq/L OF TOTAL CATION/ANION									
		Ca	Mg	Na	K	Cl	CO3 + HCO3	SO4	Cations	Anions	Water Type
		(% meq)	(% meq)	(% meq)	(% meq)	(% meq)	(% meq)	(% meq)			
2-Apr-12	Transfer Dam 1	15.07	40.80	42.26	1.87	39.31	7.94	52.75	100.00	100.00	Na-Mg-SO4
30-Apr-12	Transfer Dam 1	16.14	41.22	40.72	1.93	38.61	7.48	53.90	100.00	100.00	
31-Jan-12	Ramp 3 North	15.86	34.25	48.29	1.60	38.63	14.50	46.87	100.00	100.00	Na-Mg-SO4-Cl
30-Apr-12	Ramp 3 North	18.59	34.11	46.10	1.21	33.36	13.56	53.08	100.00	100.00	
5-Mar-85	Environmental Dam	6.36	21.86	70.98	0.80	65.32	24.55	10.13	100.00	100.00	Na-Cl
3-May-85	Environmental Dam	7.00	22.03	70.22	0.74	65.41	24.51	10.08	100.00	100.00	
6-Jun-85	Environmental Dam	6.92	20.22	72.20	0.66	66.50	21.69	11.81	100.00	100.00	
11-Jul-85	Environmental Dam	10.96	24.71	63.44	0.89	61.53	28.87	9.60	100.00	100.00	
9-Aug-85	Environmental Dam	12.19	24.43	62.45	0.92	63.75	27.28	8.97	100.00	100.00	
5-Sep-85	Environmental Dam	11.45	21.89	65.78	0.88	60.29	30.19	9.52	100.00	100.00	
9-Dec-85	Environmental Dam	12.26	14.16	72.77	0.82	59.16	22.88	17.95	100.00	100.00	
10-Dec-93	Environmental Dam	9.25	26.60	63.06	1.09	57.45	19.68	22.87	100.00	100.00	
31-Jan-12	Environmental Dam	31.67	28.12	33.97	6.24	20.64	71.23	8.13	100.00	100.00	Ca-Mg-Cl-HCO3
4-Apr-12	Environmental Dam	38.37	31.63	25.08	4.91	11.23	79.65	9.12	100.00	100.00	
30-Apr-12	Environmental Dam	31.60	37.90	27.55	2.94	20.58	78.81	0.61	100.00	100.00	
10-Jan-86	West Dam	24.29	32.04	39.52	4.15	38.22	59.38	2.40	100.00	100.00	Na-Mg-Cl-HCO3
30-Apr-86	West Dam	25.85	28.42	41.31	4.42	36.15	63.32	0.52	100.00	100.00	
23-Jun-86	West Dam	23.64	32.84	39.05	4.46	39.31	60.23	0.47	100.00	100.00	
27-Aug-90	West Dam	17.74	31.34	46.38	4.54	45.45	53.07	1.48	100.00	100.00	
14-Nov-91	West Dam	17.19	32.39	46.02	4.40	47.55	51.03	1.42	100.00	100.00	
14-Aug-92	West Dam	18.93	29.48	46.75	4.85	46.19	53.41	0.41	100.00	100.00	
26-Oct-92	West Dam	19.93	28.38	46.59	5.11	46.84	52.47	0.69	100.00	100.00	
14-Jul-93	West Dam	17.74	28.22	49.17	4.87	50.16	47.34	2.50	100.00	100.00	
23-Sep-93	West Dam	18.14	27.98	49.98	3.90	49.19	45.04	5.77	100.00	100.00	
25-Oct-94	West Dam	7.20	30.75	59.03	3.02	62.27	34.31	3.41	100.00	100.00	
2-Nov-94	West Dam	9.70	29.00	57.88	3.42	64.10	32.24	3.66	100.00	100.00	
3-Nov-11	West Dam	27.89	28.75	37.99	5.36	34.98	62.74	2.28	100.00	100.00	Na-Ca-Mg-HCO3
31-Jan-12	West Dam	25.56	26.35	43.18	4.91	40.04	59.30	0.66	100.00	100.00	
30-Apr-12	West Dam	25.69	30.27	38.40	5.64	38.45	60.74	0.81	100.00	100.00	
27-Aug-90	East Dam	23.51	38.77	35.14	2.58	27.52	69.86	2.62	100.00	100.00	Na-Mg-HCO3
17-Sep-90	East Dam	18.87	39.61	38.88	2.64	33.87	64.04	2.08	100.00	100.00	
18-Jan-91	East Dam	25.58	34.52	37.51	2.38	34.73	64.37	0.90	100.00	100.00	
16-Jan-92	East Dam	17.03	28.09	51.97	2.91	46.79	52.66	0.55	100.00	100.00	
14-Aug-92	East Dam	26.57	31.30	39.70	2.43	36.72	62.94	0.34	100.00	100.00	
24-Dec-92	East Dam	16.93	30.71	50.18	2.17	47.50	49.58	2.92	100.00	100.00	Na-Mg-HCO3-Cl
14-Jul-93	East Dam	19.64	27.76	50.87	1.73	45.89	44.50	9.61	100.00	100.00	
23-Sep-93	East Dam	22.47	26.72	49.20	1.61	45.02	45.37	9.61	100.00	100.00	
29-May-95	Industrial Dam	12.46	27.21	59.30	1.04	51.49	33.45	15.06	100.00	100.00	Na-Cl
28-Aug-95	Industrial Dam	13.96	28.78	56.50	0.77	51.36	30.75	17.90	100.00	100.00	
6-Nov-95	Industrial Dam	14.33	27.58	57.27	0.82	55.56	24.18	20.26	100.00	100.00	
29-Feb-96	Industrial Dam	15.46	26.84	56.04	1.67	46.14	35.86	18.01	100.00	100.00	
30-Jul-96	Industrial Dam	12.99	25.80	60.46	0.76	53.61	26.61	19.78	100.00	100.00	
18-Nov-96	Industrial Dam	13.56	24.71	60.64	1.10	50.94	33.04	16.01	100.00	100.00	
5-Feb-97	Industrial Dam	13.46	24.57	60.75	1.23	53.58	28.80	17.62	100.00	100.00	
19-May-97	Industrial Dam	16.06	25.68	57.27	1.00	46.89	34.65	18.46	100.00	100.00	
11-Aug-97	Industrial Dam	15.15	26.95	56.98	0.91	50.02	26.21	23.78	100.00	100.00	
19-Nov-97	Industrial Dam	11.90	25.29	61.86	0.94	53.24	21.99	24.77	100.00	100.00	
3-Feb-98	Industrial Dam	18.54	26.41	52.90	2.16	41.56	28.46	29.98	100.00	100.00	
3-Nov-11	Industrial Dam	17.11	36.52	44.31	2.06	45.10	16.76	38.13	100.00	100.00	Na-Mg-Cl-SO4
31-Jan-12	Industrial Dam	20.26	34.32	43.45	1.96	46.97	15.51	37.52	100.00	100.00	
30-Apr-12	Industrial Dam	18.91	34.98	44.22	1.89	36.95	21.86	41.19	100.00	100.00	
30-Apr-84	No. 2 Pit	14.72	30.02	54.87	0.40	48.87	23.41	27.72	100.00	100.00	Na-Cl
10-Jan-86	No. 2 Pit	16.40	32.77	50.35	0.47	47.37	23.73	28.90	100.00	100.00	
23-Jun-86	No. 2 Pit	14.62	29.24	55.77	0.37	51.27	22.78	25.95	100.00	100.00	
30-Jun-86	No. 2 Pit	14.11	28.85	56.32	0.71	51.84	18.85	29.31	100.00	100.00	
15-Sep-86	No. 2 Pit	14.52	29.23	55.91	0.35	53.18	21.78	25.04	100.00	100.00	
20-Nov-86	No. 2 Pit	12.91	29.62	57.09	0.38	52.55	19.85	27.60	100.00	100.00	
21-Jan-87	No. 2 Pit	12.54	29.97	57.03	0.47	53.34	17.76	28.89	100.00	100.00	
18-Mar-87	No. 2 Pit	12.63	28.55	58.17	0.65	53.82	18.23	27.95	100.00	100.00	
18-May-87	No. 2 Pit	13.39	29.99	56.20	0.42	51.93	19.83	28.24	100.00	100.00	
22-Jul-87	No. 2 Pit	13.43	28.35	57.80	0.42	52.79	19.90	27.31	100.00	100.00	
18-Aug-87	No. 2 Pit	14.55	28.23	56.70	0.53	51.45	19.90	28.65	100.00	100.00	
24-Dec-87	No. 2 Pit	12.13	31.69	55.61	0.57	54.30	16.20	29.50	100.00	100.00	
15-Feb-88	No. 2 Pit	10.85	32.40	56.19	0.56	54.84	14.95	30.20	100.00	100.00	
28-Apr-88	No. 2 Pit	14.31	33.41	51.83	0.45	47.69	23.80	28.51	100.00	100.00	
30-Aug-88	No. 2 Pit	13.75	30.77	54.78	0.70	55.04	18.01	26.95	100.00	100.00	
2-Nov-88	No. 2 Pit	13.98	30.00	55.12	0.91	54.56	15.90	29.53	100.00	100.00	
29-Dec-88	No. 2 Pit	15.40	29.28	54.45	0.88	53.69	15.06	31.26	100.00	100.00	
22-Feb-89	No. 2 Pit	14.56	29.09	54.92	1.43	54.38	15.10	30.52	100.00	100.00	
4-May-89	No. 2 Pit	14.80	28.84	55.12	1.24	49.13	19.00	31.87	100.00	100.00	
7-Aug-89	No. 2 Pit	18.08	28.62	52.01	1.30	49.51	19.57	30.92	100.00	100.00	
20-Oct-89	No. 2 Pit	15.75	28.73	54.32	1.20	49.75	15.56	34.69	100.00	100.00	
29-Nov-89	No. 2 Pit	16.77	28.19	54.54	0.50	51.29	17.42	31.28	100.00	100.00	
5-Feb-90	No. 2 Pit	17.53	28.91	52.17	1.39	48.74	18.19	33.07	100.00	100.00	Na-Ca-Mg-HCO3-SO4
19-Apr-90	No. 2 Pit	26.03	27.15	44.91	1.91	45.32	22.32	32.36	100.00	100.00	
19-Jun-90	No. 2 Pit	20.76	27.72	49.99	1.52	46.52	24.07	29.40	100.00	100.00	
11-Jul-90	No. 2 Pit	19.95	28.60	49.90	1.56	46.43	21.56	32.01	100.00	100.00	
30-Aug-90	No. 2 Pit	22.86	27.90	47.83	1.41	43.72	24.76	31.52	100.00	100.00	
19-Jan-91	No. 2 Pit	21.16	27.13	50.20	1.51	42.16	26.72	31.12	100.00	100.00	
14-Mar-91	No. 2 Pit	28.19	25.23	44.93	1.65	41.76	35.21	23.03	100.00	100.00	
17-May-91	No. 2 Pit	25.10	27.59	45.75	1.56	40.33	32.88	26.79	100.00	100.00	
14-Aug-91	No. 2 Pit	23.55	24.90	50.01	1.55	40.50	30.08	29.42	100.00	100.00	
14-Nov-91	No. 2 Pit	24.77	27.85	45.64	1.73	39.61	29.59	30.80	100.00	100.00	
16-Jan-92	No. 2 Pit	24.86	26.28	47.23	1.63	41.55	33.11	25.34	100.00	100.00	
24-Mar-92	No. 2 Pit	23.35	26.34	48.74	1.57	39.96	32.21	27.83	100.00	100.00	
9-Jun-92	No. 2 Pit	24.35	25.46	48.67	1.52	40.37	33.58	26.04	100.00	100.00	
14-Aug-92	No. 2 Pit	24.38	27.45	46.65	1.52	38.96	33.46	27.58	100.00	100.00	
26-Oct-92	No. 2 Pit	25.01	26.58	46.99	1.42	39.86	32.26	27.88	100.00	100.00	
24-Dec-92	No. 2 Pit	24.38	26.22	48.05	1.36	40.58	32.42	27.00	100.00	100.00	

	Surface Water	PERCENTAGE meq/L OF TOTAL CATION/ANION									
		Ca	Mg	Na	K	Cl	CO3 + HCO3	SO4	Cations	Anions	Water Type
		(% meq)	(% meq)	(% meq)	(% meq)	(% meq)	(% meq)	(% meq)			
23-Jun-09	Tailings Dam	37.06	47.01	15.53	0.40	7.06	11.57	81.37	100.00	100.00	Mg-Ca-SO4
8-Oct-09	Tailings Dam	35.84	39.72	23.92	0.52	24.90	4.60	70.50	100.00	100.00	
30-Nov-09	Tailings Dam	36.37	36.42	26.61	0.60	27.14	5.15	67.71	100.00	100.00	
17-Mar-10	Tailings Dam	35.79	34.03	29.37	0.81	25.99	6.87	67.14	100.00	100.00	
2-Jun-10	Tailings Dam	37.62	36.18	25.50	0.70	24.59	1.88	73.53	100.00	100.00	
28-Sep-10	Tailings Dam	27.53	41.91	29.54	1.02	27.22	0.09	72.69	100.00	100.00	
7-Apr-11	Tailings Dam	29.00	38.36	31.60	1.04	29.03	9.20	61.76	100.00	100.00	
30-Apr-86	Stockpile Dam	16.03	35.51	47.97	0.49	42.88	25.48	31.64	100.00	100.00	Na-Cl
23-Jun-86	Stockpile Dam	13.64	30.93	54.99	0.44	57.52	18.90	23.58	100.00	100.00	
15-Sep-86	Stockpile Dam	14.74	31.90	52.99	0.38	52.49	22.18	25.33	100.00	100.00	
1-Oct-86	Stockpile Dam	16.22	37.74	45.45	0.59	41.94	23.67	34.39	100.00	100.00	
20-Nov-86	Stockpile Dam	11.75	29.95	57.75	0.55	55.27	20.43	24.30	100.00	100.00	
21-Jan-87	Stockpile Dam	10.35	30.45	58.67	0.53	63.39	16.66	19.95	100.00	100.00	
18-Mar-87	Stockpile Dam	9.65	27.42	62.34	0.60	68.32	13.77	17.91	100.00	100.00	
18-May-87	Stockpile Dam	10.04	27.97	61.50	0.49	66.87	14.94	18.20	100.00	100.00	
22-Jul-87	Stockpile Dam	9.27	26.22	64.10	0.41	69.79	15.72	14.49	100.00	100.00	
18-Aug-87	Stockpile Dam	9.18	27.42	62.99	0.41	71.25	16.20	12.55	100.00	100.00	
24-Dec-87	Stockpile Dam	7.47	31.39	60.62	0.53	68.81	18.06	13.13	100.00	100.00	
15-Feb-88	Stockpile Dam	7.63	30.86	60.85	0.66	69.25	14.98	15.77	100.00	100.00	
28-Apr-88	Stockpile Dam	8.18	29.52	61.68	0.61	69.62	14.41	15.97	100.00	100.00	
30-Jun-88	Stockpile Dam	7.87	28.98	62.50	0.65	72.17	14.52	13.32	100.00	100.00	
30-Aug-88	Stockpile Dam	8.91	30.99	59.46	0.64	70.07	15.72	14.21	100.00	100.00	
2-Nov-88	Stockpile Dam	9.46	30.76	59.23	0.55	68.73	18.18	13.09	100.00	100.00	
3-Jan-89	Stockpile Dam	11.15	28.35	59.95	0.55	68.26	16.10	15.64	100.00	100.00	
28-Feb-89	Stockpile Dam	9.20	28.96	61.24	0.60	69.42	15.51	15.07	100.00	100.00	
4-May-89	Stockpile Dam	9.35	29.68	60.53	0.44	68.69	16.74	14.57	100.00	100.00	
9-Aug-89	Stockpile Dam	9.42	30.21	59.89	0.47	68.90	20.42	10.68	100.00	100.00	
20-Oct-89	Stockpile Dam	10.20	28.26	61.00	0.54	68.42	20.18	11.40	100.00	100.00	
27-Nov-89	Stockpile Dam	9.30	26.40	63.81	0.49	69.90	19.05	11.05	100.00	100.00	
7-Feb-90	Stockpile Dam	7.23	29.28	62.99	0.50	67.99	21.27	10.75	100.00	100.00	
26-Apr-90	Stockpile Dam	4.73	30.83	63.95	0.49	66.75	15.87	17.38	100.00	100.00	
21-Jun-90	Stockpile Dam	8.98	29.61	60.96	0.44	67.58	18.05	14.37	100.00	100.00	
27-Aug-90	Stockpile Dam	11.85	31.48	56.05	0.62	57.32	24.65	18.03	100.00	100.00	
7-Nov-90	Stockpile Dam	11.40	30.98	57.02	0.60	64.03	21.99	13.98	100.00	100.00	
18-Jan-91	Stockpile Dam	9.13	27.61	62.63	0.62	63.72	17.71	18.56	100.00	100.00	
12-Mar-91	Stockpile Dam	10.58	29.50	59.53	0.39	64.35	23.40	12.26	100.00	100.00	
17-May-91	Stockpile Dam	11.31	32.26	55.96	0.47	62.35	25.21	12.44	100.00	100.00	
15-Aug-91	Stockpile Dam	10.66	28.52	60.30	0.52	68.12	21.02	10.86	100.00	100.00	
14-Nov-91	Stockpile Dam	10.49	30.44	58.50	0.57	64.10	21.79	14.11	100.00	100.00	
16-Jan-92	Stockpile Dam	11.53	27.82	60.03	0.62	62.88	22.36	14.77	100.00	100.00	
24-Mar-92	Stockpile Dam	11.57	27.29	60.50	0.64	61.08	22.10	16.82	100.00	100.00	
9-Jun-92	Stockpile Dam	11.32	26.66	61.50	0.53	60.91	24.51	14.58	100.00	100.00	
14-Aug-92	Stockpile Dam	10.66	28.53	60.32	0.50	65.71	22.71	11.57	100.00	100.00	
26-Oct-92	Stockpile Dam	8.45	30.36	60.63	0.56	67.95	20.06	11.99	100.00	100.00	
24-Dec-92	Stockpile Dam	11.28	28.33	59.76	0.62	63.14	20.84	16.02	100.00	100.00	
3-Nov-11	Stockpile Dam	15.56	42.25	40.08	2.11	40.86	8.88	50.26	100.00	100.00	Na-Mg-SO4
31-Jan-12	Stockpile Dam	19.82	39.80	38.50	1.88	39.79	9.18	51.03	100.00	100.00	
30-Apr-12	Stockpile Dam	19.02	34.74	44.89	1.35	32.25	13.21	54.54	100.00	100.00	
27-Aug-90	East Dam. Dam wall.	23.51	38.77	35.14	2.58	27.52	69.86	2.62	100.00	100.00	Na-Mg-HCO3
17-Sep-90	East Dam. Dam wall.	18.87	39.61	38.88	2.64	33.87	64.04	2.08	100.00	100.00	
18-Jan-91	East Dam. Dam wall.	25.58	34.52	37.51	2.38	34.73	64.37	0.90	100.00	100.00	
16-Jan-92	East Dam. Dam wall.	17.03	28.09	51.97	2.91	46.79	52.66	0.55	100.00	100.00	
14-Aug-92	East Dam. Dam wall.	26.57	31.30	39.70	2.43	36.72	62.94	0.34	100.00	100.00	
24-Dec-92	East Dam. Dam wall.	16.93	30.71	50.18	2.17	47.50	49.58	2.92	100.00	100.00	Na-Cl-HCO3
14-Jul-93	East Dam. Dam wall.	19.64	27.76	50.87	1.73	45.89	44.50	9.61	100.00	100.00	
23-Sep-93	East Dam. Dam wall.	22.47	26.72	49.20	1.61	45.02	45.37	9.61	100.00	100.00	
3-Nov-11	Ned's Nest	14.36	23.68	61.03	0.92	26.32	68.10	5.58	100.00	100.00	Na-HCO3
31-Jan-12	Ned's Nest	14.73	52.43	32.44	0.40	22.77	73.11	4.12	100.00	100.00	
30-Apr-12	Ned's Nest	24.39	48.26	26.93	0.42	19.99	79.68	0.33	100.00	100.00	

APPENDIX C

COMPARISON OF SITE WATER QUALITY

TO AUSTRALIAN GUIDELINES

Appendix C - Site Water Quality Compared to Australian Guidelines

Drinking Water Guidelines (ADWG 6, 2011)

	pH_field	TDS	SO4	Cl	Ca	Na	F	Al_diss	Al_tot	As_diss	As_tot	Cd_diss	Cd_tot	Cu_diss	Cu_tot	Cr_diss	Cr_tot	Fe_diss	Fe_tot	Hg_diss	Hg_tot	Mn_diss	Mn_tot	Mo_diss	Mo_tot	Pb_diss	Pb_tot	Sb_diss	Sb_tot	Zn_diss	Zn_tot
	pH Unit	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2011 (Health)	-	-	500	-	-	-	1.5	-	-	0.01	0.01	0.002	0.002	2	2	0.05	0.05	-	-	0.001	0.001	0.5	0.5	0.05	0.05	0.01	0.01	0.003	0.003	-	-
ADWG 2011 (Aesthetic)	6.5-8.5	600	250	250	-	180	-	0.2	0.2	-	-	-	-	1	1	-	-	0.3	0.3	-	-	0.1	0.1	-	-	-	-	-	-	3	3
Groundwater Samples																															
Count	243	279	279	280	-	281	71	71	197	71	71	71	71	71	194	71	71	71	197	71	71	71	185	71	71	71	71	71	71	71	182
Max	10.25	101000	3550	4660	-	2470	1	8.83	260	0.138	0.205	0.009	0.0206	0.033	6.320	0.002	0.105	45.8	944	0	0	11.4	13.2	0.033	0.054	0.003	0.457	0.000	0.002	3.690	16.000
Min	3.82	0	1	0.04	-	26	0.1	0.01	0.01	0.001	0.001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.06	0.05	0	0	0.001	0.001	0.001	0.001	0.003	0.001	0.000	0.001	0.005	0.005
Mean	7.29	2252	332	621	-	375	0.2	0.76	4.5	0.014	0.037	0.001	0.003	0.004	0.070	0.001	0.011	2.80	12.26	#DIV/0!	#DIV/0!	0.533	0.512	0.005	0.010	0.003	0.039	#DIV/0!	0.002	0.126	0.247
Median	7.36	618.5	30	65	-	61	0.1	0.04	0.13	0.003	0.007	0.0002	0.001	0.002	0.003	0.001	0.004	0.565	0.41	#NUM!	#NUM!	0.062	0.111	0.004	0.005	0.003	0.005	#NUM!	0.002	0.014	0.032
Exceedences (Health)			68		-		0			8	21	3	4	0	1	0	2			0	0	16	44	0	2	0	16	0	0		
Exceedences (Aesthetic)	(pH <6.5) = 25	144	53	54	-	56		0	0					0	2			21	79			30	86							1	2
	(pH > 8.5) = 5																														
Surface Water Samples																															
Count	340	520	483	454	-	457	154	62	61	62	65	62	65	62	65	39	52	139	151	39	40	73	131	39	51	62	64	21	17	62	65
Max	10.95	6800	3400	1000	-	710	0.7	3.8	13	0.006	12	0.003	0.0101	0.016	0.025	0.001	0.29	0.88	17	0	0.7	2.8	3.78	0.049	0.2	0.022	0.04	0.002	0	1.3	1.3
Min	6.15	70	1	6.7	-	11	0.012	0.006	0.008	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0	0.006	0.007	0	0.7	0.001	0.001	0.001	-0.05	0.001	0.001	0.002	0	0.001	0.002
Mean	8.19	854	242	215	-	160	0.3	0.19	0.92	0.003	0.390	0.001	0.004	0.003	0.005	0.001	0.027	0.11	1.10	#DIV/0!	0.7	0.162	0.345	0.010	0.047	0.012	0.009	0.002	#DIV/0!	0.100	0.070
Median	8.2	600	115	140	-	120	0.22	0.028	0.11	0.002	0.002	0.001	0.002	0.002	0.003	0.001	0.009	0.06	0.29	#NUM!	0.7	0.02	0.1	0.005	0.010	0.012	0.002	0.002	#NUM!	0.013	0.016
Exceedences (Health)			59		-		0			0	1	1	2	0	0	0	1			0	1	7	23	0	9	1	3	0	0		
Exceedences (Aesthetic)	(pH <6.5) = 2	258	44	26	-	2		0	0					0	0			12	70			16	63							0	0
Exceedences (Aesthetic)	(pH > 8.5) = 87																														

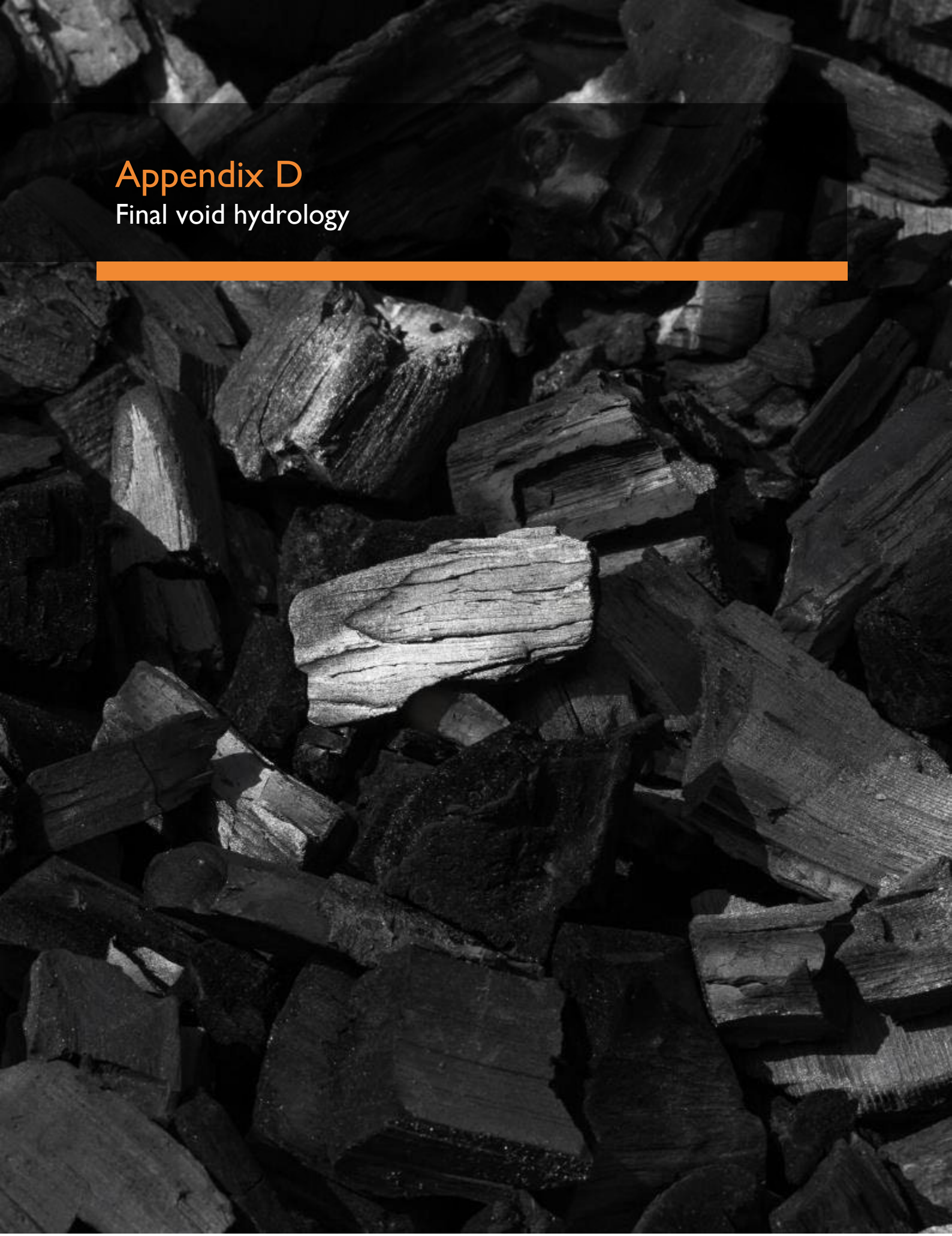
Stock Water Guidelines (ANZECC 2000)

	pH_field	TDS	SO4	Cl	Ca	Na	F	Al_diss	Al_tot	As_diss	As_tot	Cd_diss	Cd_tot	Cu_diss	Cu_tot	Cr_diss	Cr_tot	Fe_diss	Fe_tot	Hg_diss	Hg_tot	Mn_diss	Mn_tot	Mo_diss	Mo_tot	Pb_diss	Pb_tot	Sb_diss	Sb_tot	Zn_diss	Zn_tot
	pH Unit	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ANZECC (2000) Stock	6.0 - 8.5 (groundwater)	4000*	1000	-	1000	-	2	5	5	0.5-5	0.5-5	0.01	0.01	1	1	1	1	-	-	0.002	0.002	-	-	0.15	0.15	0.1	0.1	-	-	20	20
	6.0 - 9.0 (surface water)																														
Groundwater Samples																															
Count	243	279	279	-	234	-	71	71	197	71	71	71	71	71	194	71	71	-	-	71	71	-	-	71	71	71	71	-	-	71	182
Max	10.25	101000	3550	-	531	-	1	8.83	260	0.138	0.205	0.009	0.0206	0.033	6.320	0.002	0.105	-	-	0	0	-	-	0.033	0.054	0.003	0.457	-	-	3.690	16.000
Min	3.82	0	1	-	2	-	0.1	0.01	0.01	0.001	0.001	0.0001	0.0001	0.001	0.001	0.001	0.001	-	-	0	0	-	-	0.001	0.001	0.003	0.001	-	-	0.005	0.005
Mean	7.29	2252	332	-	120	-	0.2	0.76	4.5	0.014	0.037	0.0011	0.0028	0.004	0.070	0.001	0.011	-	-	#DIV/0!	#DIV/0!	-	-	0.005	0.010	0.003	0.039	-	-	0.126	0.247
Median	7.36	619	30	-	70	-	0.1	0.04	0.13	0.003	0.007	0.0002	0.0007	0.002	0.003	0.001	0.004	-	-	#NUM!	#NUM!	-	-	0.004	0.005	0.003	0.005	-	-	0.014	0.032
Exceedences	(pH <6) = 8	50	26	-	0	-	0	2	11	0	0	0	1	0	2	0	0	-	-	0	0	-	-	0	0	0	6	-	-	0.000	0.000
Exceedences	(pH >8.5) = 5																														
Surface Water Samples																															
Count	340	520	483	-	193	-	154	62	61	62	65	62	65	62	65	39	52	-	-	39	40	-	-	39	51	62	64	-	-	62.000	65.000
Max	10.95	6800	3400	-	640	-	0.7	3.8	13	0.006	12	0.003	0.0101	0.016	0.025	0.001	0.290	-	-	0	0.7	-	-	0.049	0.200	0.022	0.040	-	-	1.300	1.300
Min	6.15	70	1	-	0	-	0.012	0.006	0.008	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	-0.020	-	-	0	0.7	-	-	0.001	-0.050	0.001	0.001	-	-	0.001	0.002
Mean	8.19	854	242	-	54	-	0.3	0.19	0.9	0.003	0.390	0.0013	0.0038	0.003	0.005	0.001	0.027	-	-	#DIV/0!	0.7	-	-	0.010	0.047	0.012	0.009	-	-	0.100	0.070
Median	8.2	600	115	-	32	-	0.22	0.028	0.11	0.002	0.002	0.001	0.002	0.002	0.003	0.001	0.009	-	-	#NUM!	0.7	-	-	0.005	0.010	0.012	0.002	-	-	0.013	0.016
Exceedences	(pH <6) = 0	2	13	-	0	-	0	0	4	0	1	0	1	0	0	0	0	-	-	0	1	-	-	0	2	0	0	-	-	0	0
Exceedences	(pH >9) = 31																														

* TDS limit of 4000 mg/L for beef cattle, horses, pigs

Freshwater Ecosystem Protection (ANZECC 2000)

	pH_field	TDS	SO4	Cl	Ca	Na	F	Al_diss	Al_tot	As_diss	As_tot	Cd_diss	Cd_tot	Cu_diss	Cu_tot	Cr_diss	Cr_tot	Fe_diss	Fe_tot	Hg_diss	Hg_tot	Mn_diss	Mn_tot	Mo_diss	Mo_tot	Pb_diss	Pb_tot	Sb_diss	Sb_tot	Zn_diss	Zn_tot
	pH Unit	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
99% Species Protection	-	-	-	-	-	-		0.027	0.027	0.001	0.001	0.00006	0.00006	0.001	0.001	0.00001	0.00001	-	-	0.00006	0.00006	1.2	1.2	-	-	0.001	0.001	-	-	0.0024	0.0024
95% Species Protection	-	-	-	-	-	-		0.055	0.055	0.024	0.024	0.0002	0.0002	0.0014	0.0014	0.001	0.001	-	-	0.0006	0.0006	1.9	1.9	-	-	0.0034	0.0034	-	-	0.008	0.008
* Values in blue shading are the trigger values applying to typical *slightly to moderately disturbed systems*																															
Groundwater Samples																															
Count	-	-	-	-	-	-	-	71	197	71	71	71	71	71	194	71	71	-	-	71	71	71	185	-	-	71	71	-	-	71	182
Max	-	-	-	-	-	-	-	8.83	260	0.138	0.205	0.009	0.0206	0.033	6.320	0.002	0.105	-	-	0	0	11.4	13.2	-	-	0.003	0.457	-	-	3.69	16
Min	-	-	-	-	-	-	-	0.01	0.01	0.001	0.001	0.0001	0.0001	0.001	0.001	0.001	0.001	-	-	0	0	0.001	0.001	-	-	0.003	0.001	-	-	0.005	0.005
Mean	-	-	-	-	-	-	-	0.76	4.49	0.014	0.037	0.0011	0.0028	0.004	0.070	0.001	0.011	-	-	#DIV/0!	#DIV/0!	0.533	0.512	-	-	0.003	0.039	-	-	0.126	0.247
Median	-	-	-	-	-	-	-	0.04	0.13	0.003	0.007	0.0002	0.00065	0.002	0.003	0.001	0.004	-	-	#NUM!	#NUM!	0.062	0.111	-	-	0.003	0.005	-	-	0.014	0.032
Exceedences	-	-	-	-	-	-	-	13	69	5	16	6	14	31	117	1	30	-	-	0	0	2	7	-	-	0	29	-	-	53	133
Surface Water Samples	-	-	-	-	-	-	-																								
Count	-	-	-	-	-	-	-	62	61	62	65	62	65	62	65	39	52	-	-	39	40	73	131	-	-	62	64	-	-	62	65
Max	-	-	-	-	-	-	-	3.8	13	0.006	12	0.003	0.0101	0.016	0.025	0.001	0.29	-	-	0	0.7	2.8	3.78	-	-	0.022	0.04	-	-	1.3	1.3
Min	-	-	-	-	-	-	-	0.006	0.008	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0	-	-	0	0.7	0.001	0.001	-	-	0.001	0.001	-	-	0.001	0.002
Mean	-	-	-	-	-	-	-	0.19	0.92	0.003	0.390	0.0013	0.0038	0.003	0.005	0.001	0.027	-	-	#DIV/0!	0.7	0.162	0.345	-	-	0.0115	0.009	-	-	0.100	0.070
Median	-	-	-	-	-	-	-	0.028	0.11	0.002	0.002	0.001	0.002	0.002	0.003	0.001	0.009	-	-	#NUM!	0.7	0.020	0.100	-	-	0.0115	0.002	-	-	0.013	0.016
Exceedences	-	-	-	-	-	-	-	12	39	0	1	1	2	8	21	0	15	-	-	0	1	1	4	-	-	1	6	-	-	18	32



Appendix D
Final void hydrology

This page is intentionally blank.

Blair Athol Coal Mine

Final Void Hydrology Report

TerraCom Resources

Doc. Ref.: BAC-003-B

Date: 5 February 2025

Rev. No.	Doc Ref.	Report Date	Report Author	Reviewer
0 [DRAFT]	BAC-001-A	9 May 2024	AH	MGB
1	BAC-003-B	5 February 2025	AH	MGB

For and on behalf of **HydroBalance**
Environmental and Mine Water Management Solutions



Ashleigh Hackett
Senior Engineer

HydroBalance
Environmental and Mine Water Management Solutions
HydroBalance.au

Matthew Briody (Principal Engineer) E: Matt@HydroBalance.au M: 04 0614 4514
Ashleigh Hackett (Senior Engineer) E: Ashleigh@HydroBalance.au M: 04 6699 2924

Contents

1 Introduction 4

2 Final void geometry 5

3 Model configuration 6

3.1 Modelling approach 6

3.2 Rainfall and evaporation 6

3.3 Catchment runoff 7

3.3.1 Catchment areas 7

3.3.2 AWBM parameters 8

3.4 Salinity of the pit lake 10

3.5 Groundwater interaction 10

4 Final void results 11

4.1 Overview 11

4.2 Final void model results 11

4.2.1 Long-term water level behaviour 11

4.2.2 Long-term salinity 12

4.3 Storm event behaviour 13

4.3.1 Methodology 13

4.3.2 Results 13

5 Summary 15

6 References 16

List of Figures

Figure 2.1 – Final void stage storage curve _____ 5
Figure 3.1 – Distribution of monthly rainfall and evaporation (SILO 1889 - 2023) _____ 6
Figure 3.2 – Final void site catchment and land use mapping _____ 9
Figure 4.1 – Final void long-term predicted void water level _____ 12
Figure 4.2 – Final void long-term predicted salinity concentration and load _____ 13

List of Tables

Table 3.1 – Final void catchment and land use areas _____ 7
Table 3.2 – Adopted AWBM parameters _____ 8
Table 3.3 – Adopted salinity concentrations _____ 10
Table 3.4 – Groundwater inflows/outflows _____ 10
Table 4.1 – Final void modelling results summary _____ 12
Table 4.2 – Final void storm event modelling results _____ 14
Table 4.3 – Final void storm event modelled freeboard _____ 14

1 Introduction

The Blair Athol Coal Mine (BAC) is an open cut coal mine located approximately 15 kilometres (km) northwest of Clermont, within the Bowen Basin in Central Queensland. BAC is owned by TerraCom Resources (TerraCom) and is currently operated under the Environmental Authority EPML00876713 (the EA).

TerraCom seek to amend the EA, to change the designation of the proposed final landform from a post-mining land use (PMLU) to a non-use mining area (NUMA). HydroBalance was engaged by SGM Environmental, on behalf of TerraCom, to undertake a void hydrology assessment to support the application to amend the EA.

HydroBalance has modelled the long-term final void hydrology and water quality behaviour of the BAC final void over a 500-year period post-closure to inform whether the final void would be safe, stable and non-polluting. This report outlines the methodology and assessment of the expected final void pit lake behaviour, which has been modelled using the GoldSim water balance simulation software.

2 Final void geometry

The final landscape of BAC is a depressed landform. This depressed landform has formed from historic mining, incorporating in-pit backfilled spoil which sits atop a mined pit shell. A digital elevation model (DEM) of the mined pit shell and the final landform (i.e. the final surface expected at the end of the mine life) was provided by TerraCom.

Due to the topography of the site, any rainfall/runoff which flows through the site reports to the final void which would form at the lowest elevation. This water would be stored within the final landform, as well as in the backfilled spoil both below and adjacent to the final landform, which has the potential to store water within the spoil pore space. WRM Water & Environment previously undertook investigations (for Glencore at the neighbouring Clermont operation) into estimating the percentage of pore storage within the in-pit spoil at BAC, using site observations over a period of around 6 months in 2020. The spoil pore storage was estimated to be 2.5%. This spoil pore capacity has been adopted for this study.

For this study, a hybrid stage-storage curve was generated to account for the volume of water stored within the final void and the sub-surface volume of water stored within the backfilled spoil in the pit shell below and beside the final landform. Figure 2.1 shows the hybrid stage-storage curve derived for the final void.

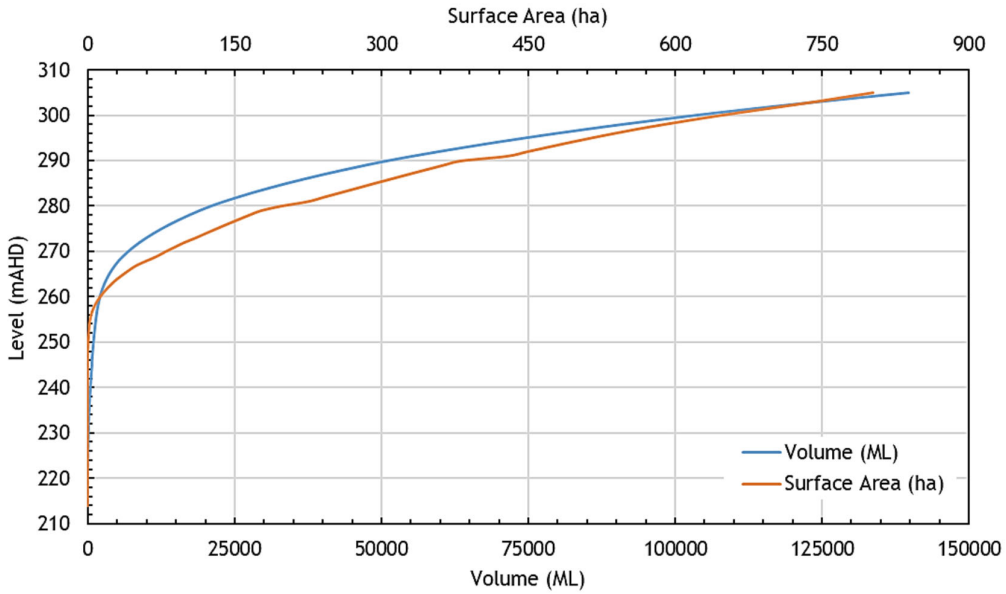


Figure 2.1 – Final void stage storage curve

3 Model configuration

3.1 Modelling approach

The GoldSim water balance model was used to simulate the long-term void water level behaviour, salinity, and the interaction between the pit lake water and the regional groundwater table. Water levels in the residual voids would vary over time, depending on the prevailing climatic conditions, and the balance between evaporation losses and inflows from rainfall, surface runoff, and groundwater.

The GoldSim model was used to simulate the generation, movement, and loss of water on a daily time-step within the final void, over a 500-year period. The volume of water in the void was calculated at each time-step as the sum of direct rainfall to the void surface, catchment runoff, and groundwater inflows, less evaporation losses. The model also tracks the quantity of salt captured and stored within the system.

Key components of the model are summarised in the following sub-sections, including descriptions of key model inputs, assumptions, and sensitivity parameters.

3.2 Rainfall and evaporation

Long-term daily rainfall and evaporation data for the area from January 1889 to December 2023 (135 years) obtained from the Department of Environment and Science (DES) SILO database forms the basis of the simulation (DES, 2022).

Morton's Lake evaporation has been used to estimate evaporation losses from storages. Figure 3.1 shows the long-term monthly averages for Morton's lake evaporation and rainfall data.

The 135 years of SILO rainfall and evaporation data was repeated three times to create an indicative long-term (500 year) climate sequence.

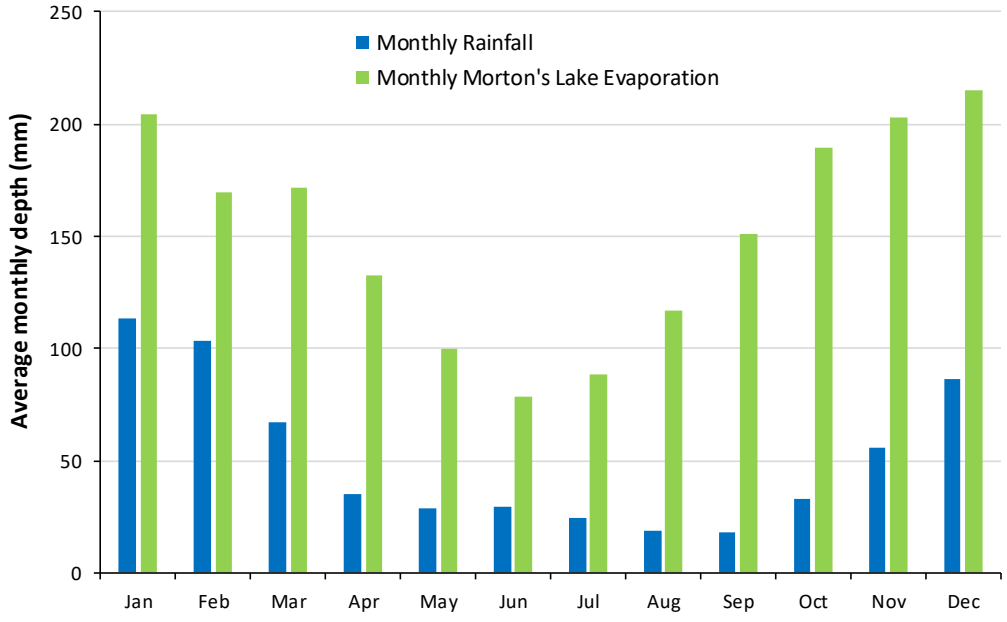


Figure 3.1 – Distribution of monthly rainfall and evaporation (SILO 1889 - 2023)

Evaporation from the final void pit lake is impacted by the final void geometry. The pit walls shade the pit lake which reduces the hours of direct sunlight on the pit lake and reduces evaporation. The depth of the pit lake below natural surface can reduce wind velocities, which increases humidity at the pit lake surface

and reduces evaporation. A pit evaporation factor is applied to the daily evaporation to account for these factors.

The shape of the pit lake at BAC changes as the water level increases. Initially, the lake is contained within the 'pit' footprint. As the water level increases, the pit lake takes on a shape that is more like a conventional lake rather than a pit lake. However, due to the mine having a 'depressed' landform, the pit lake may still have some sheltering effects from wind.

To simulate this variation in the pit lake shape, the evaporation rate has been varied through the application of a pan factor. The pan factor has been applied to the pit lake in the following way:

- Pan factor of 0.7 when the water level is at the floor of the final landform (approximately 246 mAHD – 59 m below the pit crest);
- as the water level increases, the evaporation factor increases linearly to 0.8 at 275 mAHD (30 m below the pit crest) when the pit lake shape begins to reflect conventional lakes; and
- as the water level increases above 275 mAHD, the pan factor increases linearly to 1 at 305 mAHD (the pit overflow level).

3.3 Catchment runoff

3.3.1 Catchment areas

The final landform catchment area has been generated using the final landform surface provided by TerraCom. The land use areas outside of the long-term void lake were generated using the latest aerial of the site, which differentiates mining from undisturbed areas.

The final void catchment has been characterised into the following land use types:

- natural/undisturbed, representing areas in their natural state;
- spoil, representing infrastructure, overburden, stockpile and haul roads; and
- rehabilitated spoil, representing established rehabilitated spoil areas.

The area covered by the maximum water level of the void pit lake has been assumed as spoil. All other disturbed areas within the mine footprint have been assumed as rehabilitated spoil, as it is understood that these areas will be rehabilitated post-mining.

It is assumed that the East Diversion and West Diversion would have sufficient hydraulic capacity to convey the 1 in 1,000 year annual exceedance probability (AEP) (or 0.1% AEP) flood event. Hence, the clean water catchment associated with these diversions has not been included in the final void catchment area.

Figure 3.2 shows the catchment boundary and land uses assumed for the final void. The catchment and land use values used in the GoldSim model are shown in Table 3.1.

Table 3.1 – Final void catchment and land use areas

Landuse type	Area (ha)
Natural/undisturbed	72.2
Spoil	291.6
Rehabilitated spoil	1,186.7
Total	**1,550.5**

3.3.2 AWBM parameters

Catchment runoff has been modelled using the AWBM rainfall-runoff model. The adopted rainfall runoff parameters are based on Water Solutions (2012). The AWBM parameters from the model have been summarised in Figure 3.2.

Table 3.2 – Adopted AWBM parameters

Parameter	Undisturbed	Spoil	Rehabilitated spoil
A1	0.2	0.1	0.1
A2	0.4	0.9	0.9
A3	0.4	0	0
C1 (mm)	70	12	12
C2 (mm)	105	38	125
C3 (mm)	210	0	0
Cavg (mm)	140	35.4	113.7
BFI	0	1	0.3
Kbase	0	0.997	0.997
Ksurf	0	0	0
Cv	9%	25%	14%

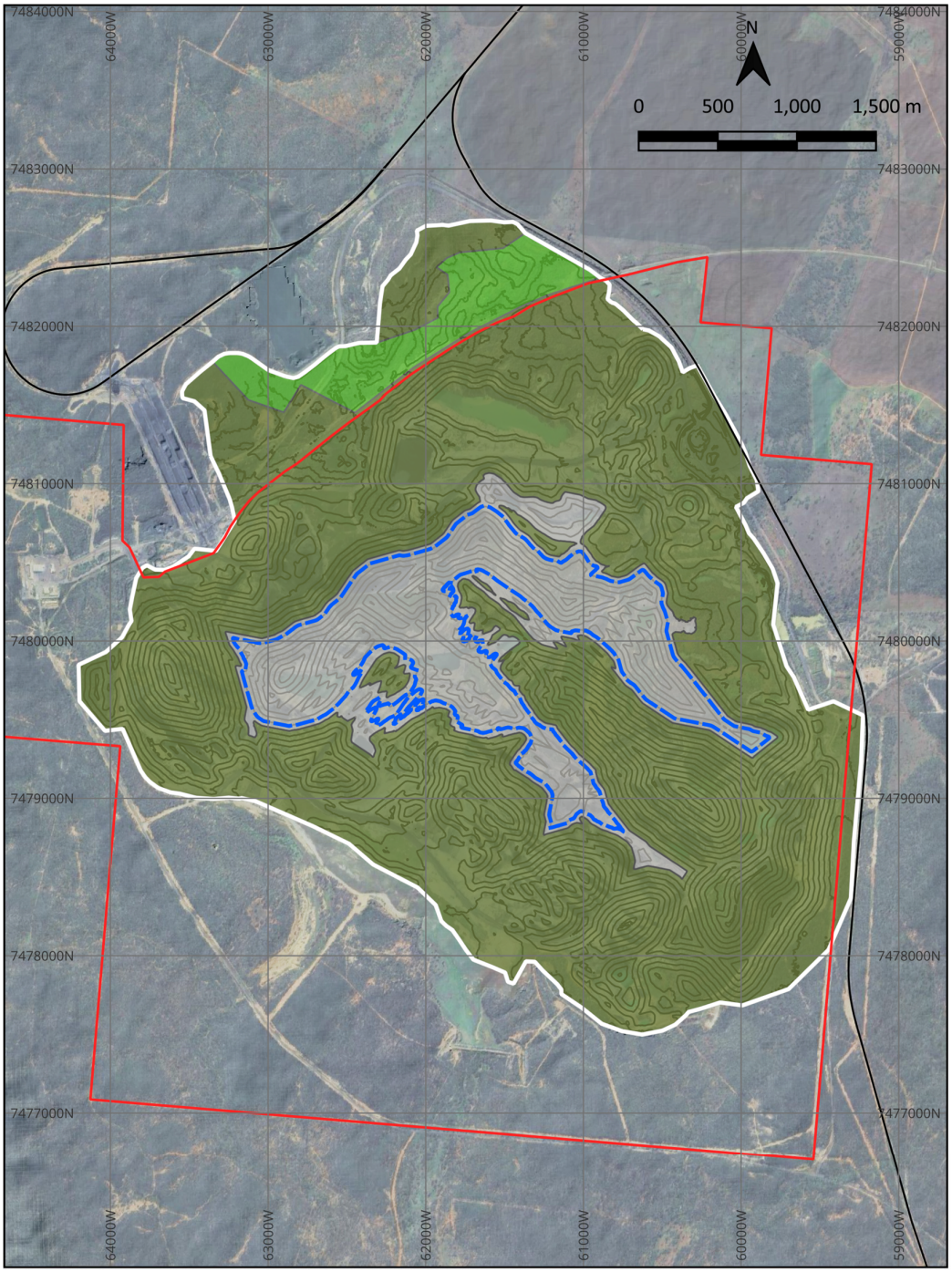


Figure 3.2 – Final void site catchment and land use mapping

3.4 Salinity of the pit lake

Sources of salinity in the final void pit lake include:

- runoff and seepage from the final void catchments; and
- groundwater inflows.

The water balance model was configured to use salinity as an indicator of water quality. This was achieved by assigning representative electrical conductivity (EC) concentrations to runoff from catchments and other sources of water.

The adopted salinity values for different land uses are based on Water Solutions (2012) as well as recent water quality monitoring data and are shown in Table 3.3. The adopted salinity for groundwater was provided by Hydrogeologist.com.au in January 2025 and is based on the median EC of site monitoring bores in the Blair Athol Coal Measures and basalt aquifers.

Salinity from baseflow (seepage) through the spoil and the rehabilitated spoil is the same as surface flow. We recommend geochemistry of the spoil be assessed to understand the potential salinity generation from spoil for both surface and baseflow.

Table 3.3 – Adopted salinity concentrations

Source	Salinity (µS/cm)	Reference
Natural/Undisturbed	290	Average result of surrounding natural waterways taken in 2019/2020 (Ecological Services, 2019, 2020)
Spoil	4,150	Average result of Ramp 1 Transfer in 2019/2020
Rehab Spoil	500	Water Solutions (2012)
Groundwater	986	Hydrogeologist.com.au (2025 advice)

3.5 Groundwater interaction

Hydrogeologist.com.au (2024) completed a groundwater assessment for BAC, relating the expected groundwater interactions to the pit lake water level. The outcomes of the groundwater assessment are presented in Table 3.4. The estimated groundwater recharge level is expected to be approximately 304.52 mAHD, based on the groundwater assessment. The estimated groundwater recharge level is the level at which the pit lake transitions from a sink to a source.

Table 3.4 – Groundwater inflows/outflows

Final void water level (mAHD)	Groundwater flux* (ML/d)
250	-3.10
260	-2.84
270	-2.52
280	-2.14
290	-1.62
300	-0.92
304.5	-0.014
310	3.20

* negative flux values represent groundwater inflows entering the final void.

4 Final void results

4.1 Overview

The final void was modelled using the assumptions outlined in Section 3 and the results are outlined in Section 4.2. In addition, an extreme event analysis was undertaken on the final void and is analysed in the results are outlined in Section 4.3.

4.2 Final void model results

4.2.1 Long-term water level behaviour

The final void water level was modelled over a 500-year period and is shown in Figure 4.1. The model results show:

- The final void initially rapidly collects water, rising from its starting level (approximately 229 mAHD) up to the void floor (at 246 mAHD) within a year. This represents the sub-surface storage of the void (i.e. backfilled spoil under the final void) reaching capacity, before the void collects water above the backfilled surface and forms a permanent pit lake.
- The final void reaches equilibrium after about 75 years, with the void oscillating between approximately 276.0 and 284.1 mAHD. The modelled average long-term water level is 280.3 mAHD.
- The final void forms a long-term groundwater sink based on the estimated groundwater recharge level of 304.52 mAHD (as shown on Figure 4.1).
- The maximum modelled water level is about 20.9 m below the pit overflow level (equivalent to 108,569 ML freeboard) and about 20.4 m below the estimated groundwater recharge level (equivalent to 104,776 ML freeboard).
- The average modelled water level is about 24.7 m below the pit overflow level (equivalent to 118,151 ML freeboard) and about 24.2 m below the estimated groundwater recharge level (equivalent to 114,359 ML freeboard).

Table 4.1 shows a summary of the storage details of the residual voids and the results of the water balance modelling.

The extent of the long-term average final void water level is presented in Figure 3.2, and is equal to a surface area of 206 ha.

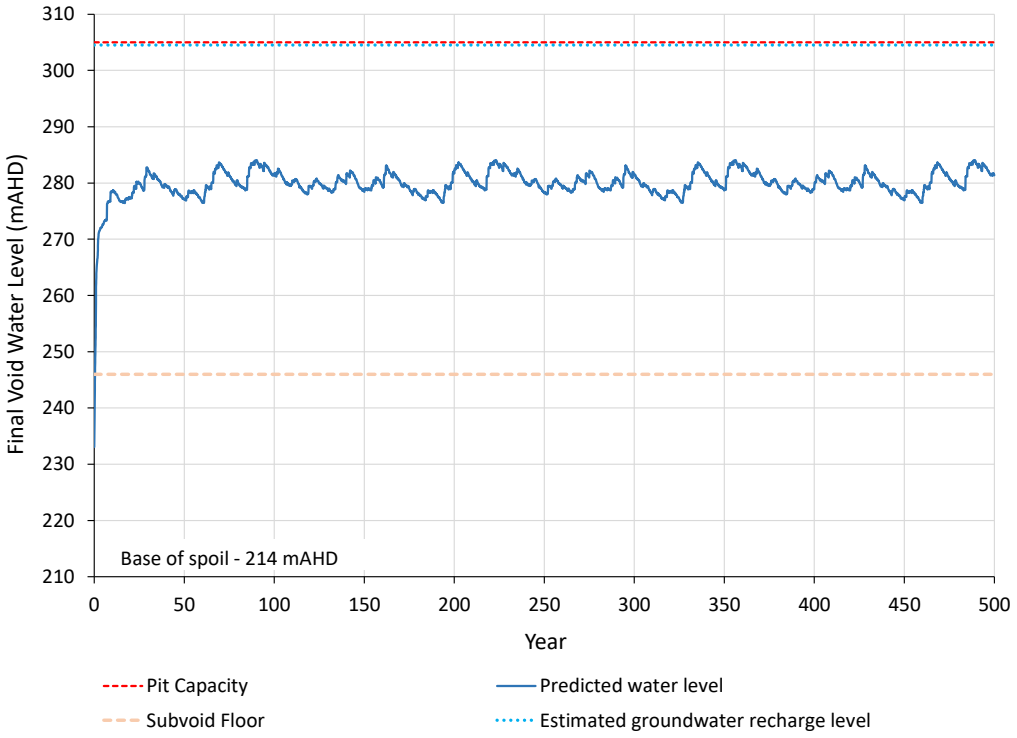


Figure 4.1 – Final void long-term predicted void water level

Table 4.1 – Final void modelling results summary

Parameter	Elevation (mAHD)
Void sub-floor level	214.0
Final landform floor level	246.0
Overflow level	305.0
Estimated groundwater recharge level	304.52
Modelled average long-term water level	280.3
Modelled peak long-term water level	284.1

4.2.2 Long-term salinity

The modelled long-term salinity of the final void is shown in Figure 4.2.

The model results show that the salinity of the pit lake progressively increases, rising to over 25,000 µS/cm after about 250 years and reaching a maximum salinity of approximately 55,000 µS/cm. The salt load also progressively increases, reaching about 900,000 tonnes after the 500-year modelled period.

This outcome is expected for closed-loop systems with no mechanism for salt removal.

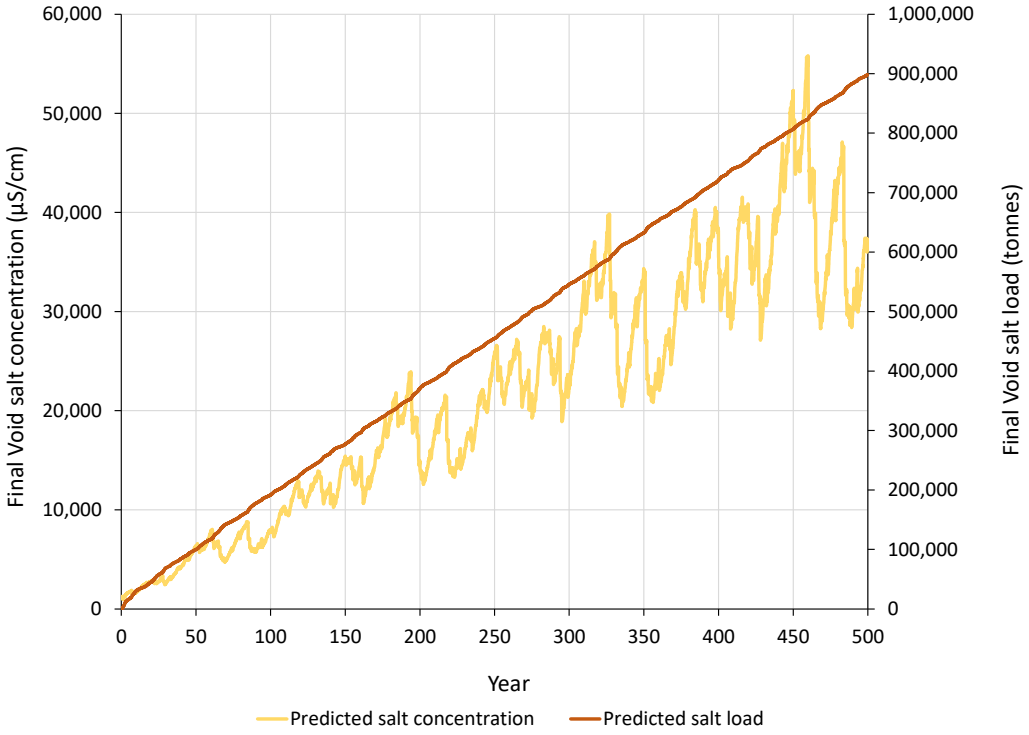


Figure 4.2 – Final void long-term predicted salinity concentration and load

4.3 Storm event behaviour

4.3.1 Methodology

An assessment of the impact of storm events on the water level in the final void has been undertaken. The potential for discharge of void water has been assessed for the following design rainfall events using 72-hour (3 day) rainfall depths:

- 1 in 100 annual exceedance probability (AEP) (or 1% AEP);
- 1 in 1,000 AEP (or 0.1% AEP);
- 1 in 2,000 AEP (or 0.05% AEP); and
- Probable Maximum Precipitation (PMP).

The maximum water level simulated in the final void water balance modelling was conservatively adopted as the initial condition for the storm event analysis. As outlined in Table 4.1, this was 284.1 mAHD (i.e. approximately 31,000 ML).

Design rainfall depths for the above events were estimated using standard procedures in Australian Rainfall and Runoff (ARR) (Ball et al., 2019). The runoff generated from the storm events have been conservatively calculated assuming 100% of runoff reports to the void (i.e. no losses) from the surface catchment reporting to the void (1,550 ha).

4.3.2 Results

The results of the storm event analysis are outlined in Table 4.2. The results show that even during a storm event with rainfall depths equivalent to the 1 in 2,000 AEP 72-hour storm, there would be a minor impact on the level of water in the final void. Simulated water level increases for such an event are in the order of

2.7 m. The 1 in 2,000 AEP design event peak water level is therefore 18.2 m below the void crest and 17.7 m below the estimated groundwater recharge level.

The modelled freeboard water levels and volumes following the storm surge events are presented in Table 4.3.

Table 4.2 – Final void storm event modelling results

Storm event (AEP)	Rainfall depth (mm)	Runoff volume (ML)	Final volume (ML)	Final level (mAHD)	Water level change (m)
1 in 100	327	5,070	36,263	285.8	1.7
1 in 1,000	489	7,582	38,775	286.6	2.5
1 in 2,000	545	8,450	39,643	286.8	2.7
PMF	1,770	27,444	58,637	291.8	7.7

Table 4.3 – Final void storm event modelled freeboard

Storm event (AEP)	Freeboard between pit lake surface and pit overflow level		Freeboard between pit lake surface and estimated groundwater recharge level	
	Water level (m)	Volume (ML)	Water level (m)	Volume (ML)
1 in 100	19.2	103,498	18.7	99,706
1 in 1,000	18.4	100,987	17.9	97,194
1 in 2,000	18.2	100,118	17.7	96,326
PMF	13.2	81,125	12.7	77,332

5 Summary

A GoldSim water balance model was developed to assess the long-term water level and salinity behaviour at the BAC final void. The final landscape at BAC forms a depressed landform, with a significant volume of sub-surface storage within backfilled spoil. A hybrid stage-storage curve using a spoil pore capacity of 2.5% was used in this analysis.

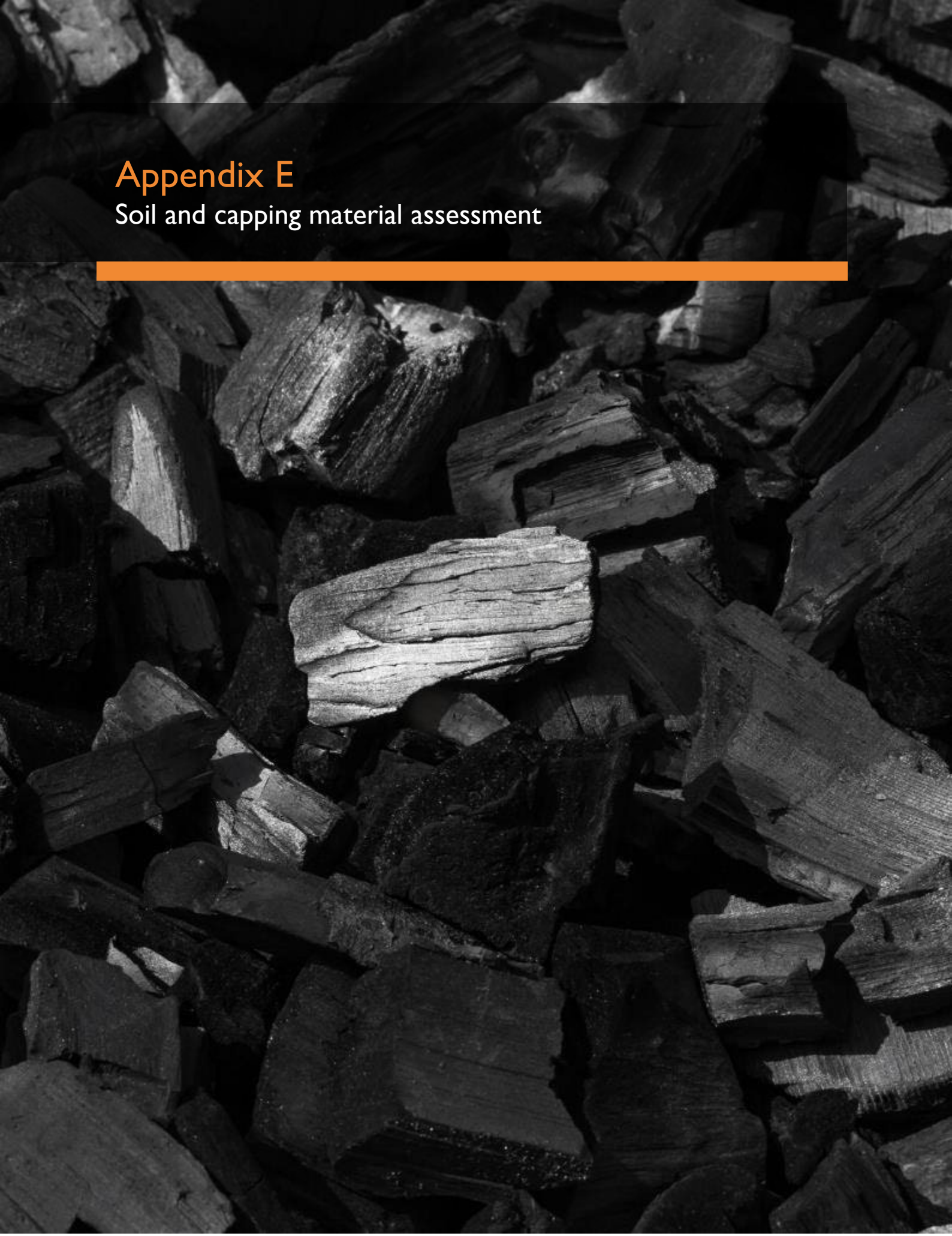
The final void was modelled for a 500-year period following mine closure. The final void model results showed the following:

- the final void rises above the sub void floor and forms a permanent pit lake after approximately 1 year;
- the final void reaches equilibrium after about 75 years, with the void oscillating between approximately 276.0 and 284.1 mAHD;
- the final void forms a long-term groundwater sink based on the estimated groundwater recharge level of 304.52 mAHD;
- the maximum modelled water level is about 20.9 m below the void overflow level and about 20.4 m below the estimated groundwater recharge level; and
- the salinity of the pit progressively increases over the simulation, reaching a maximum salinity of approximately 55,000 µS/cm.

An extreme storm event analysis was undertaken on the final void, conservatively assuming 100% runoff and an initial water level at the maximum level modelled over the 500-year period. The extreme storm analysis showed that an extreme event does not have a significant impact on the final void, with a 1 in 2,000 AEP 3-day storm increasing the final void water level by 2.7 m. This level is 18.2 m below the void crest and 17.7 m below the estimated groundwater recharge level.

6 References

Ball J et al, 2019	*Australian Rainfall and Runoff: A Guide to Flood Estimation,* Commonwealth of Australia.
DES, 2022	*The Department of Environment and Science (DES) SILO climate data. (2024).* Retrieved 1 May 2024, from https://legacy.longpaddock.qld.gov.au/silo/
Ecological Services Professional, 2020	*Blair Athol Mine Receiving Environment Monitoring Program 2019 Report,* Prepared for Orion Mining Pty Ltd. June 2019.
Hydrogeologist.com.au, 2023	*Blair Athol Coal Mine PRCP Groundwater Assessment.* Prepared for Terracom Ltd. Project number 4031. 16 January 2023.
Hydrogeologist.com.au, 2024	*Blair Athol Numerical Groundwater Modelling Report.* Prepared for Terracom Ltd. Project number 4158. 8 May 2024.
Hydrogeologist.com.au, 2025	*Email advice relating to median groundwater quality,* dated 17 January 2025.
JBT Consulting, 2012	Blair Athol Mine Closure Groundwater Investigation
Terracom, 2018	*'Residual Void Management Plan – Blair Athol Coal Mine'* Prepared by WSP on behalf of Terracom Mining, June 2018
Water Solutions, 2012	*RTCA – Blair Athol Coal/Clermont Coal Mine OPSIM Water Management Update & Review 2012*



Appendix E

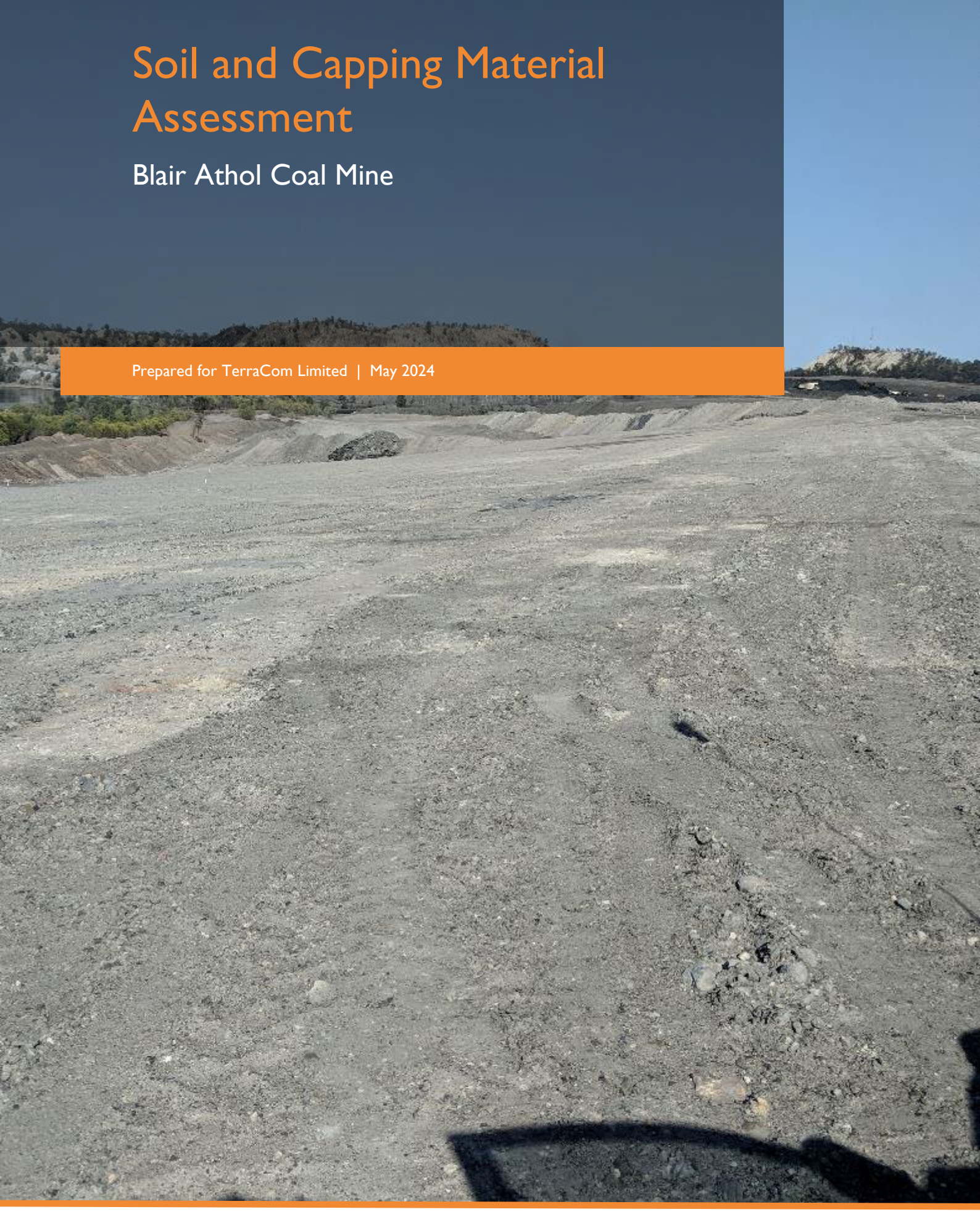
Soil and capping material assessment

This page is intentionally blank.

Soil and Capping Material Assessment

Blair Athol Coal Mine

Prepared for TerraCom Limited | May 2024



TerraCom

SGM environmental

This page is intentionally blank

Soil and Capping Material Assessment

Blair Athol Coal Mine

Prepared for TerraCom Limited | 17 May 2024

Project number:	22B031
Document title:	Soil and Capping Material Assessment | Blair Athol Coal Mine
Revision:	V2-3
Date:	17 May 2024
Client:	TerraCom Limited
Project manager:	D Borombovits
Author:	D Borombovits, H Vogler

Legal Name:	SGM Environmental Pty Limited		
Address:	PO Box 5622, Stafford Heights, Qld 4053		
ACN:	621 989 866	ABN:	65 621 989 866
Representative:	Timothy Rohde	Phone:	+61 7 3148 6288
Email:	trohde@sgmenvironmental.com		



Honest | Trust | Innovation | Safety

This Report is provided to you the abovenamed Client (Client, you or your) in respect of the above Project and in accordance with our Standard Terms. Capitalised terms that are not specifically defined in this Report have the meanings given to them in our Standard Terms.

© Copyright 2023 SGM Environmental Pty Limited. The concepts and information contained in this document are the property of SGM Environmental Pty Limited. Use or copying of this document in whole or in part without the written permission of SGM Environmental Pty Limited constitutes an infringement of copyright.

Data / confidentiality: This report contains information and data that is confidential and / or subject to restrictions in respect of Intellectual Property Rights (IP). Readers agree to be bound by confidentiality and IP provisions contained in our Standard Terms and the obligation not to cause any damage or hardship to SGM Environmental Pty Limited or the Client.

Document history and status

Revision	Date	Description	By	Review	Approved
V0-1	14/08/23	Draft	H Vogler	D Borombovits	T Rohde
V1-1	18/08/23	Draft	H Vogler	TCL	T Rohde
V1-2	07/05/24	Final draft	H Vogler	D Borombovits	T Rohde
V2-3	17/05/24	Final	D Borombovits	TCL	T Rohde

Table of contents

1.0 Introduction 1
1.1 Blair Athol Coal Mine 1
1.1.1 Location 1
1.2 Purpose and scope 1
2.0 Material characterisation 2
2.1 Soil 2
2.2 Spoil 3
2.2.1 Risk 3
2.2.2 Spoil 3
2.2.3 Co-disposal 4
3.0 Material quantities 5
3.1 Soil 5
3.2 Spoil 7
4.0 Required quantities for rehabilitation 8
4.1 Soil 8
4.2 Spoil 9
5.0 Conclusions 10
5.1 Material characterisation 10
5.1.1 Soil 10
5.1.2 Spoil 10
5.2 Material excess / deficit 10
5.2.1 Soil 10
5.2.2 Spoil 10
5.3 Recommendations 10
References 11

Table

Table 1 Soil nutrient ranges for rehabilitation 2
Table 2 Soil inventory 5
Table 3 Additional soil volumes 6
Table 4 Domain categories per mitigation strategy 8

Important note about your report

This Report is provided for the exclusive use of the Client pursuant to the Scope of Works dated 12 October 2022, which requires us to provide Services relating to a soil capping and material assessment (the assessment).

This Report is provided to the Client on the terms and conditions set out in the Standard Terms of SGM Environmental Pty Limited (SGME, we, us or our).

We derive data in this Report from information (or confirmation of the absence thereof) sourced from the Client, designated laboratories and / or information that has been made available in the public domain at the time or times outlined in this Report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the assessment and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this Report.

SGME has prepared this Report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to any applicable standards, guidelines, procedures and practices outlined in the Scope of Works as at the date of issue of this Report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this Report, to the extent permitted by law.

This Report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by SGME for use of any part of this Report in any other context.

Reporting of the assessment are based on a desktop assessment of data that has been measured by TerraCom Limited and other third parties.

SGME does not accept any Liability whatsoever for, or in respect of, any use of, or reliance upon this Report by any person contrary to the above or our Standard Terms.

1.0 Introduction

1.1 Blair Athol Coal Mine

Blair Athol Coal Mine (the Mine) is an open-cut coal mining operation owned and operated by TerraCom Limited (TCL). It was previously operated by Blair Athol Coal Pty Ltd, a subsidiary of Rio Tinto, in the 1980s until it was put into care and maintenance in 2012. Small scale mining operations date back to the 1890s.

TCL via its subsidiary bought the Mine grant of title transfer from the Queensland Government in 2017. The acquisition means that TCL can efficiently reshape and restore one of Queensland's oldest coal mines while effectively retrieving remnant resources.

1.1.1 Location

The Mine is approximately (~) 240 kilometres (km) south-west of Mackay and ~17 km north-west of Clermont in Central Queensland. The Blair Athol State Forest adjoins the west of the Mine; the Apsley State Forest is located to the south-east.

1.2 Purpose and scope

This soil and capping material assessment (the assessment) has been prepared to support the *Progressive Rehabilitation and Closure Plan* (PRC Plan). It includes the following sections, having regard for *Guideline: Progressive rehabilitation and closure plans (PRC plans)* (the PRC plan guideline):

- soil and spoil characterisation — Section 2.0;
- available quantities of soil and spoil for rehabilitation — Section 3.0;
- required quantities for successful rehabilitation — Section 4.0; and
- conclusions — Section 5.0.

2.0 Material characterisation

This section is a desktop review of the following reports:

- *Blair Athol Mine Landform Review, Testing and Design Parameters* (SKM 2012);
- *Coal Handling and Preparation Plant – CHPP Management Report* (TerraCom 2017a);
- *Disposal Plan* (SGME 2020);
- *Rehabilitation Monitoring Report – April 2021* (Earthtrade 2021); and
- *Soil and Spoil Characterisation and Suitability* (Highlands Environmental 2018).

2.1 Soil

SKM (2012) identified three soil types, including: Vertosols, Sodosols and Podosols. When soils become mixed during mining and reshaping for rehabilitation, they are Anthroposols (generically called soils herein). SGME (2020) summarised the outcomes of several reports and found that although some soil stockpiles are acceptable there are a number of stockpiles that require amelioration to meet recommended nutrient ranges (Table 1).

Table 1 Soil nutrient ranges for rehabilitation

Parameter	Ideal range[1]
pH	6.0 – 7.5
Organic carbon	Great than (>) 1% (preferably >2%)
Colwell phosphate (P)	6 parts per million (ppm)
Calcium: magnesium ratio (Ca:Mg)	>1.5:1
Electrical conductivity (EC)	0.4 deciSiemens per metre (dS/m)
Exchangeable sodium percentage (ESP)	Less than (<) 6%
Clay plus silt particle size	<30%

1. Agricultural industry benchmarks sourced from Rayment & Bruce 1984, Baker & Eldershaw 1993, Department of the Environment and Resource Management (DERM) 2011, Hazelton & Murphy 2016 and Peverill, Sparrow & Reuter 1999.

Although nutrient ranges vary slightly depending on the report, the outcomes are the same. The *Soil and Spoil Characterisation and Suitability* report (Highlands Environmental 2018) supports the summarisation done by SGME (2020) in that soils may need amelioration to satisfy rehabilitation outcomes due to salinity and nutrient deficiencies.

SGME (2023a, 2023b) supports early findings for soil because soil testing indicates that it is:

- moderately alkaline;
- restricted plant growth from elevated exchangeable sodium (Na);
- restricted plant growth from elevated exchangeable magnesium (Mg);
- there is limited Ca exchangeable cations;
- there is limited potassium (K) exchangeable cations;
- exchangeable Ca % is dominated and cation exchange capacity (CEC) are outside of the desirable range;
- there is enough CEC indicating stored inherent fertility;
- base saturation indicates negligible past leaching; and
- dominated by Mg, and Ca is low — soil has potential for dispersion;
- ESP is <6 indicating it is non-sodic and unlikely to be dispersive; and
- Emerson class number suggests it maybe sodic and dispersive.

2.2 Spoil

SGME (2020) states that historically, mineral wastes generated at the Mine include:

- spoil;
- overburden;
- interburden;
- coal rejects and fine tailings from the coal wash plant; and
- backfill material from underground workings.

It should be noted that once delivered to a landform spoil, overburden and interburden become intermingled and are the same unit from a rehabilitation perspective.

2.2.1 Risk

SGME (2020) completed a risk assessment of mineral waste and determined the risk of acid mine drainage (AMD) as very low. The results indicate:

- Spoil is a low-risk mineral waste with low sulfur contents (average 0.05% sulfur) and low to high acid neutralising capacity (ANC).
- Coal rejects are a high-risk mineral waste but do not contain enrichment of metals. With a previous study also indicating that approximately equal portions of the samples tested indicated potential to either form or not form AMD. Coal rejects also have potential to be a medium-risk mineral (where there is limited AMD potential).
- Tailings are a high-risk mineral waste.

Sodicity is another environmental risk that is of concern for mineral waste because strongly sodic materials increase the risk of erosion. ESP has been classified as follows:

- <6% — non-sodic;
- 6-15% — sodic;
- 15-30% — strongly sodic; and
- >30% — very strongly sodic.

2.2.2 Spoil

Low-risk mineral waste (spoil) is an asset for rehabilitation. Where practical low-risk waste can be used as a capping material for high-risk mineral waste, coal rejects, tailings and waste coal.

Fertility and erosion potential analysis indicates that it is:

- moderately alkaline;
- restricted plant growth from elevated exchangeable Na;
- there is limited Ca and K exchangeable cations;
- exchangeable Mg and Na cations are excessive and plant performance may be hindered;
- CEC is low, indicating potential fertility issues;
- base saturation indicates negligible past leaching; and
- spoil is dominated by Mg and is Ca deficient — soil has potential for dispersion;
- ESP is > 6 indicating potential for slaking and dispersion;
- the ESP result is supported by the Emerson class number (dispersive).

2.2.3 Co-disposal

The co-disposal of tailings and coal rejects has been occurring since closure of the tailings dam. This has created a mix of high-risk material that is disposed of together to minimise environmental impacts (TerraCom 2017a).

3.0 Material quantities

This section is a desktop review of the following reports that give the current quantities of soil and spoil:

- *Coal Handling and Preparation Plant – CHPP Management Report* (TerraCom 2017a);
- *Growth Media – Mitigation & Management Strategy* (TerraCom 2017b);
- *Growth Media – Mitigation & Management Strategy* (TerraCom 2020a); and
- TerraCom internal stockpile inventory data sheet (2024).

3.1 Soil

The *Growth Media* report by TerraCom (2020a) uses the 2017 *Growth Media* report (TerraCom 2017b) to adjust soil quantities. These inventories were reviewed internally by TerraCom in 2024. An additional seven locations were also identified in TerraCom (2020a) with suitable soil for rehabilitation. Amalgamated soil inventory, including stockpile ID, soil type and volume are in Table 2.

Table 2 Soil inventory

Soil ID	Soil type	Volume (cubic metres (m^3))
TSP_01	Unknown	14,185.46
TSP_02	Unknown	12,852.03
TSP_03	Sodosol	23,485.50
TSP_04	Vertosol	23,818.79
TSP_05	Vertosol	155.72
TSP_06	Vertosol	92,978.30
TSP_07	Vertosol	18,899.56
TSP_08	Vertosol	30,349.50
TSP_09	Vertosol	5,589.00
TSP_10	Sodosol	28,125.00
TSP_11	Sodosol	29,459.04
TSP_12	Sodosol	27,759.00
TSP_13	Sodosol	3,049.72
TSP_14	Sodosol	10,717.32
TSP_15	Sodosol	37,919.67
TSP_16	Sodosol	8,551.86
TSP_17	Sodosol	4,422.28
TSP_18	Vertosol	38,710.49
TSP_19	Sodosol	14,725.50

Soil ID	Soil type	Volume (cubic metres (m^3))
TSP_20	Sodosol	12,768.00
TSP_21	Kandosol	20,740.45
TSP_22	Sodosol	9,300.94
TSP_23	Vertosol	54,549.40
TSP_24	Sodosol	1,276.52
TSP_25	Sodosol	9,826.50
TSP_26	Sodosol	2,479.50
TSP_27	Sodosol	10,535.37
TSP_28	Unknown	35,975.00
TSP_29	Sodosol	4,005.72
TSP_30	Kandosol	10,813.19
TSP_31	Kandosol	147,748.13
TSP_32	Sodosol	9,366.21
TS0803	Kandosol	5,397.97
TS0906A	Kandosol	5,473.09
TS0913A	Vertosol	8,965.00
TS0913B	Vertosol	23,018.80
TS0913C	Vertosol	7,305.40
TS0913D	Vertosol	5,130.30
Total	-	810,429.23

Table 3 gives the seven additional soil volumes and locations. It should be noted that these locations do not have soil ID or soil type information.

Table 3 Additional soil volumes

Soil location	Volume (m^3)
In situ topsoil from south pit clearance	21,909.00
Black soil / subsoil	27,708.00
In situ soil from the train load out (TLO) rail side	42,000.00
In situ topsoil from TLO crusher pad	36,000.00
In situ soil from south pit boxcut	116,555.70
Reclaimed soil from west pit rehabilitation	64,953.00

Soil location	Volume (m^3)
TLO sediment pond	2,938.00
Total	312,063.70

There is ~1,122,492.93 m^3 of soil available for rehabilitation.

3.2 Spoil

There is no specific spoil registry, TCL moves waste constantly during mining. The *CHPP Management Plan* (2017a) estimates that ~18,000,000 bank cubic metres of spoil is moved annually.

4.0 Required quantities for rehabilitation

This section is a desktop review of the following reports:

- *Environmental Management Overview Strategy* (*EMOS*) (Blair Athol Coal Project 1992);
- *Final void hydrology report* (WRM 2023);
- *Growth Media – Mitigation & Management Strategy* (TerraCom 2020a);
- *Plan of Operations* (*PoO*) *1 April 2019 – 31 July 2020* (TerraCom 2020b);
- *Rehabilitation Management Plan* (WSP 2020); and
- *Residual Void Management Plan* (RVMP) (WSP 2018).

4.1 Soil

The *Growth Media* report (TerraCom 2020a) provides a section on the required soil requirements for rehabilitation. Disturbance is separated by domain areas. The areas are further separated against mitigation strategies. Table 4 gives the domains and the desired mitigation strategy.

Table 4 Domain categories per mitigation strategy

Domain	Area (hectare (ha)	Topsoil	Strip placement	Hydro mulch	Direct seed	Not required
Exploration						
	29.4	-	-	-	29.4	-
Infrastructure						
Topsoil stockpiles	40.7	-	-	-	-	40.7
Haul road	86.3	-	86.3	-	-	-
Minor roads	34.9	-	-	-	-	34.9
CHPP	12.6	-	12.6	-	-	-
Industrial area	46.4	-	46.4	-	-	-
Laydown areas	19.2	-	-	-	19.2	-
TLO	12.0	-	-	-	-	12.0
Borrow pits	2.3	-	2.3	-	-	-
Spoil						
Reshaped areas	64.6	64.6	-	-	-	-
Spoil	493.8	493.8	-	-	-	-
Tailings						
Tailings beach	6.6	6.6	-	-	-	-
Pits						
Active pit	84.0	84.0	-	-	-	-

Domain	Area (hectare (ha)	Topsoil	Strip placement	Hydro mulch	Direct seed	Not required
Water management						
Voids	72.2	-	-	-	-	72.2
Storages	26.0	-	-	-	-	26.0
Miscellaneous						
Cleared	8.6	-	-	-	-	8.6
Creeks & diversions	66.0	-	18.2	17.5	-	30.3
Historical Rehab – RIO	344.5	-	-	-	-	344.5
Rehabilitation – TER	102.9	-	-	-	-	102.9
Proposed rehabilitation	135.0	135.0	-	-	-	-
Total disturbed	1,688	784.0	165.8	17.5	48.6	672.1

In accordance with EMOS (Blair Athol Project 1992) a 0.15 m thick layer of soil was determined to be suitable. Based on the layer thickness the required volume of soil can be calculated using total area of soil and strip placement (784.0 and 165.8 ha respectively). The total volume of soil required for rehabilitation is 1,300,350 m^3 (1,176,000 m^3 and 124,350 m^3 for soil and strip placement respectively).

4.2 Spoil

The amount of spoil required for rehabilitation purposes has not been clearly defined. However, given the requirements of the EA (specifically condition E9) and the *Rehabilitation Management Plan* (2020) the amount of spoil can be roughly estimated. Due to the closure and rehabilitation of the tailings storage facility (TSF) tailings is no longer disposed of separately to the coal rejects (TerraCom 2020b).

The EA outlines that all coal waste is to be disposed of in voids and covered with at least 5 m of spoil (condition E9) this also covers condition F14 which states all mineral waste with an ESP >30% must be covered with a minimum of one metre of material with an ESP <15%. Table 4 shows the extent of all voids as 72.2 ha. If it is assumed the entire void area is being utilised for disposal, the amount of spoil needed is ~3,610,000 m^3 (at a minimum spoil depth of 5 m).

However, at closure the void will collect water above the backfilled surface and form a permanent lake (WRM 2023). The constant water cover will limit oxygen ingress to coal wastes, negating the requirement of the spoil cover.

5.0 Conclusions

5.1 Material characterisation

5.1.1 Soil

The outcome of several soil characterisations has determined that all soil stockpiles are available for rehabilitation. The majority of soil would benefit from gypsum application due to high salinity. Phosphorus fertiliser may also be needed.

5.1.2 Spoil

The majority of spoil is considered low-risk indicating that it is suitable for use in rehabilitation. Only spoil with an ESP<15% can be used as cover material for the co-disposal waste (high-risk).

5.2 Material excess / deficit

5.2.1 Soil

Based on the desktop review the amount of soil available for rehabilitation is ~1,122,492.93 m^3 (TerraCom 2020a; 2024). From the available reports the required soil quantity for rehabilitation is ~1,300,350 m^3 indicating that there is a soil deficit of ~177,857.07 m^3.

5.2.2 Spoil

There currently is no assessment on the quantity of spoil; however, ~18,000,000 bank cubic metres is moved annually during mining. Based on requirements for rehabilitation (covering coal rejects and tailings) ~3,610,000 m^3 is needed.

5.3 Recommendations

The following recommendations are based on the outcome of this assessment:

- testing of the soil stockpiles before use in rehabilitation, with application of soil ameliorants if required;
- assess the soil volume required for rehabilitation, assess the possibility of replacing soil with spoil (or combination of both);
- determine the actual quantity of useable spoil at the Mine, to determine what is available for rehabilitation and what is not; and
- determine if a water cover will be sufficient as a spoil replacement of the co-disposal material.

References

Baker & Eldershaw 1993, *Interpreting soil analyses — for agricultural land use in Queensland*, Department of Primary Industries.

Blair Athol Coal Project 1992, *Environmental Management Overview Strategy*, prepared for Blair Athol Coal Project.

DERM 2011, *Protecting Queensland's Strategic Cropping Land: Guidelines for Appling the Proposed Strategic Cropping Land Criteria,* Department of Environment and Resource Management.

Earthtrade 2021, *Rehabilitation Monitoring Report – April 2021*, prepared for TerraCom Limited.

Highlands Environmental 2017, *Fertiliser Recommendations for 2017 Rehabilitation*, prepared for TerraCom Limited.

Highlands Environmental 2018, *Soil and Spoil Characterisation and Suitability*, prepared for TerraCom Limited.

Peverill, K, Sparrow, L & Reuter, D 1999, Soil Analysis: An Interpretation Manual, *Catena* 39(2000), pp. 301-303.

Rayment, G E & Bruce, R C 1984, *Soil testing and some soil test interpretations used by the Queensland Department of Primary Industries*, Department of Primary Industries.

SGME 2020, *Disposal Plan: Overburden, Interburden, Spoil, Coal washery Coarse Rejects and Tailings,* prepared for TerraCom Limited by SGM environmental Pty Limited.

SGME 2023a, *WEPP Modelling*, prepared for TerraCom Limited by SGM environmental Pty Limited.

SGME 2023b, *Revegetation Plan*, prepared for TerraCom Limited by SGM environmental Pty Limited.

SKM 2012, *Blair Athol Mine Landform Review, Testing and Design Parameters*, prepared for Rio Tinto Coal Australia.

TerraCom 2017a, *Coal Handling and Preparation Plant – CHPP Management Report*, prepared for TerraCom Limited.

TerraCom 2017b, *Growth Media — Mitigation and Management Strategy*, prepared for TerraCom Limited.

TerraCom 2020a, *Growth Media — Mitigation and Management Strategy*, prepared for TerraCom Limited.

TerraCom 2020b, *Plan of Operations 1 April 2019 – 31 July 2020*, prepared for TerraCom Limited.

URS Australia 2006, *Blair Athol Coal – Geochemical Characterisation of Spoil from Ramp 3 and Ramp 4 Rehabilitation Areas*, prepared for Rio Tinto Coal Australia.

WRM Water & Environment Pty Ltd (WRM) 2023, *Final void hydrology report*, prepared for TerraCom Limited.

WSP 2018, *Residual Void Management Plan*, prepared for TerraCom Limited.

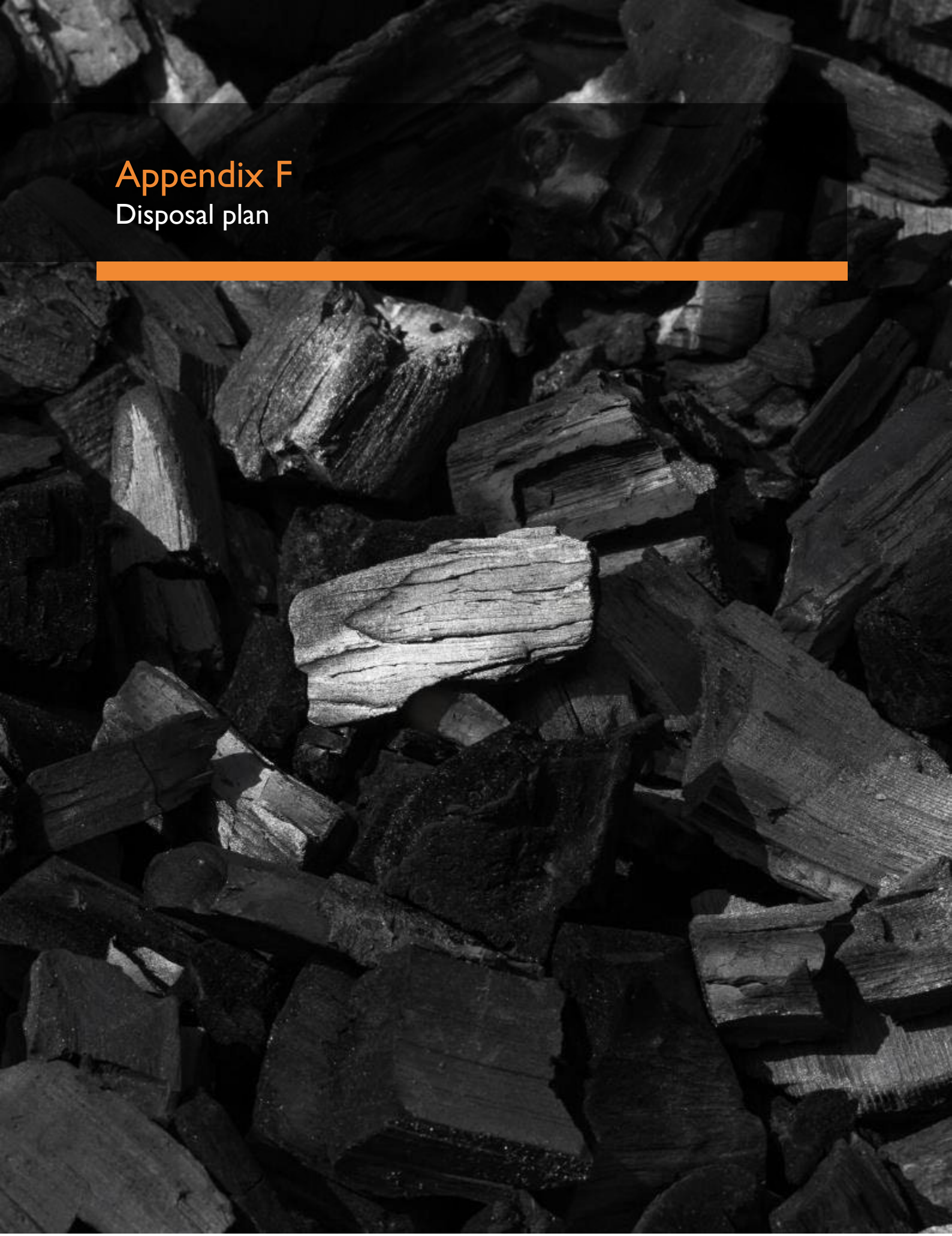
WSP 2020, *Rehabilitation Management Plan*, prepared for TerraCom Limited.

URS Australia 2006, *Blair Athol Coal – Geochemical Characterisation of Spoil from Ramp 3 and Ramp 4 Rehabilitation Areas*, prepared for Rio Tinto Coal Australia.

WRM Water & Environment Pty Ltd (WRM) 2023, *Final void hydrology report*, prepared for TerraComTerraCom Limited.

WSP 2018, *Residual Void Management Plan*, prepared for TerraComTerraCom Limited.

WSP 2020, *Rehabilitation Management Plan*, prepared for TerraComTerraCom Limited.



Appendix F
Disposal plan

This page is intentionally blank.

Disposal Plan

Overburden, Interburden, Spoil, Coal Washery Coarse Rejects and Tailings

Blair Athol Mine

Prepared for TerraCom Limited | October 2020



TERRACOM

SGMenvironmental

This page is intentionally blank

Disposal Plan

Overburden, Interburden, Spoil, Coal Washery Coarse Rejects and Tailings

Blair Athol Mine

Prepared for TerraCom Limited | 29 October 2020

Project number:	18014
Document title:	Disposal Plan | Overburden, Interburden, Spoil, Coal Washery Coarse Rejects and Tailings
Revision:	V3-1
Date:	29 October 2020
Client:	TerraCom Limited
Project manager:	T Rohde
Author:	T Rohde / J Vohland

Legal Name:	SGM Environmental Pty Limited		
Address:	PO Box 5622, Stafford Heights, Qld 4053		
ACN:	621 989 866	ABN:	65 621 989 866
Representative:	T Rohde	Phone:	+61 7 3148 6288
Email:	trohde@sgmenvironmental.com		



Honest | Trust | Innovation | Safety

This Report is provided to you the abovenamed Client (Client, you or your) in respect of the above Project and in accordance with our Standard Terms. Capitalised terms that are not specifically defined in this Report have the meanings given to them in our Standard Terms.

© Copyright 2020 SGM Environmental Pty Limited. The concepts and information contained in this document are the property of SGM Environmental Pty Limited. Use or copying of this document in whole or in part without the written permission of SGM Environmental Pty Limited constitutes an infringement of copyright.

Data / confidentiality: This report contains information and data that is confidential and / or subject to restrictions in respect of Intellectual Property Rights (IP). Readers agree to be bound by confidentiality and IP provisions contained in our Standard Terms and the obligation not to cause any damage or hardship to SGM Environmental Pty Limited or the Client.

Document history and status

Revision	Date	Description	By	Review	Approved
V0-1	21/05/18	Draft	T Rohde	TerraCom	T Rohde
V1-1	12/06/18	Draft	T Rohde	TerraCom	T Rohde
V3-1	29/10/20	Final	J Vohland	TerraCom	T Rohde

Table of contents

1.0 Introduction 1
1.1 Context and purpose 1
1.2 Scope 1
1.3 Objectives 2
2.0 Legal and other requirements 3
2.1 Legal 3
2.1.1 Legislative and leading practice guidelines 3
2.1.2 EA 5
3.0 Site description 7
3.1 Location 7
3.2 Processing 9
3.2.1 Management of high-risk waste 9
3.2.2 Rehabilitation 9
4.0 Risk, past management and material balance 10
4.1 Risk 10
4.1.1 AMD and / or NMD 10
4.1.2 Sodicity 11
4.1.3 Erosion, sedimentation and hydrological issues 12
4.1.4 Spontaneous combustion 12
4.2 Past management 12
4.2.1 Classification 12
4.2.2 Placement 14
4.2.3 Soil quality 17
5.0 Operational controls 18
5.1 Control approaches 18
5.2 Rehabilitation strategy 18
6.0 Monitoring 19
6.1 Topsoil inventory 19
6.2 Mineral waste 19
6.2.1 AMD and / or NMD 19
6.2.2 Spontaneous combustion 19
6.2.3 Erosion potential 19
6.3 Rehabilitation 19
6.4 Surface water and groundwater 20
7.0 Administration 21
7.1 Criteria for assessing this plan 21
7.2 Roles and responsibilities 21
7.3 Training and competence 22

7.4 Review 22
References 23
Appendix A Spontaneous combustion control 24

Figure

Figure 1 Location 8
Figure 2 Locations of waste coal 15

Table

Table 1 Summary of legislative and leading practice guidelines 3
Table 2 EA conditions related to management of mineral waste 5
Table 3 Classification of mineral waste 11
Table 4 Description of waste coal locations 14
Table 5 Operational control procedures 18
Table 6 Soil nutrient ranges for rehabilitation 19
Table 7 Roles and responsibilities 21

Important note about your report

This Report is provided for the exclusive use of the Client pursuant to the Scope of Works 16 October 2020, which requires us to provide Services relating to disposal plan for waste rock, spoil and rejects.

This Report is provided to the Client on the terms and conditions set out in the Standard Terms of SGM Environmental Pty Limited (SGME, we, us or our).

We derive data in this Report from information (or confirmation of the absence thereof) sourced from the Client and their subconsultants, designated laboratories and / or information that has been made available in the public domain at the time or times outlined in this Report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the disposal plan for waste rock, spoil and rejects and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this Report.

SGME has prepared this Report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to any applicable standards, guidelines, procedures and practices outlined in the Scope of Works as at the date of issue of this Report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this Report, to the extent permitted by law.

This Report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by SGME for use of any part of this Report in any other context.

Reporting of the disposal plan for waste rock, spoil and rejects are based on a desktop assessment of data that has been measured by the Client and their subconsultants and other third parties.

SGME does not accept any Liability whatsoever for, or in respect of, any use of, or reliance upon this Report by any person contrary to the above or our Standard Terms.

1.0 Introduction

1.1 Context and purpose

Mineral waste associated with open-pit coal mining often results in issues of concern for mine operators and stakeholders regarding cost and environmental hazards. This is indeed the case at Blair Athol Mine (the mine) where open-pit mining has generated considerable inventories of low risk (non-acid forming (NAF) and / or acid consuming (AC) overburden and interburden) and to a lesser extent medium to high-risk (potentially acid forming (PAF) and / or dispersive coal washery coarse reject (the coal rejects), waste coal, tailings and interburden). Careful management of these inventories in the medium to long-term is essential in achieving the strategic goals of the mine.

Development of the coal resources at the Orion Mining Pty Ltd, a fully owned subsidiary of TerraCom Limited (TerraCom), mine has resulted in the generation of waste rock, spoil, coal rejects and tailings (the mineral waste).

Assessment of mineral wastes have been undertaken at the mine since the start of production in 1983. The focus of the assessments has primarily been on the characterisation of mineral wastes for acid mine drainage (AMD) and / or neutral mine drainage (NMD) (including salinity and sodicity). The assessments show that the risk of AMD and / or NMD is very low.

The results from the assessments indicate that:

- Spoil is low risk mineral waste with low sulfur content and low to high acid neutralising capacity (ANC). Since the landforms contain significant volumes of spoil, there is significant volumes of low risk mineral waste available to cover the smaller volumes of medium or high-risk mineral waste.
- Coal rejects are high-risk mineral waste but do not contain enriched metals. 2007 studies (EGI 2007) indicated that approximately equal portions of the samples tested indicated potentials to form and not form AMD.
- Tailings are high-risk mineral waste.

Additional details on the relevant assessments are provided in Section 4.0.

The purpose of this disposal plan (the plan) is to describe the systems, processes and procedures used at the mine to manage the development of the landforms (the rehabilitation strategy) to minimise environmental risks from AMD and / or NMD.

1.2 Scope

The scope of this plan includes aspects of developing landforms including:

- in-pit landforms;
- out of pit (ex-pit) landforms;
- reshaping of existing spoil landforms from the previous mine operator; and
- open-pits (final voids).

The scope of this plan also includes the development of control measures associated with the permanent storage of high-risk mineral waste. Such structures include containment bunds, covers and erosion control covers including vegetation.

1.3 Objectives

This plan has been designed and developed to provide a framework for the management of mineral waste at the mine.

The objectives of this plan are three-fold:

- minimise the risk of environmental harm by minimising the evolution and release of acid and / or saline / alkaline drainage containing dissolved metals, metalloids and non-metallic inorganic substances (ie AMD and / or NMD);
- confirm that statutory obligations regarding sound mineral waste management and final relinquishment are identified and incorporated into management of the mine; and
- manage the long-term storage of high, medium and low risk mineral waste so they are both physically and chemically stable and that the landforms can support self-sustaining vegetation cover.

2.0 Legal and other requirements

The management of mineral waste in Queensland is subject to several legal and other requirements. A key function of the landform is that it provides permanent storage of mineral waste that can have a potential to cause environmental harm. As a result, this plan seeks to establish a framework of environmental objectives under which the development of the landforms can proceed.

2.1 Legal

2.1.1 Legislative and leading practice guidelines

A summary of legislation and leading practice guidelines that may apply to management of mineral waste, particularly for the construction of the landforms are summarised in Table 1.

Table 1 Summary of legislative and leading practice guidelines

Legislation / guideline	Objective	Obligation or leading practice guideline	Consideration
Planning Act 2016	The principal objective of this act is to achieve ecological sustainability.	Obligation	Where land is included on a mining lease (ML) pursuant to the *Mineral Resources Act 1989*, closure and rehabilitation activities (ie building the landforms) conducted under an environmental authority (EA) do not require a planning approval from the local government.
Environmental Protection Act 1994	To protect the environment while allowing development that improves the total quality of life and ecologically sustainable development.	Obligation	General environmental 'duty of care' to be observed to manage any potential environmental impact from the mine so that it is minimised.
Aboriginal Cultural Heritage Act 2003 which give rise to *Duty of Care Guidelines 2004*	Provide effective recognition, protection and conservation of Aboriginal cultural heritage.	Obligation	All reasonable practical measures need to be taken to manage landform construction activities so that they do not harm Aboriginal cultural heritage, ie demonstrate 'cultural heritage duty of care'. All reasonable practical measures are described in the *Duty of Care Guidelines 2004*.
Environmental Protection (Air) Policy 2019	Specifies air quality indicators and goals to protect environmental values and provides a framework for making	Obligation	Air quality measurement parameters may be taken from the policy ie may be relevant to the management of potential spontaneous combustion.

Legislation / guideline	Objective	Obligation or leading practice guideline	Consideration
	consistent and fair decisions about managing the air environment and involving the community.		
Strategic framework for Mine Closure	States life of mine criteria and rehabilitation guidelines.	Leading practice guideline	May be relevant to landform design.
Environmental Protection (Water) Policy 2009	Provides a framework to develop water quality guidelines to protect Queensland waters and prevent pollution.	Leading practice guideline	Establishes water quality measurement parameters for closure ie after the mine EA has been extinguished.
Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 and *Water Quality Guidelines 2018*	Provide guidelines for the monitoring and management of water ways.	Leading practice guideline	Provides guidance on water monitoring requirements.
Environmental Protection Regulation 2019 and *National Environment Protection (Assessment of Site Contamination) Measure 1999*	National Environmental Protection Measure (NEPMs).	Leading practice guideline	The NEPM allows the development of mine specific clean-up criteria to determine the required level of remediation. These criteria are known as Health Investigation Levels (HIL's).
Department of Minerals and Energy (1995a) Assessment and Management of Acid Drainage	Advice on how to identify, evaluate and deal with mineral waste which have the potential to generate AMD or be affected by products of sulfide oxidation	Leading practice guideline	Procedure for the identification and management of AMD.
Department of Minerals and Energy (1995) Guidelines for the Assessment and Management of Saline/Sodic Waste	Advice on how to identify, evaluate and manage mineral waste which have the potential to be saline or sodic	Leading practice guideline	Indicative criteria for sample analysis test results.
AMIRA (2002) Acid Rock Drainage (ARD) Test Handbook	Test methods and result interpretation to determine the potential for AMD	Leading practice guideline	Indicative criteria for determining high-risk and low risk mineral waste.

Legislation / guideline	Objective	Obligation or leading practice guideline	Consideration
Department of Industry, Innovation and Science Australia (2016) Managing Acid and Metalliferous Drainage, Leading Practice Sustainable Development Program for the Mining Industry	Management of AMD in Australia	Leading practice guideline	Provides guidance specific to Australia on the management of AMD.
International Network for Acid Prevention (INAP) (2009) The Global Acid Rock Drainage Guide (the GARD guide)	Engineered cover and landform design process to limit the potential for AMD	Leading practice guideline	Engineered cover design process should be given due regard in the plan.

2.1.2 EA

The Department of Environment and Sciences (DES) issued EA EPML00876713 (January 2018) to authorise mining activities in accordance with the EA conditions on ML1804. EA conditions that relate to mineral waste management are presented in Table 2 including a cross reference to where they have been addressed in this plan.

Table 2 EA conditions related to management of mineral waste

EA condition	Reference
Condition E9	
Waste products generated on or after the 30 August 2017 from the washing of coal must be disposed of within mining voids and covered with spoil to a depth of at least 5 metres (m)	Note: this condition allows the separation of management processes to deal with the mining that TerraCom is undertaking versus existing mine spoil and wastes. Section 4.2.2.3
Condition E10	
(a) effective characterisation of the waste rock, spoil and rejects to predict under the proposed placement and disposal strategy the quality of runoff and seepage generated concerning potentially environmentally significant effects including salinity, acidity, alkalinity and dissolved metals, metalloids and non-metallic inorganic substances	Section 4.1
(b) a program of progressive sampling and characterisation to identify dispersive and non-dispersive spoil and the salinity, acid and alkali producing potential and metal concentrations of waste rock, spoil and rejects	Section 6.2

EA condition	Reference
(c) a materials balance and disposal plan demonstrating how potentially acid forming and acid forming waste rock, spoil and rejects will be selectively placed and/or encapsulated to minimise the potential generation of acid mine drainage	Section 4.2
(d) where relevant, a sampling program to verify encapsulation and/or placement of potentially acid- forming waste rock, spoil and rejects	Section 5.0
(e) how often the performance of the plan will be assessed	Section 7.4
(f) the indicators or other criteria on which the performance of the plan will be assessed	Section 7.1
(g) a rehabilitation strategy	Section 5.2
(h) monitoring or rehabilitation, research and / or trials to verify the requirements and methods for decommissioning and final rehabilitation of the placed materials, including the prevention and management of acid mine drainage, erosion minimisation and establishment of vegetation cover	Section 0 Appendix A

Condition E11	
The *Waste Rock, Spoil and Rejects Disposal Plan* developed by an appropriately qualified person must be updated and submitted to the administering authority for approval by 30 June 2018. The *Waste Rock, Spoil and Rejects Disposal Plan* must be reviewed and updated by 30 June every 2 years and made available to the administering authority on request	Submission of this plan and future updates (on request) satisfies this condition.
Condition F14	
Coal washery wastes and spoil with exchangeable sodium percentage (ESP) >30% must be covered with a minimum of 1 m of benign material (ie with ESP <15%) prior to rehabilitation commencing	Section 4.2.1

3.0 Site description

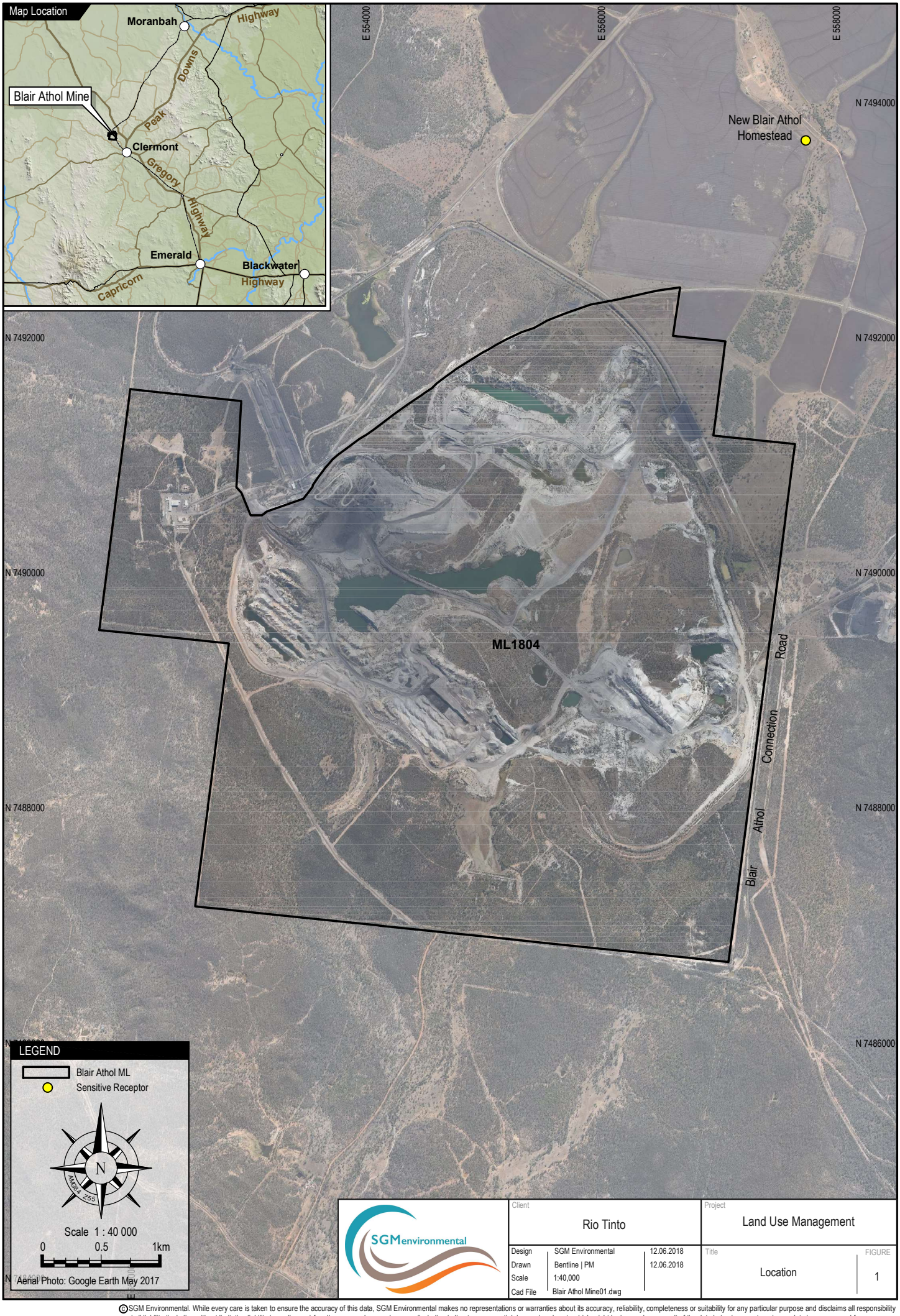
The mine, approved under ML1804 and EA EMPL00876713, is owned and operated by Orion Mining Pty Ltd, wholly owned by TerraCom. TerraCom took over ownership in May 2017 and recommissioning activities commences immediately.

3.1 Location

The mine is located in Clermont, Central Queensland, approximately 14 km north-west of Clermont, approximately 110 km north-west of Emerald, approximately 320 km south-west of Point Abbot, Bowen and approximately 240 km south-west of Hay Point, Mackay.

The mine is located within the Blair Athol Basin, which covers approximately 25 square kilometres (km^2). The surrounding land use at the mine includes state forest, grazing and limited cropping. Blair Athol State Forest adjoins the east, south and west sides of the ML.

Figure 1 shows the location of the nearest sensitive receptors relative to the mine.



SGMenvironmental

Client	Rio Tinto	Project	Land Use Management
Design	SGM Environmental	12.06.2018	
Drawn	Bentline | PM	12.06.2018	
Scale	1:40,000		
Cad File	Blair Athol Mine01.dwg	Title	Location
		FIGURE	1

©SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability (including without limitation liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

3.2 Processing

TerraCom are utilising the pre-existing Coal Handling and Preparation Plant (CHPP) to wash coal and manage coal rejects and tailings disposal.

Thickened tailings will be pumped to the tailings dam with additional inline flocculant added prior to discharge to the dry cells.

Coal rejects will be stockpiled at the CHPP.

3.2.1 Management of high-risk waste

Coal rejects will be co-disposed into the active mining areas and will be covered with spoil. The proposed management strategy has considered:

- environmental aspects — to minimise impacts and footprint;
- resource expectations — to maximise recovery and not interfere with potential reserves by creating a separate impoundment;
- economic constraints — cost effective solution considering the life of mine and water / power consumption;
- flexibility — enable cells to be "taken out" of the processing cycle or allow the addition of extra cells if required, to meet production expectations; and
- rehabilitation — enabling active management of wastes and progressive rehabilitation.

3.2.2 Rehabilitation

The dried tailings will be co-disposed with coal rejects and will have a minimum of 5 m of spoil placed over the top.

4.0 Risk, past management and material balance

Historically, mineral wastes generated at the mine include:

- spoil;
- overburden;
- interburden;
- coal reject and fine tailings from the coal wash plant; and
- backfill material from underground workings.

It should be noted that once delivered to a landform the spoils from dragline operation, overburden and interburden from truck and shovel fleet become intermingled and therefore are the same unit from a rehabilitation perspective. Waste coal from the CHPP and coal rejects generally have been delivered to the coal reject dump adjacent to the Ramp 2 TSF.

Mining undertaken by TerraCom will generate:

- quaternary overburden and spoil of siltstone, sandstone, gravel and clay associated with an open-pit cut-back to access coal seam 4; and
- interburden of sandstone, siltstone and conglomerate associated with the lower coal measures; and
- coal reject and fine tailings from the coal wash plant.

4.1 Risk

Assessment of mineral wastes have been undertaken at the mine since the start of production in 1983. The focus of the assessments has primarily been on the characterisation of mineral wastes for AMD and / or NMD (including salinity and sodicity) as this has been the most significant environmental risk associated with mineral waste. The assessments show that the risk of AMD at the mine is very low.

The results from the assessments indicate that:

- Spoil is low risk mineral waste with low sulfur contents (average 0.05% sulfur) and low to high acid ANC. Since the landforms contain significant volumes of spoil, there is significant volumes of low risk mineral waste available to cover the significantly smaller volume of high-risk mineral waste.
- coal rejects are high-risk mineral waste but do not contain enrichment of metals. 2007 studies (EGI 2007) indicated that approximately equal portions of the samples tested indicated potentials to form and not form AMD.
- Tailings are high-risk mineral waste.

Additional details on the relevant assessments are provided in the following sections.

4.1.1 AMD and / or NMD

AMD and / or NMD are potential environmental risks at the mine.

When mineral waste that contains sulfide (high-risk mineral waste) is exposed to air and rain, a reaction occurs with the sulfides and metals (the constituents) in the mineral waste which results in a change in the characteristics of the water that drains off. The acidic water mobilises constituents such as heavy metals and sulfate (oxidised sulfide) resulting in drainage that can lead to significant and long-lasting harm to the receiving environment. This phenomenon is widely known as AMD.

Medium-risk mineral waste at the mine may contain sulfide, the most common being iron-sulfide or pyrite. When sulfidic medium-risk mineral waste is subjected to fragmentation (from mining), its surface area is increased. In

addition, fragmentation also allows oxygen and water from the atmosphere to meet the now exposed sulfide. The availability of pyrite, in the presence of water and oxygen drives an oxidation reaction described in Equation 1 (EQ1).

$FeS_2 + 15/4O_2 + 7/2\ H_2O \rightarrow Fe(OH)_3 + 2SO_4^{2-}(aq) + 4H+(aq)$ EQ 1

Pyrite oxygen water iron hydroxide sulfate acid

Medium and low risk mineral waste that has been historically produced at the mine is summarised in Table 3.

Table 3 Classification of mineral waste

Low risk (no AMD and / or NMD potential)	Medium-risk (limited AMD potential)
Spoil/overburden	coal rejects
Interburden	Coal washery fine tailings
Coal seam 3 roof coal	Coal seam 4 roof and floor
Coal seam 3 and seam 4 interburden	
Coal contaminated with underground mining backfill	

Potential AMD risk from mining by TerraCom is associated with coal reject and fine tailings from the coal wash plant which result from the roof and floor of coal seam 4.

In most cases, it is not practicable to restrict the oxidation of medium-risk mineral waste. The increased mineral waste surface area cannot be reduced, and there is sufficient oxygen and water in the atmosphere to drive the oxidation reaction. It is possible to stop the oxidation reaction by storing medium-risk mineral waste in an anaerobic state e.g. complete submersion under a permanent water cover.

Just as medium-risk mineral waste can be present, so too can AC low risk mineral waste. Such mineral wastes include minerals of carbonates of potassium, calcium and magnesium. Acid generated in an AMD type reaction can be neutralised in part or fully by the action of available AC minerals. NMD refers to a situation where AMD is neutralised in-situ and drainage is characterised by circum neutral pH. NMD generally presents a lower risk to receiving environments due to reduced acidity and suppressed solubility of constituents. NMD however is not without risk as it often contains appreciable quantities of problematic salts such as sulfate.

Another effective means of risk mitigation is to restrict the transport of AMD and / or NMD into the receiving environment. This can be achieved by eliminating or limiting the flow of water through high-risk mineral waste. This concept is further explored in Section 5.0.

4.1.2 Sodicity

Condition F14 of the EA requires that mineral waste with an ESP greater than 30% must be covered with a minimum of 1 m of sodic or non-sodic mineral waste (ie with ESP <15%) prior to the commencement of rehabilitation.

ESP at the mine has been classified as follows:

- <6% — non-sodic;
- 6-15% — sodic;
- 15-30% — strongly sodic; and
- >30% — very strongly sodic.

Strongly sodic mineral waste may be subject to surface crusting and high erosion rates if placed on the surface of the landforms and exposed directly to rainfall.

4.1.3 Erosion, sedimentation and hydrological issues

The third broad class of environmental risk associated with mineral waste at the mine is erosion and sedimentation.

The primary driver of this risk class is mineral waste fragmentation. When mineral waste is subjected to drill and blast, a significant fines content is generated with little or no cohesion. These particles are highly susceptible to erosion and transport by water. This can result in contaminant transport (particularly of less soluble forms) as well as water turbidity in the receiving environment.

The second driver of this risk class is angle of repose slopes. All the landforms developed at the mine have been built by dragline and end dumping off tip faces. This leads to the development of multiple angle of repose slopes on the margins of the landforms. Angle of repose slopes are highly susceptible to erosive forces and this is particularly so of incised erosion. In addition, angle of repose slopes at the mine may also 'self-armour' quite rapidly if strongly sodic mineral waste is at the landform surface and don't absorb a great deal of rainfall. This results in very dry soil and low risk mineral waste conditions which makes establishment of vegetation difficult.

Effective controls for this risk class generally involve reducing slope angles, managing surface runoff and the establishment of vegetation. The approaches adopted by the mine are further explored in Section 5.2.

4.1.4 Spontaneous combustion

Spontaneous combustion is recognised as a serious safety risk associated with mineral waste, however it is a low environmental risk. Air emissions from spontaneous combustion are rated as a higher risk, due to their potential impact on mine workers and off site sensitive receptors.

The potential risk from spontaneous combustion results from two sources:

- waste coal and coal rejects in the existing landform; and
- in-situ coal in the highwalls, sidewalls and end walls.

To date the risk has been managed by covering waste coal, coal reject and in-situ coal with a buttress / layer of low risk mineral waste and track rolling to exclude oxygen and water. The mine has not had spontaneous combustion issues since last coal was extracted in 2012 — noting that monitoring is still on-going. The mine operations have the potential to interact with waste coal and coal rejects existing within the landforms and in-situ coal in the open-pits. Management of the spontaneous combustion risk is described in Section 5.0 and Appendix A.

4.2 Past management

The following sections describe how mineral waste was managed at the mine during past operations.

4.2.1 Classification

Prior to 2012 spoil, overburden and tailings was classified, based on geochemistry alone as:

- Low risk. NAF and / or AC mineral waste. Where static and / or kinetic testing shows that the mineral waste has a high likelihood of not generating AMD and / or NMD and are sodic or non-sodic; and
- Medium-risk. PAF mineral waste. Where static and / or kinetic testing shows that the mineral waste may produce AMD and / or NMD, regardless of the lag period until the onset of impacted drainage.

From an operational perspective medium risk mineral waste was treated as high-risk mineral waste following the precautionary principal.

It should be noted that once delivered to a landform the spoils from dragline operation, overburden and interburden from truck and shovel fleet become intermingled and therefore are the same unit from a rehabilitation perspective. Waste coal from the CHPP and coal rejects generally have been delivered to the coal reject dump adjacent to the Ramp 2 TSF. Notwithstanding, coal seam 2 was consigned as waste coal to the landforms and top of coal clean-up has also resulted in sporadic placement of waste coal in the landforms.

Tailings have been pumped and deposited by spigot in the Ramp 2 TSF and the TSF wall has been constructed from compacted coal reject.

Previous geochemical characterisation has been principally completed as seven studies (the studies):

- Dames and Moore (1983) — six composite samples of spoil;
- URS (2006) — 14 composite samples of spoil; and
- EGI (2004, 2006a, 2006b, 2007 and 2008) — drill hole samples collected from overburden, coal rejects and tailings.

a Spoil geochemical properties

The results from the studies indicate that the spoil is low risk mineral waste with low sulfur contents (average 0.05% sulfur) and low to ANC (average 1 kilogram of sulfuric acid per tonne (kg H_2SO_4/t)). Of the samples collected only one sample (by Dames and Moore 1983) was shown to be high-risk mineral waste. All other geochemistry analysis indicates that spoil is low risk mineral waste. The EGI study (2006) indicates that spoil is unlikely to be a concern with respect to AMD and / or NMD and is low risk mineral waste.

The EGI (2006) study also identified limited acid forming potential in coal seam 2 (high-risk mineral waste). Coal seam 2 was deemed uneconomic and was mined out and disposed of as spoil.

b Waste coal and coal rejects geochemical properties

EGI (2004) found that coal rejects are high-risk mineral waste. The same study (EGI 2004) compared key elements of environmental concern to criteria listed in the EPA guideline, Determining Dams Containing Hazardous Waste. There was found to be no enrichment of metals; however, the solubility of metals remains important to effectively control leachate quality. The EGI (2004) results were supported by further studies completed by the same company in 2007 (EGI 2007). The 2007 study (EGI 2007) indicated that approximately equal portions of the samples tested indicated potentials to form and not form AMD. The recommendation of the report was that coal rejects should be managed and treated as high-risk mineral waste. This sentiment is again reinforced in EGI (2008) reporting.

c Tailings geochemical properties

EGI (2004) found that tailings are high-risk mineral waste. The EGI (2004) results were supported by further studies completed by the same company in 2007 (EGI 2007). The recommendation of the reports was that tailings should be managed and treated as high-risk mineral waste. This sentiment is again reinforced in EGI (2008) reporting. A 2008 and 2009 column leachate trial (EGI 2008 and 2009) indicated that low concentration high-risk mineral waste samples identified within the 2004 and 2007 studies are, in fact, high-risk mineral waste and have the potential to produce AMD after a very short lag time (12 months) following deposition.

d Mineral waste ESP

Analysis of ESP for spoil was undertaken by URS (2006) on the rehabilitated Ramp 3 and Ramp 4. URS (2006) found that the ESP ranged between 0.3-7.9% and average 2.85%. The study indicates that spoil ESP is well below the 15% threshold identified in condition F14 of the EA. Further ESP analysis was performed by EGI (2006) which again indicated that the ESP is expected to remain below 15%; however, the study did return results greater than 15% for two samples (out of ten).

4.2.2 Placement

4.2.2.1 In-situ coal

In-situ coal at the mine consists of:

- waste coal in the landform;
- remnant coal in the highwalls, sidewalls and end walls; and
- economic coal in seam 4.

a Waste coal in landforms

Coal rejects were used for forming the wall of the TSF and has been compacted to reduce oxygen and rainfall ingress. Coal rejects were also used in the construction of haul roads. This practice minimised the quantity of waste coal available for spontaneous combustion as the haul roads were regularly compacted during construction.

Known spontaneous combustion, resulting from in-situ coal, waste coal or coal rejects, locations are shown in Figure 2 and are described in Table 4.

Table 4 Description of waste coal locations

Stockpile	Description
1,2	Spoil at this location has been contaminated by waste coal produced from the practice of shearing coal during blasting and dragline mining. These are sites of high-risk mineral waste but not considered to be problematic due to low volume of waste coal thought to be stored at the location.
3,4	The area (previously known as the hot coal dump) between locations 2, 3 and 4 was originally used to receive hot coal discovered during the excavation of old underground workings from Ramp 1 and Ramp 4. The surface mining of Ramp 1 to Ramp 4 exposed an old underground colliery which resulted in significant spontaneous combustion. Burning coal was excavated from this area and transferred to the hot coal dump. The hot coal dump continues to be the mines most significant area of high-risk mineral waste.
5	This location includes spoil contaminated with coal resulting from the practice of shearing coal during blasting and dragline mining. It is not considered to be a problematic area as the quantities of waste coal are likely to be small. There is a small amount of exposed coal in the highwalls in this area. This has the potential to cause spontaneous combustions issues if it is not managed adequately.
6	Waste coal was buried in this location from the old open-pit that was operating in the adjacent area before bulk mining if the mine commenced in 1985.
7	This location includes waste coal contaminated with underground backfill. The waste coal was dumped in the coal floor in this location.
8	This location includes contaminated waste coal stockpiles.
9	This location includes coal contaminated from being in contact with the underground backfill. The waste coal was dumped on the coal floor at this location. This location has been partially covered with spoil from end-dumping
10	Contaminated waste coal was dumped in this location, but anecdotal evidence suggests that most of the waste coal was removed, and only small amounts remain.



Client	Rio Tinto	Project	Land Use Management
Design	SGM Environmental	13.06.2018	Title: Locations of Waste Coal — FIGURE 2
Drawn	Bentline | PM	13.06.2018	
Scale	1:30,000		
Cad File	Blair Athol Mine02.dwg		

©SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability (including without limitation liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

Coal seam 2 was considered uneconomic and was removed by dragline and placed in the landform. Small scale spontaneous combustion did occur after placement. However, the risk is now assumed to be low as the coal was consumed quickly where spontaneous combustion did occur.

Finally, top of coal clean-up has resulted in sporadic placement of waste coal with 1-2 m of low risk mineral waste at the top of the landform. It is possible that this coal will be intercepted while completing earthworks to build the landform. It is unlikely that waste coal sporadically placed throughout the landform can be delineated prior to completing earthworks to build the landform.

If any of these areas are intersected during earthworks to build the landform, there is a potential for the coal to produce AMD, NMD or to spontaneously combust.

b Remnant coal in highwalls, sidewalls and end walls

Following the previous mining operations, residual amounts of coal seam 3 and most of coal seam 4 were left in place. However, prior to the mine entering care and maintenance the walls were rolled over and a buttress of low risk mineral waste was placed over the side walls.

Whether or not remnant coal in highwalls, sidewalls and end walls will pose an environmental risk after rehabilitation will depend on the height of the landform. If any of these areas are intersected during earthworks to build the landform, there is a potential for the coal to produce AMD, NMD or to spontaneously combust.

c Economic coal in seam 4

Economic coal in seam 4 will be mined out by TerraCom and will not pose an environmental risk after rehabilitation.

4.2.2.2 Spoil

a Low risk mineral waste

Low risk mineral waste is an asset for rehabilitation of the mine. Where ever practical low risk mineral waste will be placed to a high position resulting in the maximum amount of capping for high-risk mineral waste, coal rejects, tailings and waste coal.

Placing low risk mineral waste high in the landform will also reduce the risk that high-risk mineral waste, coal rejects, tailings and waste coal will be intercepted during rehabilitation earthworks to create the landform.

b Medium-risk mineral waste

Medium-risk mineral waste was previously managed by placing it within the mining area and keeping it as low as practical in the spoil profile. Examples include:

- dumping medium-risk mineral waste as close as possible to the open-pit floor;
- dozing interburden into the void rather than hauling it to an elevated position; and
- dumping waste coal as close to the pit floor as practical resulting in the maximum amount of capping with spoil.

4.2.2.3 Coal rejects

The coal rejects disposal area is high-risk mineral waste with a significant potential to produce AMD. Coarse rejects are being disposed of into current and old mining voids with a maximum of 5 m of spoil coverage

4.2.2.4 Tailings

The tailings dam contains high-risk mineral waste (tailings). The tailings dam will be covered with at least 4 m of spoil with at least the final 1 m constructed from low risk mineral waste with an ESP >15%. The TSF wall will

also be covered with a buttress of low risk mineral waste. The proposed rehabilitation strategy will reduce the potential for AMD, NMD and spontaneous combustion.

It should be noted that extreme acid conditions have never been recorded for the Ramp 2 TSF.

4.2.3 Soil quality

SKM (2012) has identified three main soils at the mine. These include Vertisols, Sodsols and Podsols. This is based on a soil survey carried out by Dames and Moore in 1983. When soils become mixed during the processes of mining and reshaping for rehabilitation they are referred to as Anthroposols.

The black Vertisols are fertile swelling clays with more than 35% clay that crack when dry. They are highly suited for use in areas of high-water concentration such as the contours and waterways.

The Podsols have a B horizon dominated by the accumulation of organic compounds, iron or aluminium.

The Sodosols are highly erodible soils and not well suited for soil use without prior amelioration. They generally contain high percentages of sodium on the clay surface.

The Podsols and Sodsols are characterised as red / brown and grey soils. However, anecdotal evidence suggests that there are minor quantities of grey soil available for use on-site.

Landloch (2012) suggested the following parameters and ideal ranges for selecting the most appropriate soil for use in rehabilitation:

Table 5 Soil nutrient ranges for rehabilitation

Parameter	Ideal range
pH	6.0-8.5
Organic carbon	>1% (preferable >2%)
Colwell phosphate	6 parts per million (ppm)
calcium: magnesium ratio	>1.5:1
Electrical conductivity (EC)	0.4 deciSiemens per metre (dS/m)
ESP	<6%
Clay plus silt%	<30%

It has been recommended that gypsum be added to each soil stockpile (Landloch 2012 and La Tierra 2017). This is to either to increase exchangeable calcium levels or increase sulfur levels. Application rates vary between 5-15 tonnes per hectare (t/ha). Further (La Tierra 2017) has recommended that triple superphosphate (fertiliser) should also be added. The requirements or gypsum and fertiliser application will be assessed on an area-by-area basis as rehabilitation proceeds.

5.0 Operational controls

The primary objective in managing the risks associated with permanent storage of high-risk mineral waste is to resist or prevent the migration of AMD and / or NMD into the receiving environment.

In general terms, landforms at the mine have / will be arranged in one of three configurations:

- exposed mineral waste in open-pit final voids;
- low risk mineral waste arranged in in-pit and ex-pit landforms; and
- high-risk mineral waste arranged within in-pit and ex-pit landforms.

5.1 Control approaches

Potential AMD and / or NMD and spontaneous combustion risk from mining by TerraCom is associated coal reject and fine tailings from the coal wash plant which result from the roof and floor of coal seam 4.

To facilitate the consistent and sound management of mineral waste at the mine, TerraCom has developed a suite of control procedures that inform and control and development of landforms. Not all operational control procedures apply in all circumstances.

Table 5 presents the operational controls that control the design, development and rehabilitation of landforms at the mine.

Table 5 Operational control procedures

Procedure	Scope	Reference
Soil control	Identification and management of the soil inventory	Refer to the *Blair Athol Mine Growth Media — Mitigation & Management Strategy* (TerraCom 2017)
Spontaneous combustion control	Identification of spontaneous combustion risk areas and management	Appendix A

5.2 Rehabilitation strategy

The landforms will be built by excavating, loading and hauling suitable materials for the landform (spoil) and cover (soil). The landform will be built by pushing with a dozer to a maximum slope angle of 15%. The mine has generally placed most of the spoil and coal reject during operation within the open-pit. There are however ex-pit landforms which were constructed during the prior operation of the mine.

If required, high-risk mineral waste with a potential to produce AMD and / or NMD and / or spontaneous combustion will be covered with and engineered cover, or at a minimum, 1 m of low risk mineral waste that has been tracked rolled.

Some mine infrastructure including roads, powerlines, water storages (including open-pit voids) and buildings may remain after closure to assist with the future land use.

The final land use after rehabilitation will be consistent with the underlying land tenure as well as posing an acceptable level of risk to the environmental values of the receiving environment.

Further detail on the closure and rehabilitation of the mine is provided in the *Mine Closure Plan*.

6.0 Monitoring

The following sections summarises monitoring related to this plan. Further detail on monitoring is provided in the *Rehabilitation Monitoring Plan* and the control procedures appended to this plan.

6.1 Topsoil inventory

Soils will be assessed for their suitability for use in rehabilitation following Table 6.

Table 6 Soil nutrient ranges for rehabilitation

Parameter	Ideal range
pH	6.0-8.5
Organic carbon	>1% (preferable >2%)
Colwell phosphate	6 ppm
calcium: magnesium ratio	>1.5:1
EC	0.4 dS/m
ESP	<6%
Clay plus silt%	<30%

Soils that do not meet the criteria presented in Table 6 are still to be stockpiled. The mine will investigate amelioration options available to improve the soil quality so that it meets the strategic goals of the mine.

6.2 Mineral waste

6.2.1 AMD and / or NMD

Monitoring of mineral waste physical and chemical properties is described in the *Rehabilitation Management Plan*. The program examines the changes in soil / spoil interfaces with rehabilitated areas. The focus for the monitoring program is described in the design standards sections of the *Mineral Waste Control* and the *Soil Control*.

6.2.2 Spontaneous combustion

The mine will monitor for the potential for spontaneous combustion using visual inspection and temperature data logger (heat probe) as required. Thermal aerial images will continue to be taken on an annual basis.

6.2.3 Erosion potential

Erosion monitoring is described in the *Erosion and Sediment Control Management Plan*.

6.3 Rehabilitation

Rehabilitation monitoring is described in the *Rehabilitation Management Plan*; however, monitoring will include parameters required to assess the land suitability class of rehabilitated land following the DME (1995) procedure.

6.4 Surface water and groundwater

Surface water and ground water quality monitoring is undertaken in pit and within spoil disposal areas as per the EPML00876713 and is described in the *Water Management Plan*.

7.0 Administration

7.1 Criteria for assessing this plan

The following corrective actions are to be employed by the mine where required:

- revision of this plan and control procedures as required;
- an incident report will be filled out if any non-conformances with this plan are found;
- in the event of an environmental incident, appropriate response measures will be implemented to safeguard against environmental harm from the event;
- all non-conformances will be corrected as soon as possible, and strategies identified, evaluated and implemented to reduce the likelihood of the non-conformance re-occurring; and
- all non-conformances and corrective actions will be closed out as soon as practicable.

7.2 Roles and responsibilities

The role and responsibilities for the implementation of the actions in the rehabilitation monitoring program are outlined in Table 7.

Table 7 Roles and responsibilities

Role	Responsibility
Site Senior Executive (SSE) & General Manager	Management of the mine
	Ensure resources are available to implement the contents of this plan
	Facilitate review of this plan
Senior Mining Engineer and HSE&T Superintendent	Implement the contents of this plan
	Report environmental incidents to Department of Environment and Sciences (DES)
	Train staff in environmental awareness, site issues and requirements
	Facilitate the monitoring and implementation of measures outlined in this plan
	Reports non-conformances to SSE/GM and ensure corrective actions are closed out
	Advise SSE/GM and other management on EA requirements and provide advice to assist with achieving compliance
	Investigate environmental incidents and liaise with DES where necessary / as requested by the SSE
Employees	Be familiar with the contents of this plan
Contractors	Be familiar with this plan

7.3 Training and competence

All personnel affected by the content of this plan, including those persons who will be responsibilities, will receive formal instruction on the requirements of this plan and other documents relevant to management and disposal of mineral waste.

7.4 Review

This plan will be reviewed as follows:

- when there is a change of method and / or technology that may affect the accuracy of this plan; or
- when there has been a significant event to which this document was relevant; or
- because of audit findings.

References

ATC Williams (2010). *Blair Athol Coal, Ramp 2 Tailings Storage Facility, Technical Specification for rehabilitation and closure civil works*. Report prepared for BAC JV.

Dames and Moore, (1983). *Waste Management and Rehabilitation Programme Soil and Overburden Characterisation. Final Report*. Report prepared for BAC JV.

Department of Mines and Energy (DME) (1995). *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques*. No longer published.

EGI, (2004). *Geochemical Assessment of Coal Washery Wastes Blair Athol Mine*. Report prepared for BAC JV.

EGI, (2006a). *Geochemical Assessment of Overburden from Blair Athol Mine*. Report prepared for BAC JV.

EGI, (2006b). *Geochemical Assessment of Overburden from Four Drill Holes – Blair Athol Mine*. Report prepared for BAC JV.

EGI, (2007). *Geochemical Assessment of Rejects and Tailings from the Blair Athol Coal Washery Plant*. Report prepared for BAC JV.

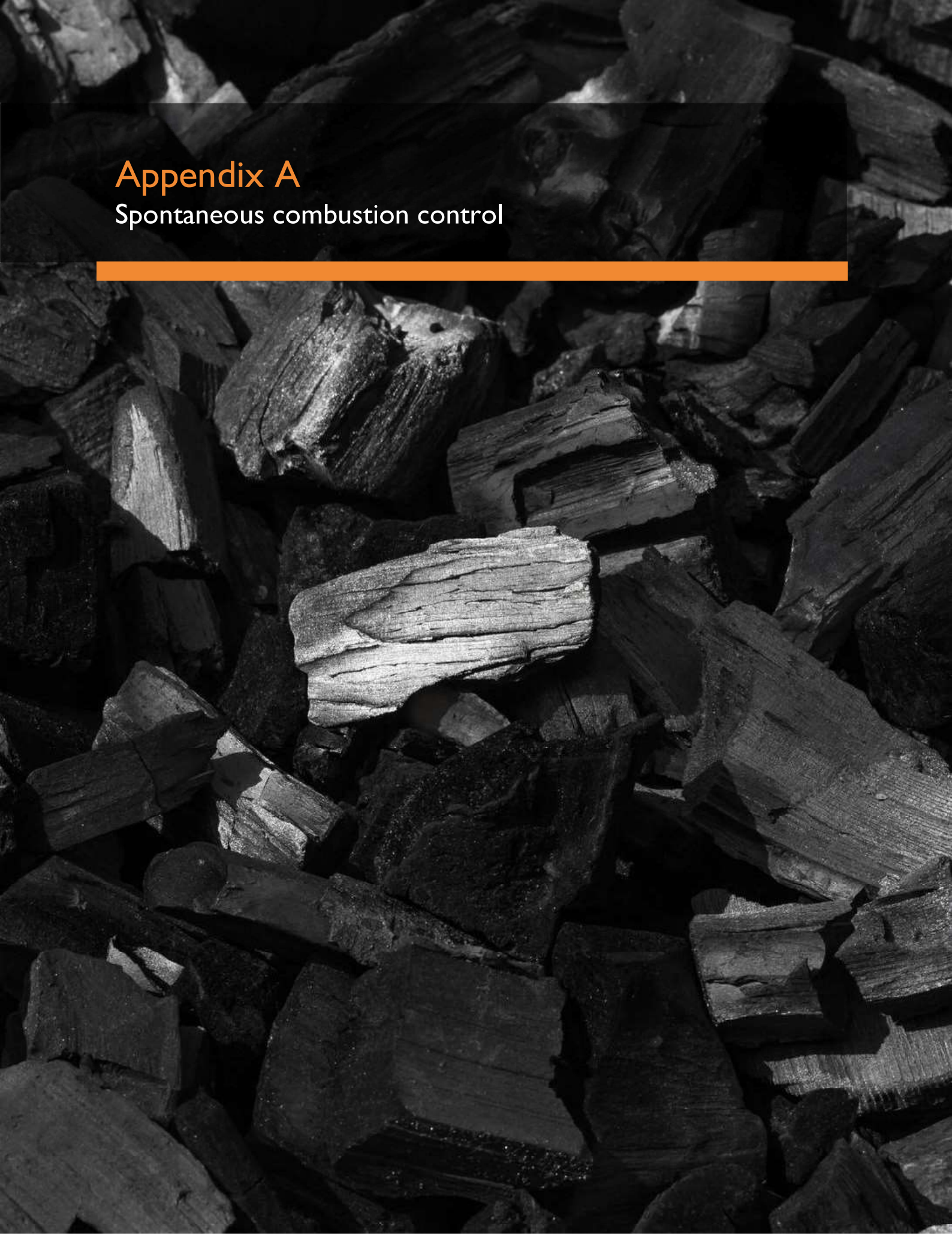
EGI, (2008). *Column Leach Test Results for Rejects and Tailings from the Blair Athol Coal Washery Plant*. Report prepared for BAC JV.

EGI, (2009). *Column Leach Test Results for Rejects and Tailings from the Blair Athol Coal Washery Plant*. Report prepared for BAC JV.

La Tierra Pty Limited (La Tierra) (2017). *Fertiliser Recommendations for 2017 Rehabilitation*. Report prepared for TerraCom Limited.

SKM (2012). *Blair Athol Mine Landform Review, Testing and Design Parameters*. Report prepared for Rio Tinto Coal Australia.

TerraCom Limited (TerraCom) (2017). *Blair Athol Coal Mine Growth Media — Mitigation & Management Strategy*.



Appendix A
Spontaneous combustion control

Appendix C

Spontaneous Combustion Control

Blair Athol Mine

Prepared for TerraCom | 26 June 2018

Project number:	18014
Document title:	Appendix C | Spontaneous Combustion Control | Blair Athol Mine
Revision:	V1-1
Date:	26 June 2018
Client:	TerraCom Limited
Project manager:	T Rohde
Author:	T Rohde

SGM environmental Pty Limited
T 0488 111 722
E admin@sgmenvironmental.com
W www.sgmenvironmental.com



Positivity | Trust | Innovation | Safety

© Copyright 2017 SGM environmental Pty Limited. The concepts and information contained in this document are the property of SGM environmental Pty Limited. Use or copying of this document in whole or in part without the written permission of SGM environmental Pty Limited constitutes an infringement of copyright.

Limitation: This document has been prepared on behalf of, and for the exclusive use of SGM environmental Pty Limited clients, and is subject to, and issued in accordance with, the provisions of the contract between SGM environmental Pty Limited and the client. SGM environmental Pty Limited accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this document by any third party.

Document history and status

Revision	Date	Description	By	Review	Approved
V0-1	31 May 2018	Draft	T Rohde	TerraCom	T Rohde
V1-1	26 June 2018	Final			T Rohde

Table of contents

1.0 Purpose 4
2.0 Scope and application 5
3.0 References 6
4.0 Background 7
5.0 Procedure 8
5.1 Operations 8
5.1.1 Identifying high risk mineral waste 8
5.1.2 Monitoring 8
5.1.3 Trend analysis 8
5.2 Mine closure 9
5.2.1 Identifying high risk mineral waste, monitoring and data analysis 9
5.2.2 Landform design procedures 9
5.3 Response 9
6.0 Record keeping 10
6.1 Storage of records 10
6.1.1 Contractor/consultant 10
6.2 Archiving 10
6.2.1 Contractor/consultant 10
References 11

Appendix
Spontaneous combustion visual inspection proforma 12

1.0 Purpose

The purpose of this *Spontaneous Combustion Procedure* is to describe the management measures that the mine will undertake to limit the risks from spontaneous combustion to staff and the environment during operation and during execution of closure.

2.0 Scope and application

This control procedure addresses:

- control procedures to address on-going historical spontaneous combustion;
- control procedures to address the risk of spontaneous combustion during operation; and
- control procedures to address risk of spontaneous combustion during execution of closure.

3.0 References

This control procedure refers to the following plans and control procedures:

- *Disposal Plan | Overburden, Interburden, Spoil, Coal Washery Coarse Rejects and Tailings | Blair Athol Mine;*
- *Water Management Plan;*
- *Mineral Waste Control;*
- *Soil Control;* and
- *AMD (acid mine drainage) and NMD (neutral mine drainage) Control.*

4.0 Background

The risk of spontaneous combustion at the mine comes from in-situ coal that remains in the landforms:

- waste coal in the landform;
- remnant coal in the highwalls, sidewalls and end walls;
- economic coal in seam 4;
- coal washery coarse reject (the coal rejects); and
- tailings in the Ramp 2 TSF.

Noting that the risk of spontaneous combustion in the Ramp 2 TSF is considered very low because of the wet conditions of the tailings. The risk of spontaneous combustion from coal seam 4 will be removed once it is mined out.

Waste coal in the landforms has resulted from the mining out of the uneconomic coal seam 2 and top of coal clean-up. The placement of waste coal has at times been sporadic and the placement of some waste coal has not been controlled. The locations of some waste coal that is a potential risk of spontaneous combustion is shown in Figure 3 of the *Disposal Plan | Overburden, Interburden, Spoil, Coal Washery Coarse Rejects and Tailings | Blair Athol Mine*.

Residual coal from coal seam 3 also remains in place. However, prior to the mine entering care and maintenance the walls were rolled over and a buttress of low risk mineral waste was placed over the side walls..

Finally, the coal rejects disposal area is high-risk mineral waste with a significant potential to produce spontaneous combustion. The facility will continue to be operated by TerraCom and will be rehabilitated at last coal. Rehabilitation planning may include an engineered cover, which will require further investigation.

How the landforms will be rehabilitated to limit the future potential for spontaneous combustion is directly related to the *Mineral Waste Control* and the *AMD and NMD Control*. That is, it is the high-risk mineral waste that is at risk from spontaneous combustion. And the same control measures used to manage the potential for AMD and/or NMD will also limit future potential for spontaneous combustion. That is, ACARP project 1609 investigated the factors likely to contribute to the occurrence and spread of spontaneous combustion in landforms. Findings from the project suggest the primary contributing factors were:

- Coal/carbonaceous shale oxidation — the oxidation of coal and carbonaceous shale within the landforms. A direct relationship was found between the percentage of carbonaceous waste and the propensity for spontaneous combustion to occur and to be sustained;
- Heat and wetting — when water interacts with coal, heat is liberated. This phenomenon can generate sufficient heat to cause oxidation in both solid and broken coal and carbonaceous material;
- Heat and water condensation and evaporation — the transfer of heat throughout a landform by condensation and evaporation of water contributes to the spread of spontaneous combustion; and
- Oxidation of pyrite — the oxidation of pyrite, whilst not essential, can further increase the likelihood of spontaneous combustion of spoil material if sufficiently carbonaceous.

The landforms must meet the following Environmental Authority (EA) conditions:

- (E9) Waste products generated on or after the 30 August 2017 from the washing of coal must be disposed of within mining voids and covered with spoil to a depth of at least 5 metres (m).
- (F14) Coal washery wastes and spoil with ESP >30% must be covered with a minimum of 1 m of low risk mineral waste (i.e. with ESP <15%).

5.0 Procedure

5.1 Operations

5.1.1 Identifying high risk mineral waste

Identification of high risk mineral waste is described in the *Mineral Waste Control*.

The mine will also develop a procedure for:

- visual inspection and monitoring of operational and rehabilitated sections of the mine to determine on-going spontaneous combustion risk; and
- thermal imaging of the mining lease (ML).

5.1.2 Monitoring

Early detection of the onset of spontaneous combustion most often will provide time for action to be taken to control the heating.

5.1.2.1 Inspections

Known potential-risk spontaneous combustion areas (Figure 3 of the *Disposal Plan | Overburden, Interburden, Spoil, Coal Washery Coarse Rejects and Tailings | Blair Athol Mine*) will be visually assessed at regular intervals for:

- a rise in temperature at the ground surface;
- smell (indication that ground temperatures are approximately 110°C);
- visible haze; and
- visible smoke indication that ground temperatures are approximately 300°C).

Visual inspections will be recorded on the *MDG 1006 Spontaneous Combustion Management Guideline* (NSW Industry & Investment 2011) proforma attached as Appendix A.

5.1.2.2 Continuous temperature analysis

If the visual assessment identifies an increase in risk, then the mine will consider installing a temperature sensor on a data logger and monitor ground temperature. Continuous monitoring will be used to detect changes in the landform by comparison to ambient air temperatures.

5.1.2.3 Thermal imaging

The mine will complete thermal imaging of the ML annually.

5.1.3 Trend analysis

Monitoring will be compared to the historical record available from Figure 3 and Table 7 in *Disposal Plan | Overburden, Interburden, Spoil, Coal Washery Coarse Rejects and Tailings | Blair Athol Mine*) (the spontaneous combustion prone areas).

The spontaneous combustion prone areas will be further will be updated and high-risk areas will be further delineated as subsequent thermal imagery monitoring is undertaken. Figure 3 and Table in *Disposal Plan | Overburden, Interburden, Spoil, Coal Washery Coarse Rejects and Tailings | Blair Athol Mine*) will be used as a planning tool for the management of know spontaneous combustion during landform development.

5.2 Mine closure

5.2.1 Identifying high risk mineral waste, monitoring and data analysis

The same operational procedures will apply to mine closure.

5.2.2 Landform design procedures

The design of in-pit and ex-pit landforms to limit the risk of spontaneous combustion are described in the *AMD and NMD Control*. That is, areas that exhibit visible signs or temperature changes as indicators of spontaneous combustion as a minimum will have a 1 m thickness of low risk mineral waste. The angle of the landform should also be reduced following the *AMD and NMD Control* including track rolling to limit oxygen ingress.

Landforms may require an engineered cover to exclude oxygen from zones of high risk. The need for engineered covers is yet to be assessed. Notwithstanding, previous assessment work completed by the Blair Athol Coal Joint Venture (BAC JV) has identified that engineered cover may be required for Locations 1, 2, 3 and 4 (Figure 3 and Table 7 in *Disposal Plan | Overburden, Interburden, Spoil, Coal Washery Coarse Rejects and Tailings | Blair Athol Mine*).

5.3 Response

The mine will develop a response plans for the mitigation of the effects of spontaneous combustion, including means for the protection of personnel and the mine. This will be reported in the mine emergency response plan and will cover the life of mine.

The use of water to prevent an outbreak of spontaneous combustion can accelerate the process of spontaneous combustion. Water should only be used on open flames. Where there is an outbreak of spontaneous combustion and open flames are identified the area should be saturated in water to put out the flames and cool the combustible waste coal. The *Emergency Response Plan* will be initiated in the event of open flames from spontaneous combustion.

6.0 Record keeping

Detailed records of the spontaneous combustion monitoring are required to ensure that the mine has enough data to evaluate the potential risk a continuous basis.

6.1 Storage of records

All records shall be maintained electronically on the relevant project file.

6.1.1 Contractor/consultant

If the work is being completed by a contractor/consultant than the records shall also be maintained in accordance with the contractor/consultant's quality management system in a relevant project file.

6.2 Archiving

Archiving of records shall be in accordance with the mines quality management process.

6.2.1 Contractor/consultant

If the work is being completed by a contractor/consultant than the records shall also be archived in accordance with the contractor/consultant's quality management system. The archiving system must be maintained in perpetuity.

References

NSW Industry & Investment, (2011). *MDG 1006 Spontaneous Combustion Management Guidelines* [online] Available from https://www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0006/419514/MDG-1006-TR-spontaneous-combustion-management.pdf [Accessed] 1 June 2018.

Rio Tinto Coal Australia (RTCA 2013). *Rio Tinto Coal Spontaneous Combustion Management Plan*

Appendix A

Spontaneous combustion visual inspection proforma

14.2 Appendix 2 - Recording of Spontaneous Combustion Event.

Mine:	Date:
Seam (s):	
Raw or washed coal:	
Attach a Proximate analysis if possible:	
Area and Depth of origin:	
Size of the event:	
Location of the event, (geographic):	
Location of the event with respect to the seam, roof, floor or elsewhere:	
Description of the surrounding mine and mine conditions:	
Environmental conditions leading to the event:	

Time since material affected has been first exposed:
Description of the event:
Method of controlling the event:
Ventilation, ventilation appliances and seals, attach plans diagrams, ventilation appliance status reports, ventilation flows and pressures:

Rank the impact of each of the following factors on the event. The ranking is from 'Very Low' to 'Very High'. N/A denotes not applicable to the event. If information is not available indicate 'Don't Know'.

	Very Low	Low	Med	High	Very High	N/A	Don't Know
Mining System:							
Broken coal in waste or goaf							
From:							
Roof - roof coal							
Roof - rider seam							
Floor - floor coal							
Floor - rider seam							
Worked Seam -remnant pillars/stooks							
Worked Seam - rib spall							
Worked Seam - working method (ramping, poor coal recovery)							
Panel design:							
Panel dimensions (width, length)							
Caving - closed/open goaf							
Working time for panel							
Rate of retreat							

	Very Low	Low	Med	High	Very High	N/A	Don't Know

Panel Design contd.	Very Low	Low	Med	High	Very High	N/A	Don't Know
Standing/Interuption time(s)							
Face startup/finish delays							
Roadway design - dimenensions							
Roof/Rib support							
Mining method (longwall, bord & pillar)							
Stability of pillars (abutment, roadway) and adjacent areas							

Ventilation:

Design - single, flanking, bleeders							
Nature of goaf ventilation and migration paths							
Pressure and flow magnitude							
Variation to pressure and flow							
Ventilation stability							
Seam gases (need to dilute or as goaf inerting medium)							
Leakage from surface							
	Very Low	Low	Med	High	Very High	N/A	Don't Know

Pressure differential (drop):	Very Low	Low	Med	High	Very High	N/A	Don't Know
Across stoppings/ seals/regulators							
Across goaf/waste							
Across pillars (roadway, abutment, interpanel)							
Across/along balance roadway/chamber							

Ventilation Appliances/Airways:							
Stoppings/Seals - location, design, construction, timing with respect to mining schedule,							
Regulators - location, design, construction, interference with/ overuse							
Failure - collapse							
Airway constriction (falls, flooding)							

Effect of Gas Capture/Drainage:							
Capture from goaf							
Pre drainage							
Post drainage							
Air ingress							
Water removal							

	Very Low	Low	Med	High	Very High	N/A	Don't Know

Geological/Seam Factors:	Very Low	Low	Med	High	Very High		N/A	Don't Know
Nature of roof and floor strata								
Faulting/Structures								
Strength of coal - friability								
Cleat/Jointing								
Previous oxidation								
Impurities (Pyrite)								
Seam gas (as preventer of oxygen ingress)								
Water (effect of dewatering via gas drainage)								

Intrinsic (Coal) Factors:

How would you rate the accuracy of any testing conducted of the coal involved in predicting the ultimate propensity for spontaneous combustion?

Very Low	Low	Med	High	Very High		N/A	Don't Know

Method of first detection:

Attach the Results of monitoring or other detection data:
Attach a Diary of events and decisions:
Investigating person(s):

SGM Environmental Pty Limited (SGME) is a boutique consulting firm of experienced industry experts working with our clients and their stakeholders to develop and deliver innovative solutions to complicated challenges that create enduring value.

SGME was established to provide services in soil science, geochemistry, mine closure and Environmental management, planning & approvals cost efficiently. When you engage SGME you engage a partner to your business, priding themselves on:

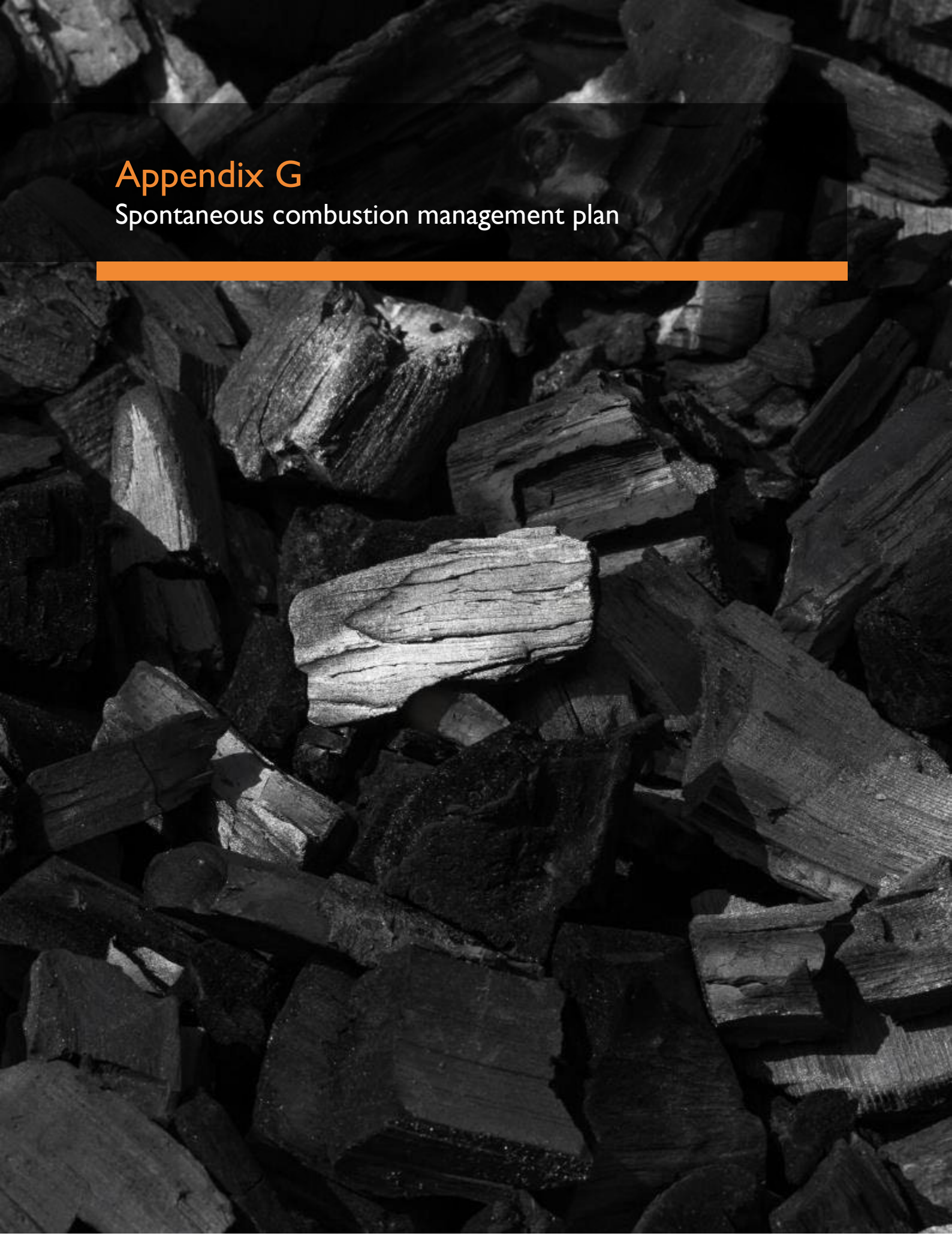
Honest – Straight-up and no nonsense.

Trust – We say what we mean and we will deliver on our promises. We will advocate strongly for you.

Innovation – We will always look for new ways to help and create enduring value because that is what friends do when they work together.

Safety – We do it right so we all go home safely.

Australian Location
PO Box 5622, Stafford Heights, Qld 4053
Tel +61 7 3148 6288
Email admin@sgmenvironmental.com
Web sgmenvironmental.com



Appendix G

Spontaneous combustion management plan

This page is intentionally blank.

Rio Tinto

Blair Athol

Spontaneous Combustion Management Plan

HSEQ MS – Plan

BAM-10-PLN-OR-0035_1

14 April 2016

Approvals ***Original signed by**

	Name	Position	Signed	Date
Originator	Emma Beale	Administration	E Beale	14/04/2016
Checked	Sandra Verano	Environmental Specialist		14/04/2016
Approved	Prue Lonergan	Closure Manager		14/04/2016

Revisions

	Date	Description	By	Check	Approved
1	14-Apr-2016	Issued for Review	EB	SV	PL
0	Oct-2013	Issued for Use			

Contents

1. Introduction 3
2. Objectives 3
3. Statutory Requirements 4
4. Historical Spontaneous Combustion 4
   - 4.1 Waste Coal Stockpiles 5
   - 4.2 Underground Workings 5
   - 4.3 Historical Dragline and Blasting Practices 6
   - 4.4 Seam 2 Coal 6
   - 4.5 Top of Coal Clean-up 6
5. Location of Waste Coal Stockpiles 7
   - 5.1 CHPP Waste Coal 9
   - 5.2 Insitu Coal 10
6. Spontaneous Combustion Management 11
   - 6.1 Monitoring for Spontaneous Combustion 11
   - 6.2 Affected areas 11
   - 6.3 Preventing Spontaneous Combustion 13
7. Spontaneous Combustion Documents 13
   - 7.1 Procedures 13
   - 7.2 Reports 14
8. Roles and Responsibilities 14
9. References 16

Appendix A – Thermal Image 17

Appendix B – Location of Spontaneous Combustion Monitoring Station 18

1. Introduction

The Blair Athol Mine (BA) is located 20 km northwest of Clermont, Queensland in the Bowen Basin and comprised a conventional strip-mining, open-cut coal operation, with a single dragline. BA is owned by the Blair Athol Coal Joint Venture (BACJV) with Rio Tinto Coal Australia managing the operation on behalf of the BACJV partners. The mine was in operation from 1984 to 2012 and produced over 200 million tonnes of high quality thermal coal.

The last coal sequence was brought forward from the planned closure date in 2016 to 23rd November 2012. As a result of the early closure a gap period was planned between the last coal sequence and the start of the rehabilitation activities to allow the update and preparation of required closure documentation.

BA has a history of spontaneous combustion issues due to a number of factors including coal type, mining practices and the management of spoil material. Spontaneous combustion is a significant risk to safety (e.g. personal injury, fires and smoke pollution) and the environment (e.g. destruction of rehabilitation and/or surrounding areas). Therefore spontaneous combustion must be managed adequately during the rehabilitation activities to minimise these risks.

This Spontaneous Combustion Management Plan (SCMP) comprises a summary of the history of BA's spontaneous combustion and the management protocols that have been adopted to mitigate the aforementioned risks.

2. Objectives

The objective of this SCMP is to

1. Summarise the existing status of spontaneous combustion at BA.
2. Describe the controls to ensure that no new spontaneous combustion issues are developed as a result of BA's closure activities, in particular bulk landform reshaping.
3. Describe the controls to be implemented for the management of on-going historical spontaneous combustion at BA.

This SCMP has been prepared to detail the management measures that BA will incorporate to ensure protection against risks to safety and the environment during the planning and execution of BA's closure. The plan will also ensure compliance with BA's EA and other relevant licences and approvals.

RTCA has total commitment to managing the safety of personnel and environmental impacts from BA. The practices to be undertaken to manage spontaneous combustion during BA's closure planning and execution are contained in this SCMP and will be revised as required.

3. Statutory Requirements

There are no specific requirements relating to spontaneous combustion in BA's EPML 008767713. However, given that spontaneous combustion can impact the air and affect the stability and vegetation covers of final landforms appropriate measures should be considered to control or minimize environmental impacts and fulfil the following EA conditions:

Table 1. Environmental Authority Conditions

Condition B6	Subject to condition B7 and B8 the release of noxious or offensive odour(s) or any other noxious or offensive airborne contaminant(s) resulting from the mining activity must not cause an environmental nuisance at any sensitive or commercial place.
Condition B7	When requested by the administering authority, odour monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive or commercial place, and the results must be notified within 14 days to the administering authority following completion of monitoring.
Condition B8	If monitoring indicates Condition B6 is not being met then the environmental authority holder must: a) address the complaint including the use of appropriate dispute resolution if required; and b) immediately implement odour abatement measures so that emissions of odour from the activity do not result in further environmental nuisance.
Condition F4	All areas significantly disturbed by mining activities must be rehabilitated to a stable landform with a self-sustaining native vegetation community.

4. Historical Spontaneous Combustion

BA has a history of spontaneous combustion issues caused by a number of factors relating to the type of coal, the methods used to mine coal, and the management of spoil. The types of spontaneous combustion issues at BA can be divided into 3 categories: 1) waste coal stockpiles, 2) CHPP waste coal, and 3) insitu coal. These categories are discussed under the respective headings below.

It is noted that only historical spontaneous combustion issues at BA which have the potential to impact on spontaneous combustion management today or in the future have been discussed. For example, spontaneous combustion previously occurred in the pit areas during mining when the coal in the pit was left exposed for extended periods of time. These areas were eventually mined out and sent to the ROM where the coal was cooled and processed through the coal plant (RTCA 2013b, 2009).

Similarly, production coal stockpiled for periods longer than 2 months prior to being loaded onto the train would typically start heating and a spontaneous combustion fire would occur if the stockpiles were not managed adequately. Coal stockpile management included compaction of the stockpiles, particularly in the interface region where the coal is stockpiled below ground. Coal stockpiles would also be shaped into a 'whalebone' form to prevent the coal from heating (RTCA 2013b).

Spontaneous combustion associated with pit coal exposed by mining and production coal stockpiles are no longer a risk for BA given that mining operations ceased in November 2012 and the production coal stockpile area of BA is now the responsibility of Clermont Mine.

4.1 Waste Coal Stockpiles

Throughout the history of BA's mining operation, waste coal has been discarded within the spoil. This coal is distributed within the spoil in two forms:

1. Stockpiles of waste coal that has been placed at locations across the mine in various-sized stockpiles. This coal has originated from the following sources:
    a. Burnt or burning coal that was not suitable to send through the coal plant. One example is the material from the exposed underground workings, which is discussed in the section below.
    b. Soot material that was not suitable for sale and consequently dumped as waste.
    c. Contaminated coal that was recovered off the low-wall by the coal excavator or shovel that did not meet the specification for coal washing.
    d. Coal that was contaminated with the backfill material used to mitigate spontaneous combustion in the old underground workings.
2. Waste coal spread sporadically within the spoil piles as smaller pieces of coal from the following practices:
    a. Historical dragline and cast blasting practices that would shear off a triangle of coal up to 8m thick. This coal would fall into the low wall slot where it was eventually deposited near the surface of the spoil pile.
    b. Discarded Seam 2 coal due to being highly banded and uneconomical to mine.
    c. Top of coal clean-up activities that would sometimes result in coal being taken with the overburden. This was done to reduce contamination and the chance of spontaneous combustion.

4.2 Underground Workings

Spontaneous combustion fires within BA's historical underground operations have been a significant issue at BA. The old underground workings provided a source of oxygen and a pathway for fire to travel rapidly through the coal seam. The underground workings were predominantly located in Seam 3. As the BA open cut operation progressed through the reserve, highwalls intersected the underground workings and allowed a significant amount of oxygen to be delivered to the underground workings. This allowed the fire to advance ahead of the surface mining operation.

During the excavation of Ramp 1 to Ramp 4 (R4 E&W) a significant amount of hot coal was discarded as it could not be processed through the coal plant. The material was transferred to an area known as the hot coal dump. Approximately 1 million tonnes of burning coal was

placed here during the clean-up. Some of the material within these stockpiles continues to burn (RTCA 2013b).

The material within the hot coal dump continues to be a problematic source of spontaneous combustion at BA.

The old workings were backfilled in the early 2000's with an inert material to control the spontaneous combustion. A spoil/cement product was pumped into the underground workings through drill holes from the surface. The mixture was designed to harden over time to produce plasticine-like product and fill the void completely, thereby extinguishing all spontaneous combustion and preventing the influx of further oxygen. All underground fires previously occurring the in the old underground workings have been extinguished via this backfilling process (RTCA 2009).

Due to the backfill material being pumped to within close proximity of the coal seam, contamination of some areas of the coal seam occurred during the subsequent surface mining of these areas. Coal that did not meet the specifications for the wash plant was dumped into waste stockpiles within the spoil. Left exposed, these stockpiles eventually started to burn.

4.3 Historical Dragline and Blasting Practices

Early practices at BA included waste coal being produced from the practice of shearing coal during blasting and dragline mining. This practice contaminated spoil with coal which was prone to spontaneous combustion due to its exposure to oxygen. Some of the waste coal near the surface of the stockpiles ignited over time (RTCA 2013b).

4.4 Seam 2 Coal

Due to cessation of mining BA did not mine the thin Seam No. 2 located above the major coal resource in Seam No. 3. Seam No. 2 was removed along with overburden by dragline operations. Small scale spontaneous combustion heating therefore occurred in spoil areas where this coal was exposed to oxygen. These areas of heating are relatively short lived as the coal is consumed during the spontaneous combustion process (RTCA 2009).

4.5 Top of Coal Clean-up

The top of coal clean-up and clearing of the blasted coal in the low-wall slot were the last operations in a dragline cut. The mixed coal and overburden material would be placed on top or near the surface of the spoil piles. This material was dumped along with 1-2m of overburden within the roof of seams 3 and 4 last (i.e. near the surface of the spoil piles). Inadequately covered waste coal stockpiles and coal placed sporadically on top or near the surface of spoil piles can lead to water and oxygen ingress and potentially spontaneous combustion.

5. Location of Waste Coal Stockpiles

Surveyed locations and volumes of the waste coal stockpiles have been kept from 2003-2009 however no register was kept in the years prior to or after this time period. Some locations and volume estimates have been developed through knowledge sharing of past employees. These locations are shown in Figure 1.

A brief history of these stockpiles is explained in Table 2. These stockpiles, given the right conditions can be assumed to be current or potential spontaneous combustion issues and will need to be capped appropriately during rehabilitation. It should be noted that Figure 1 only contains the larger waste coal stockpiles within the mining lease. Over the life of the mine many small stockpiles of coal were dumped throughout the mine. These were mainly dumped on the coal floor however some were dumped high up within the spoil piles. It is likely that during the bulk reshaping that some of these stockpiles will be exposed, in which case the general principles of this SCMP should be followed.

It is unlikely that the coal sporadically dumped throughout the spoil piles can be delineated. This is due to the difficulty of determining the volumes and locations of the coal that has been dumped over time, particularly given that little records were kept. A register of the coal, soot and PAF interburden material was kept from 2003 to 2009. This provided locations and approximate volumes of each material. This relied on the operators and supervisors in the past to accurately record the correct information when loading and dumping the material. This Mineral Waste Register is on the current Site Document Register and should be consulted when performing the rehabilitation.

Thermal imagery, visual inspection and local knowledge were used to locate the stockpiles in Figure 1 that are showing signs of heating – shown as yellow boxes. The stockpiles that are not expected to be heating are in the green boxes.

It is noted that the locations shown in Figure 1**Error! Reference source not found.** have been identified by anecdotal site information and visual identification. The thermal image monitoring is also an important source of information as this will show areas that are heating but may not be showing signs of spontaneous combustion (therefore not identified via visual inspection).

Thermal images conducted to monitor spontaneous combustion at BA are provided in Appendix A.

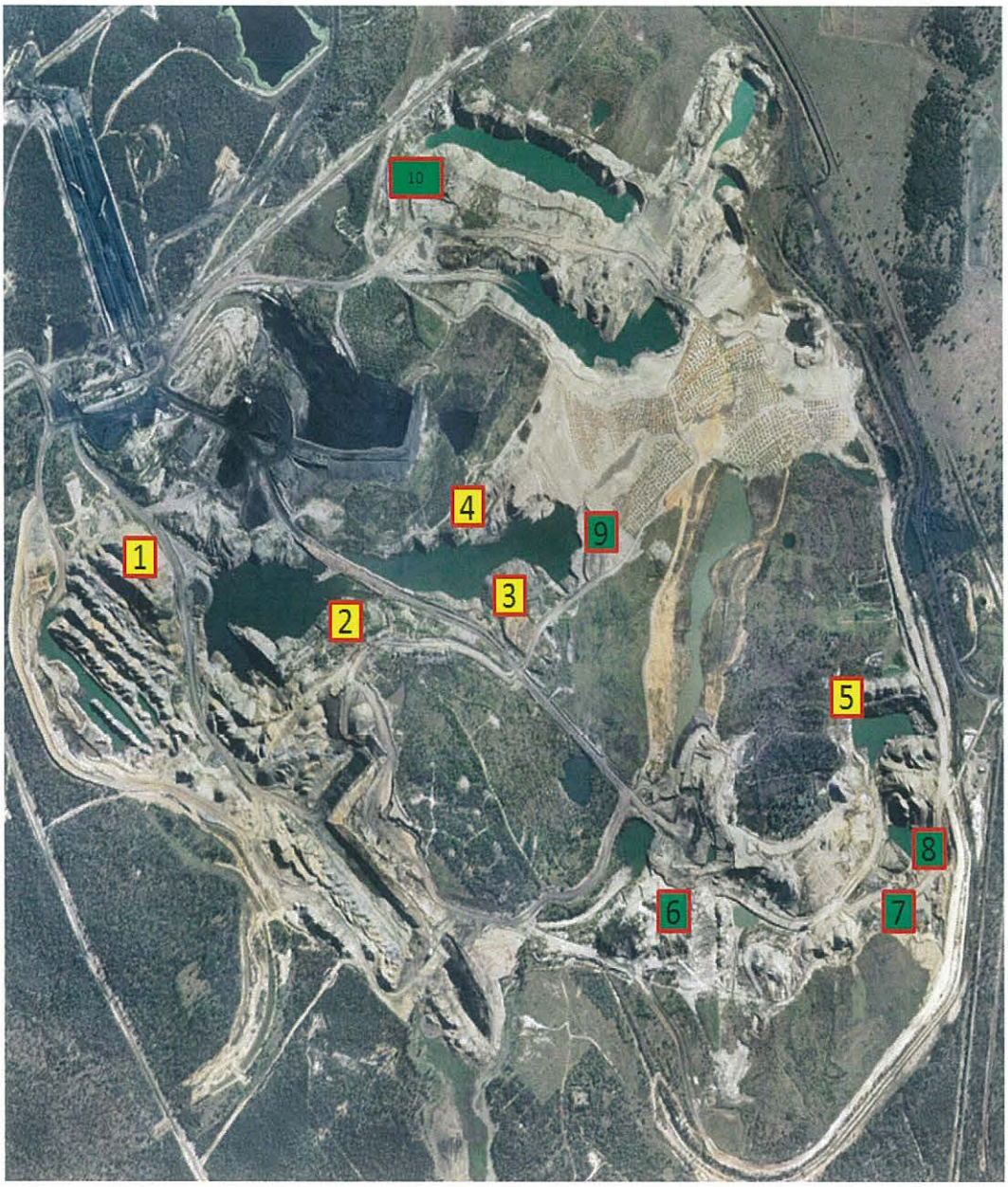


Figure 1 Estimated Locations of Waste Coal Stockpiles at BA

Table 2 Description of Waste Coal Stockpiles at BA

Stockpile	Description of Area
1, 2	Spoil in this area has been contaminated by waste coal produced from the practice of shearing coal during blasting and dragline mining. These are sites of spontaneous combustion but not considered to be problematic due to the size of the area and the severity of the spontaneous combustion.
3,4	The area (known as the hot coal dump) between areas 2, 3 and 4 was originally used to receive hot coal discovered during the excavation of old underground areas from Ramp 1 to Ramp 4 (R4 E&W). The surface mining of Ramp 1 to 4 exposed an old underground colliery which resulted in significant spontaneous combustion. Burning coal was excavated from this area and transferred to the hot coal dump. Approximately 1 million tonne of coal was placed here during the clean-up. The hot coal dump area continues to be one of BA's most significant areas for spontaneous combustion.
5	This area includes spoil contaminated by coal resulting from the practice of shearing coal during blasting and dragline mining. It is not considered to be a problematic area as the quantities of waste coal are likely to be small. There is a small amount of exposed coal in the highwall in this area. This has the potential to cause spontaneous combustion issues if it is not managed adequately.
6	Coal was buried here from the old open cut that was operating in the adjacent area before bulk mining of BA took place in 1985.
7	This area includes coal contaminated from being in contact with the underground backfill. The waste coal was dumped on the coal floor in this location.
8	This area includes contaminated waste coal stockpiles.
9	This area includes coal contaminated from being in contact with the underground backfill. The waste coal was dumped on the coal floor in this location. This area has been partially covered with spoil from a dump truck.
10	Contaminated waste coal was dumped in this location but anecdotal evidence suggests that the majority of the material has been removed and only small amounts remain.

5.1 CHPP Waste Coal

CHPP waste coal includes coal located in the tailings storage facility (TSF) and the coarse rejects. There is considered to be very little spontaneous combustion risk associated with the coarse reject. This is based on the observation at BA that fine-grained coal material has generally exhibited a low propensity to generating heat. This is potentially related to the particle size distribution where fine grained materials are more likely to be densely packed.

Reject coal has in the past been used for forming the wall of the Washery Rejects Dam and is compacted to reduce access of oxygen to the material. Reject coal has also been used in the

construction of haul roads. This practise minimises the quantity of reject coal available for spontaneous combustion as the haul roads are regularly compacted and watered (RTCA 2009).

An exposed stockpile of coarse reject located adjacent to Sedgman's hill has been left for over 5 years and does not exhibit signs of spontaneous combustion. On this basis, the course reject waste at BA is considered to have a low risk of generating spontaneous combustion in the future (RTCA 2013a).

It is unknown whether the tailings within the TSF will be prone to spontaneous combustion because since the TSF was installed, the tailings have been saturated. Given that the tailings are finer-grained material than the coarse reject, the tailings are also assumed to have a low risk of spontaneous combustion arising in the future. However this is an assumption not based on anecdotal evidence and in order to clarify the potential for the tailings to generate spontaneous combustion, samples should be taken and tested for spontaneous combustion propensity. This will allow the TSF to be adequately managed for spontaneous combustion if required.

5.2 Insitu Coal

Insitu coal comprises the coal left at BA within:

1. The highwalls, endwalls and sidewalls; and
2. The remnant coal within Seam 3 and 4.

Historically, large surface areas of coal were left exposed for extended periods of time during mining operations, and these areas would start to burn. This coal was eventually extracted and sent to the ROM where it would be cooled.

Similarly during the mining operation highwalls, endwalls and sidewalls that were exposed for long periods of time would start to burn (RTCA 2013b).

Given that BA's last coal was in November 2012 and since this time operations at the site has been limited to maintenance, the majority of the spontaneous combustion issues associated with the highwalls/endwalls/side walls and exposed seam in the ground have been mitigated.

Following BA's last coal, residual amounts of Seam 3 and the majority of Seam 4 were left in place. However during the mining shutdown all walls were rolled over, and a shallow cover was placed over the sidewalls. Currently there are no areas of exposed insitu coal (RTCA 2013a).

Whether or not the remnant insitu coal will pose a risk of spontaneous combustion in the future will depend on the height of the final landform. If any of these areas are intersected during final landform construction, there is a potential for the coal to generate spontaneous combustion upon oxygen ingress.

It is unlikely that the final landform will intersect these areas however careful planning and review of the final landform design will be required to ensure that the remnant insitu coal will not be disturbed.

6. Spontaneous Combustion Management

Efforts for managing spontaneous combustion at BA will be focussed on the prevention of new outbreaks as well as the management of historical and on-going outbreaks. All employees will be educated in the basic identification of smoke and heat associated with spontaneous combustion (via the spontaneous combustion procedures – Section **Error! Reference source not found.** below) and all employees will be responsible for detecting spontaneous combustion and reporting any visible signs of smoke to the Closure Superintendent or OCE immediately.

6.1 Monitoring for Spontaneous Combustion

During care and maintenance of Blair Athol Mine, Spontaneous combustion is currently monitored via:

- Field inspections are part of the routine site inspections conducted on weekly basis by the OCE.
- Thermal image monitoring is conducted every 3 years.

Areas found to be exhibiting unacceptable levels of as carbon monoxide, hydrogen sulphide, combustibles and total volatile organic compounds will be integrated into the Spontaneous Combustion Areas Map) and will trigger a review and improvement of the spontaneous combustion management protocols for that area.

6.2 Affected areas

The spontaneous combustion-prone areas and materials on-site are presented in Figure 1. This figure will be updated and high-risk areas will be further delineated as the on-going thermal imagery monitoring is undertaken. This map will be used as a planning tool for the management of known spontaneous combustion areas during the bulk landfill reshaping activities.

Areas which exhibit smoke or other visible evidence of spontaneous combustion prior to or during the bulk landform reshaping are recommended to have a cap of at least 1 m thickness of appropriate inert material placed over the top of the areas. The angle of the batters should also be reduced and the batters should be track rolled to accelerate airflow over the top of the compacted batters.

The use of water to prevent an outbreak of spontaneous combustion can aid and accelerate the process of spontaneous combustion. Water should only be used on open flames. Where there is an outbreak of spontaneous combustion and open flames are identified the area should be saturated in water to put out the flames and cool the combustible material. The Emergency Response Procedure will be initiated in the event of the identification of any open flames.

Table 2 outlines the current management and/or treatments that have been applied to the spontaneous combustion issue areas shown in Figure 1, and also provides recommendations for future management.

Table 1 Management of Spontaneous Combustion Areas at BA

Stockpile	Current Management	Future Management - Final Landform
1,2	Currently there is no management or treatment of this zone.	Ensure that any remnant waste coal in this area is placed deep within final landform and a capping layer of ideally greater than or equal to 1 metre is applied. Maintain accurate records of observations and location of capping material. Alternatively use the dragline and dozers to mix and dissipate into surrounding spoil.
3,4	Initially the hot coal dump had over 10 m spoil placed on top however this material was moved at a later date. The process was not well documented and files have been lost. The south-eastern side of the hot coal dump (Zone 3) currently has 2-3 m of material capping. The surface is cracking and discolouration from the burning coal underneath can be observed. Larger weathered cracks could be mistaken for erosion gullies. The location between Zone 2 and Zone 3 does not currently have a capping layer. The material was pushed around without controls to disperse the hot material. Smoke is visible from this zone. Zones 3/4 have 2 vents with smoke observed. Zone 3 across to zone 4 is where hot material was placed from ramp 1 to ramp 4. The material was capped with overburden 3-15 m in some zones. Over time continued heating and cracking occurred. Zone 4 – rehabilitation – this spoil was pushed to create final landform (without consideration of spontaneous combustion). This zone generates heat from time to time. If water is removed from around this area it could lead to further spontaneous combustion events.	Areas 3 & 4 are high up and may require excavation for final landform. Area 3 is to be cut below final landform and capped. Ensure that the cut material is filled nearby and compacted. Zones 3 and 4 will have a focus on repairing and thickening or placing a new capping layer of 3 metres deep or as close to this as practically possible. 1 metre minimum is required in DEHP (1995) guideline however given the high-risk of this zone, a greater depth of capping is recommended. Maintain accurate records of observations; and location of any cut/fill and capping material. Particular caution with this zone will be required if the water body between zone 3 and 4 is removed as it is considered likely that this will lead to an increase in propensity for spontaneous combustion in this area.
5	Heating and smoke was observed and material was pushed down-gradient and spread out by dozers. The coal was then covered by inert spoil. The highwall is not showing any signs of spontaneous combustion.	Maintain or place a capping layer of minimum 1 metre thickness. Maintain accurate records of observations and location of capping material.
6	Currently there is no sign of spontaneous combustion, prone material is buried under spoil.	

7	Some of this coal has been covered by spoil however there is a small amount left uncovered that is not showing any signs of heating.
8	This coal has been covered by spoil it is not showing any signs of heating.
9	This area has been covered by spoil it is not showing any signs of heating.
10	If this coal is still present it has been covered by spoil.

6.3 Preventing Spontaneous Combustion

The SCMP focusses on minimising the risk of new spontaneous combustion areas developing and managing existing spontaneous combustion areas. In order for these objectives to be achieved, a preventive approach in all spontaneous combustion-prone areas will be required.

Prior to closure activities commencing, an inert material inventory will be developed to record the amount of material of suitable quality available at BA for use in controlling spontaneous combustion-prone material. Inert material will be identified on the basis of properties that inhibit ingress of air and moisture to the carbonaceous material.

Oxidised coal-contaminated material that is considered to be prone to spontaneous combustion that is exposed during the bulk landform reshaping will be buried deep within the reshaped landform (minimum 1 metre depth). This will minimise exposure of the material to oxygen and generation of a spontaneous combustion issue. The coal-contaminated material will be placed within the landform that will be track-rolled to form low-angle batters and covered with inert material as soon as practicable. Low-angle batters and compacted oxidised coal has been shown to reduce airflow through the batters and accelerate the air over the top of the batters. The final approved landform does not include extensive exposed batters.

The map provided in **Error! Reference source not found.** can be used to indicate the potential for generating new spontaneous combustion areas, or disturbing existing spontaneous combustion areas as the landform design is finalised.

7. Spontaneous Combustion Documents

7.1 Procedures

BA has a number of spontaneous combustion-related procedures that will be applicable during the closure activities. The documents, including a short description of their purpose, are listed as follows:

- Spontaneous Combustion Management Standard Operating Procedure (SOP): The purpose is to reduce the risk to persons when working in or near heated areas, or areas with the potential for spontaneous combustion.
- Spontaneous Combustion Gas Assessment and Control Work Instruction (WI): This WI outlines the step by step process on how to monitor for potentially harmful gases given off during spontaneous combustion events.

- BAC Underground Gas Monitoring (Underground Workings) TARP 2005. Historical document that summarises and clarifies the appropriate actions and responsibilities for underground gas monitoring based on experiences to date throughout all of the old underground collieries. Monitoring of the underground workings is no longer required following the infilling of the colliery, however this TARP may still provide relevant and useful information relating to gas monitoring.
- Spontaneous Combustion TARP: Lists the trigger, immediate action, notification, prevention and investigation options for the different characteristics of spontaneous combustion events. Includes photo images of different phases of spontaneous combustion.
- Spontaneous Combustion Monitoring WI: The objective is to monitor the impact of BA Operations on the air quality of the surrounding region, ensure that the site's monitoring station is maintained in working order and that the data it produces is collated to optimise its potential uses.
- Extinguish Coal Fire Procedure WI 2005: The procedure that details how to extinguish or dig out a coal fire. This WI requires updating to a closure scenario however the content is still relevant to BA.

7.2 Reports

In addition, the relevant technical studies that relate to spontaneous combustion at BA include the following:

- Blair Athol Mine Spontaneous Combustion Monitoring Review 2011
- Blair Athol Air quality Background Document 2009.

8. Roles and Responsibilities

Role	Accountability
Manager/ SSE	• From time to time audit the implementation and operation of this plan. • Ensure that all persons that have responsibilities under this plan are aware of those responsibilities. • Ensure resources are available to implement the requirements of this plan • Advise BA General Manager and the Mines Inspectorate of any spontaneous combustion events.
Closure Superintendent	• Responsible for the implementation of this plan. • Ensure the OCE conducts inspections competently. • Consult with the OCE about appropriate management of spontaneous combustion. • Ensure key planning information is forwarded at appropriate times to personnel responsible for managing spontaneous combustion in the field. • Be responsible for the coordination of remedial actions as required. Remedial actions are identified in Section 6 of this plan. • Manage any outbreaks or potential outbreaks as required. • Assist the Closure Manager and OCE in the collection of any relevant information associated with a spontaneous combustion outbreak

OCE	• Consider spontaneous combustion in the design of mining operations and spoil emplacement areas. • Ensure appropriate assessment of coal is conducted to identify possible risks of spontaneous combustion occurring. • Assist in the development of a strategy to manage spontaneous combustion for areas identified as requiring attention in consultation with the Closure Superintendent
Environmental Advisor	• Identify areas where spontaneous combustion is likely to occur. • Be responsible for considering spontaneous combustion in the planning of the final landform. • Ensure all materials are correctly disposed of and have responsibility of planning the movement of carbonaceous materials. • Conduct regular inspections of the coal seams and coal stockpiles to monitor for signs of spontaneous combustion. • Maintain all records on the age and location of stockpiles. • Ensure all inert materials are correctly placed and not unduly wasted in areas where no spontaneous combustion exists. • Assist the Closure Manager and Mining Superintendent in the collection of any relevant information associated with a spontaneous combustion outbreak
Contractor Environmental Advisor (if applicable)	• Consult with the Closure Superintendent and OCE about appropriate management of spontaneous combustion. • Ensure compliance with approval and statutory requirements for environmental management of spontaneous combustion. • Maintain a series of plans indicating areas where spontaneous combustion is known to have occurred. • Notify the Closure Manager, Closure Superintendent and OCE of community issues associated with management of spontaneous combustion.
Landform Engineer	• Verify that plans combustion management is consistent with the final landform design. • Determine the quantity of inert materials available to mitigate spontaneous combustion areas. • Measure and record the type and depth of cover of materials applied as inert capping on final landform surfaces. • Maintain records associated with management of spontaneous combustion
HSE Manager	• Ensure management of spontaneous combustion is conducted in a safe and competent manner. • Ensure management of spontaneous combustion complies with all statutory safety obligations.
All Other Personnel	• Notify the Closure Superintendent of any potential or actual outbreaks of spontaneous combustion

9. References

QLD DEHP guideline *Rehabilitation of Spontaneous Combustion Areas* (DEHP 1995)

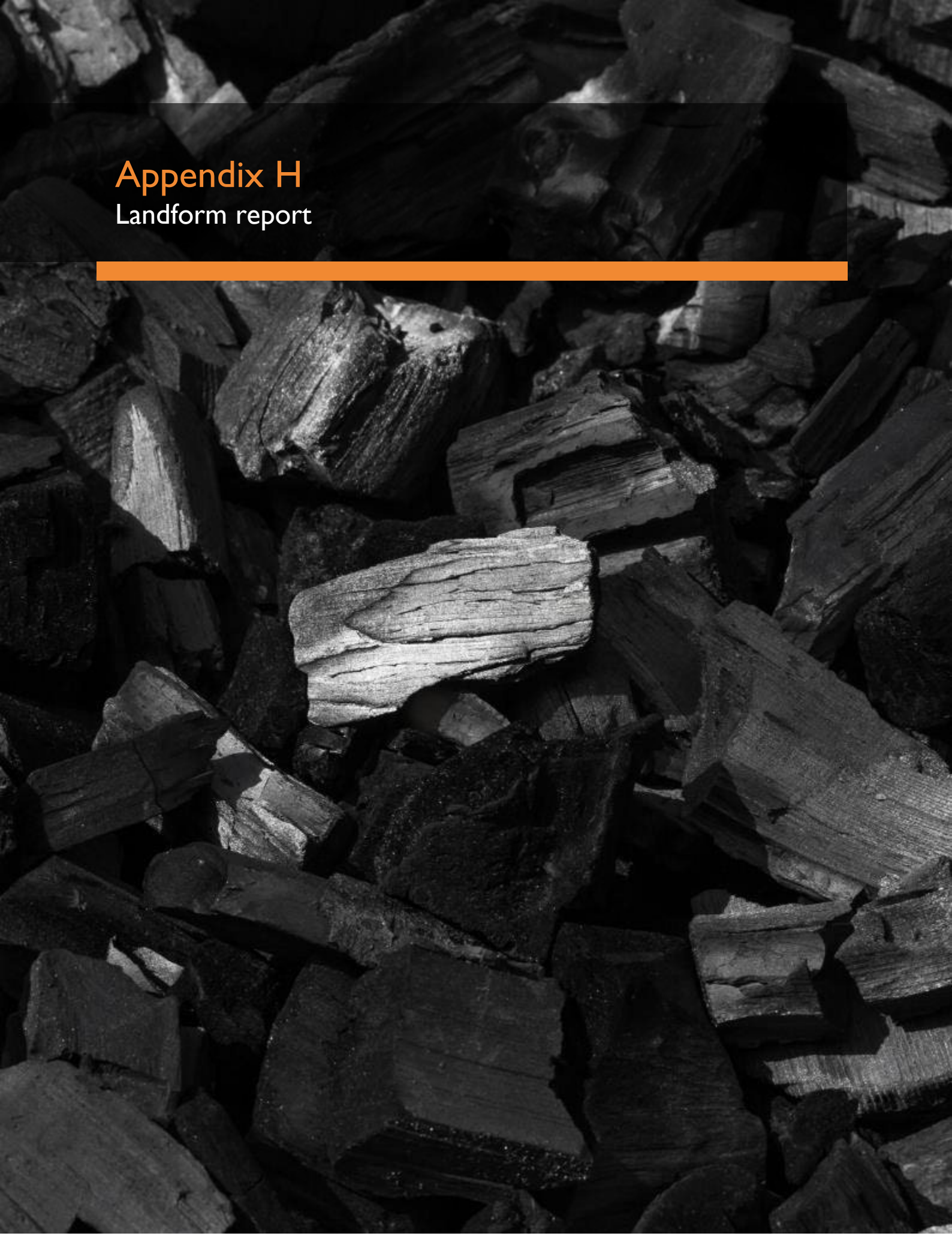
RTCA 2013a Interviews with OCE from Blair Athol.

RTCA 2013b Draft Blair Athol Decommission Plan

RTCA 2009, *Blair Athol Air quality Background Document*

Carres J. N., Saghafi A., 1998, University of Wollongong, Research Online, Coal Operators' Conference Faculty of Engineering and Information Sciences, *Predicting spontaneous combustion in spoil piles from open cut coal mines*, CSIRO Division of Coal and Energy Technology CSIRO Division of Coal and Energy Technology

DEHP 1995 *Rehabilitation of Spontaneous Combustion Areas*



Appendix H
Landform report

This page is intentionally blank.



Terracom

RESHAPE ASSUMPTIONS REPORT 21-1823-V1

RELEASE DATE: 9TH JUNE 2022

DOCUMENT VERSION: 1.4

DOCUMENT DETAILS

Copyright

Copyright in this document and any accompanying materials is reserved by Deswik Mining Consultants Pty Ltd ("Deswik"). They may not be distributed to third parties, reproduced or circulated in the public domain, or edited or amended in any way, unless expressly agreed to by Deswik. Products and registered logos referred to in this document are trademarks of their respective owners and these trademarks are hereby acknowledged.

Confidentiality

You must always treat this report and any accompanying materials as confidential. If we have entered a confidentiality / non-disclosure agreement, or another agreement containing confidentiality obligations relating to this document or the accompanying materials, those obligations also apply.

Disclaimer

This document may not be used or relied upon by anyone other than you, or for any other reason than the intended purpose outlined herein. Deswik accepts no duty of care or liability in respect of any such use or reliance.

RELEASE DETAILS

Report Name:	Reshape Assumptions Report
Report Number:	21-1823-V1
Client Name:	Terracom
Author:	Ian Neilsen

REVISION DETAILS

Date	Version	Modified By	Comments
11th August 2021	1.0	Ian Neilsen	Initial draft
11th August 2021	1.1	Anthony Walker	Internal review
25th August 2021	1.2	Ian Neilsen	Finalise document
17th March 2022	1.3	Ian Neilsen	Update smoothed progressive rehab estimate
8th June 2022	1.4	Ian Neilsen	Included annual reshape closure estimates

DRAFT

EXECUTIVE SUMMARY

This report outlines the reshape modelling conducted as part of Life of Mine Planning support for Blair Athol Mine from FY22 to closure. Using the Post Mining surface generated from the mine schedule, a final landform was simulated using a 15% grade constraint and quantified using Deswik.Enviro tools. The post mining reshape physicals results are summarised in Figure 1-1 for spatial layout of the reporting domains.

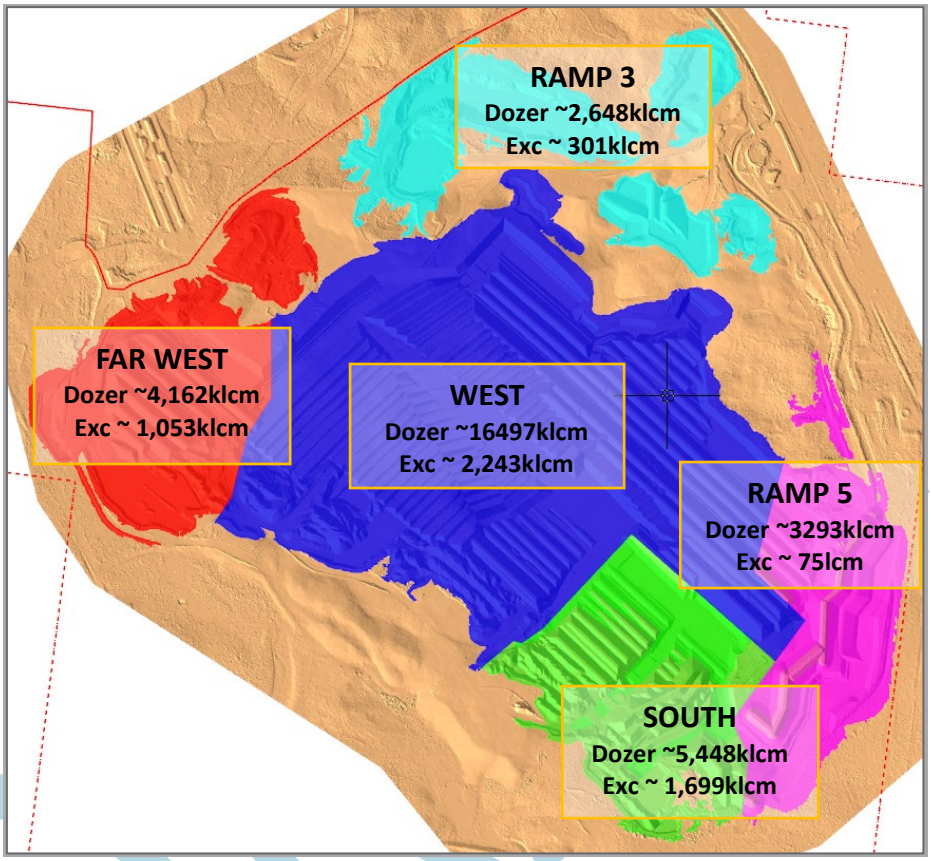


Figure 1-1 - Modelling Results

Progressive Reshaping has also been estimated based on area release from the mine schedule and manually constraining several voids used for water storage and tailings & reject dumping. The progressive reshaping effort is approximately **1.4Mlcm** per year of mine operation and is consistent with current reshape budget estimates. Once mining operations cease, the reshaping effort remaining is approximately 19.8Mlcm of dozer push and dragline reshape and 4.0Mlcm of longer haul quantity. The progress and final reshape physicals are summarised in Table 1.

Table 1 - Progressive and Final Reshape Physicals

	Dozer Total (klcm)	Dozer Avg Dist (m)	Dozer Avg Grade (%)	Exc Total (klcm)	Exc Avg Dist (m)	Total Cut Volume (klcm)	Total Cut Volume (klcm)	Total Cut Volume (klcm)
Progressive Reshape	12,686	116	-25%	1,368	752	-	-	**14,054**
Closure Reshape	6,808	161	-21%	3,955	811	13,025	85	**23,788**
TOTAL	**19,494**	**132**	**-24%**	**5,323**	**796**	**13,025**	**85**	37,842

DRAFT

TABLE OF CONTENTS

1. Introduction 6
1.1. Previous Modelling 7
2. Model Settings 8
2.1. Post Mining Surface 8
2.2. Reshape Model Extents 8
2.3. Surface Preparation 10
2.4. Reshape Model Settings 11
2.5. Dozer Modelling 13
3. Model Outputs 14
3.1. Progressive Reshaping Estimation 17
3.2. Annual Closure Estimate 19
APPENDIX A: Detailed model settings 20

DRAFT

1. INTRODUCTION

This report details the reshape modelling process followed at Blair Athol and the results generated. A brief overview of the process undertaken:

Reserves	•Generate mining solids to establish an economic mining footprint
Schedule	•Mine scheduling to determine a practical sequence
Dump Design	•Dump design and simulation using mine schedule to determine a Post Mining Surface
Reshape	•Simulate reshaping of the Post Mining Surface to achieve rehabilitation or closure objectives •Estimate annual progressive reshaping areas based on operating area availability. The annual areas are then used to re-run a final reshape model to improve cut fill balance for each period.
Review	•Quantify reshaping effort and review for any efficiencies or opportunities

DRAFT

1.1. PREVIOUS MODELLING

Reshaping simulations for Blair Athol Mine have been conducted at several stages from 2019 using a various mining surfaces, including surveyed surfaces and planned post mining surfaces. The previous modelling activities are summarised in Table 2. The modelling design principles have not changed significantly during this time, briefly:

- Final reshaped surface should be less than or equal to 8.5 degrees (15%)
- Lease area has not changed

Table 2 - Historical Reshape Modelling List

Reshape Date (date of closure)	Surface Type	Final Reshape Quantity (mlcm)	Progressive Reshape Quantity (mlcm)
March 2019	Survey Surface	18.0	-
December 2019	Survey Surface	18.0	-
May 2020	Survey Surface	18.7	-
December 2020	Survey Surface	18.5	-
June 2021	Survey Surface	19.6	-
June 2021	Budget Surface @2.2mtpa	20.1	2.0 for FY21
June 2022	Budget Surface @2.6mtpa	20.0	2.0 for FY22
June 2023	Budget Surface @2.8mtpa	20.0	3.0 for FY22-23
June 2032	**LOM Surface @2-2.6mtpa**	**23.8**	**14.1 for FY22-FY31**

2. MODEL SETTINGS

This report details the model settings and outputs from the following files:

Reshape File: "LOM21 Reshape 220305 - Progressive - v1 RL285.dcf"

2.1. POST MINING SURFACE

The reshaping results for Blair Athol have been generated using the modelled post mining surface from "BA 90D FY22 20210621 V1.5 Rev2.3.dcf", a schedule and haulage (LHS) model used as part of the 2021 Life of Mine (LOM) planning process. The surface was generated using the "Min Dist" haulage scenario.

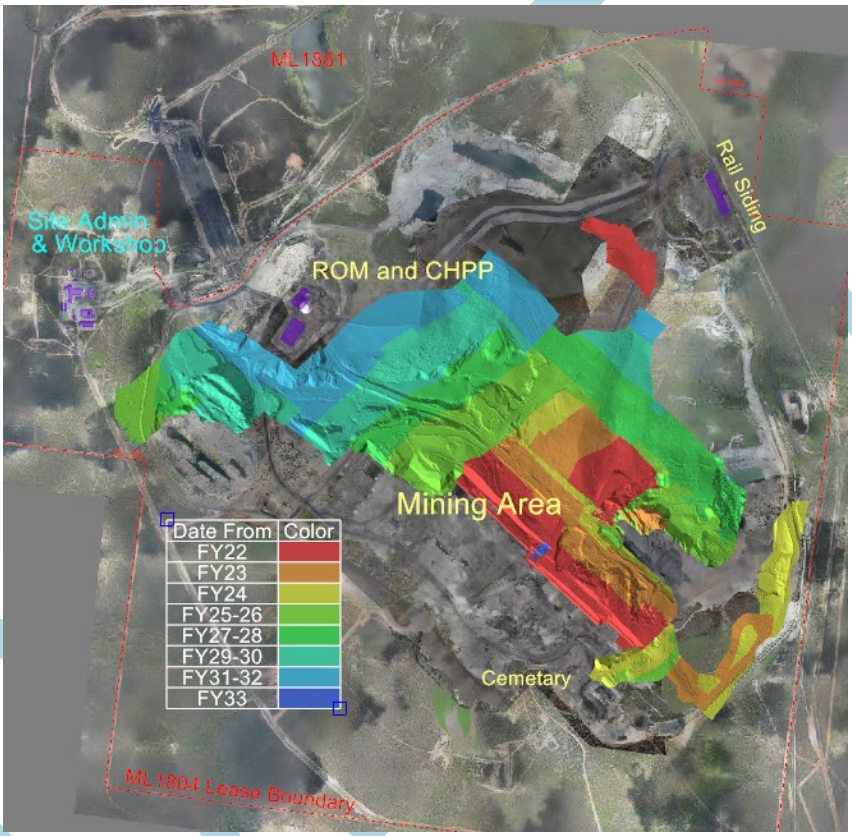


Figure 2-1 - Life Of Mine Progress Plot

2.2. RESHAPE MODEL EXTENTS

Seven model domains have been constructed for reshape modelling, refer to Figure 2-2. Please note that the modelling domains have been deliberately named so as not to coincide with the Reporting Areas, see Figure 2-3:

1. COMBINED: covers the dragline operating area for LOM
2. NORTHWEST: covers a spoil dump that is separable from the COMBINED modelling domain
3. NORTHEAST: covers minor pit areas to the east of the COMBINED domain
4. NORTH1: covers a legacy mining void (Ramp3) that is planned for tailings/reject dumping
5. NORTH2: covers a legacy mining void that is planned for reject dumping
6. NORTH3: covers a legacy mining void
7. NORTH4: covers a dozer push pit area that is also planned for reject dumping

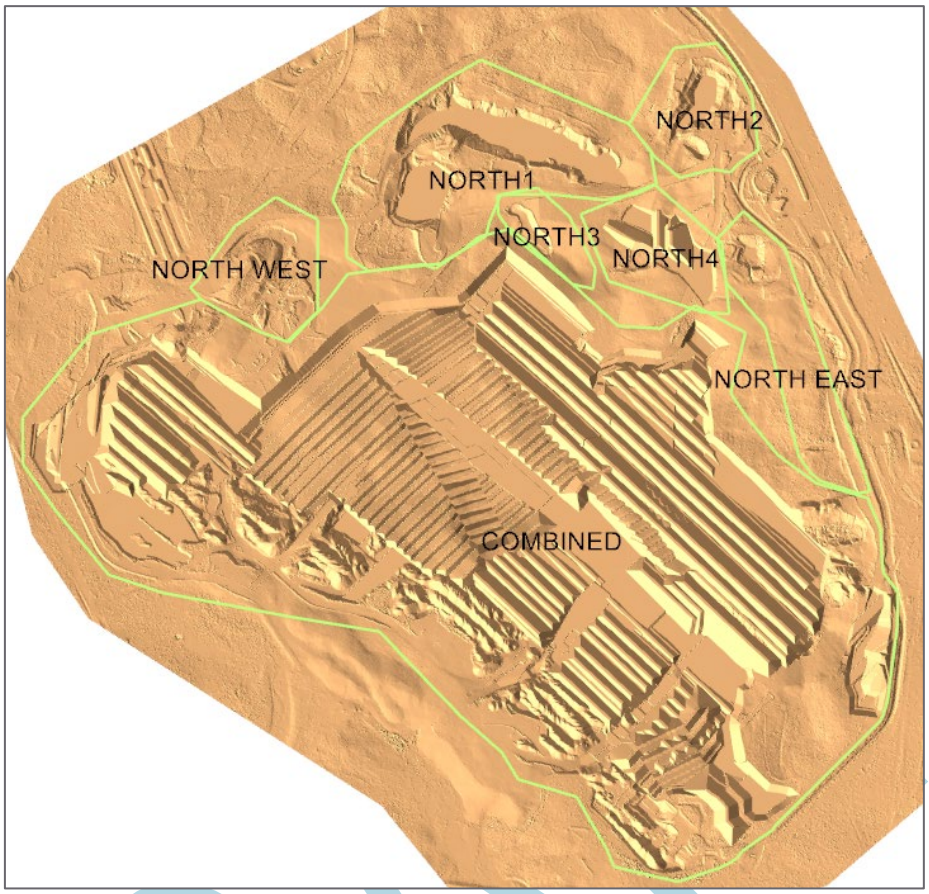


Figure 2-2 - Modelling Domains

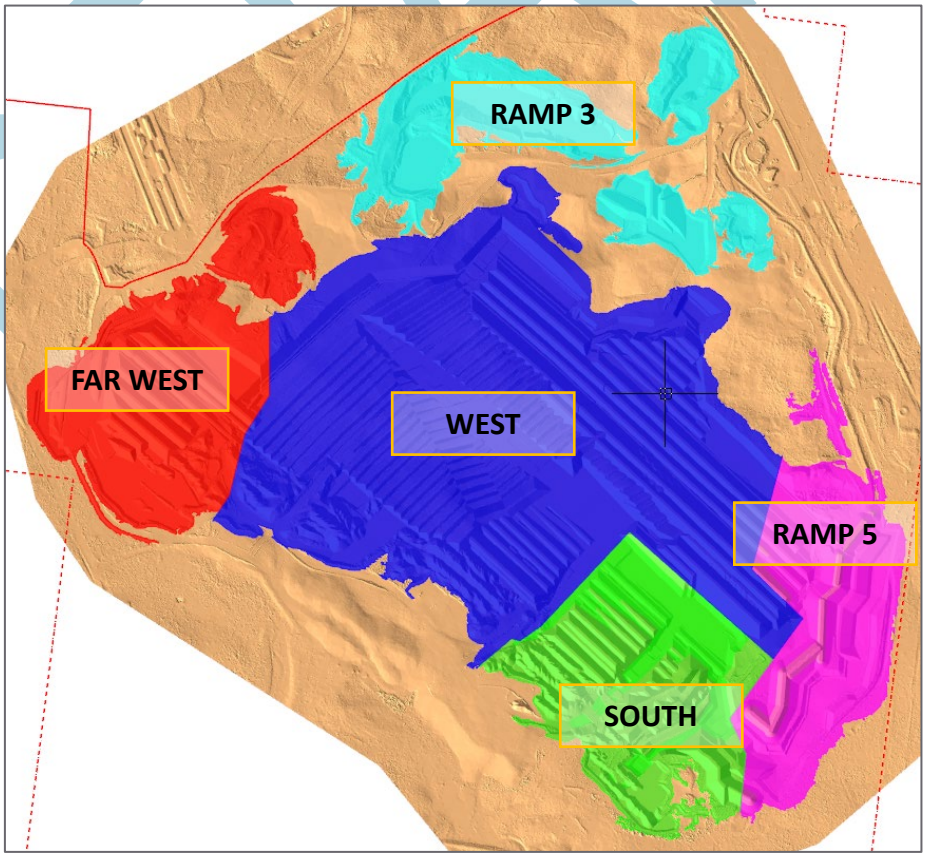


Figure 2-3 - Reporting Domains

2.3. SURFACE PREPARATION

Using the Post Mining surface generated from the LHS model, two main edits were conducted, as follows:

1. The combined tailings and reject volume was estimated for each pit in North 1, North 2 and North 4 modelling domains and the surface updated to this level, as seen in Figure 2-4.
2. In the active mining area that is being modelled, an adjustment was made to the surface to reduce near-vertical faces generated as part of the block dumping simulations back to a more realistic repose angle of 38 degrees (see Figure 2-5).

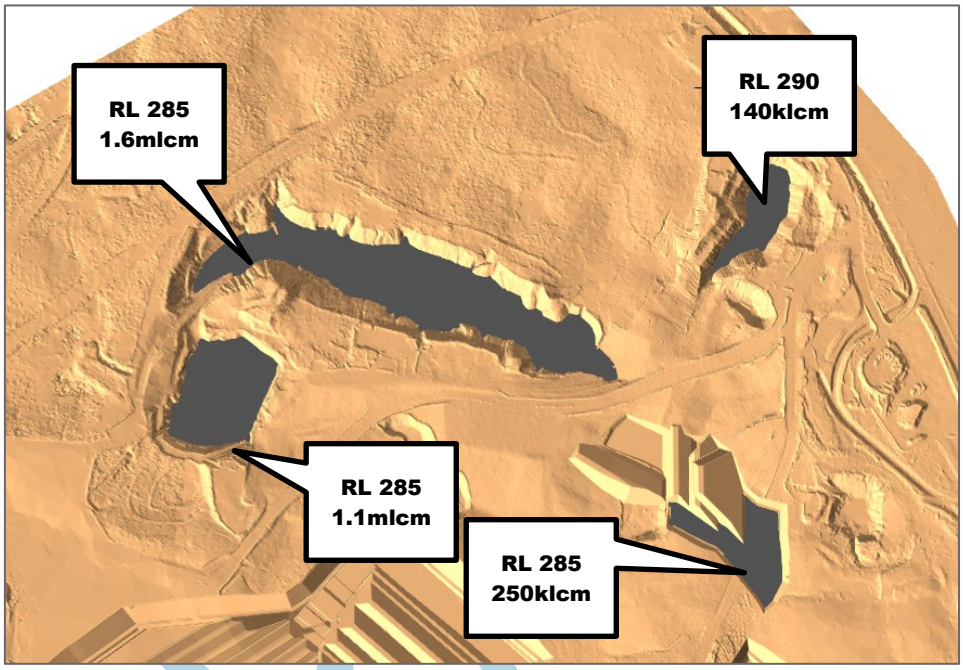


Figure 2-4 - Provisions for Tailings & Reject Dumping

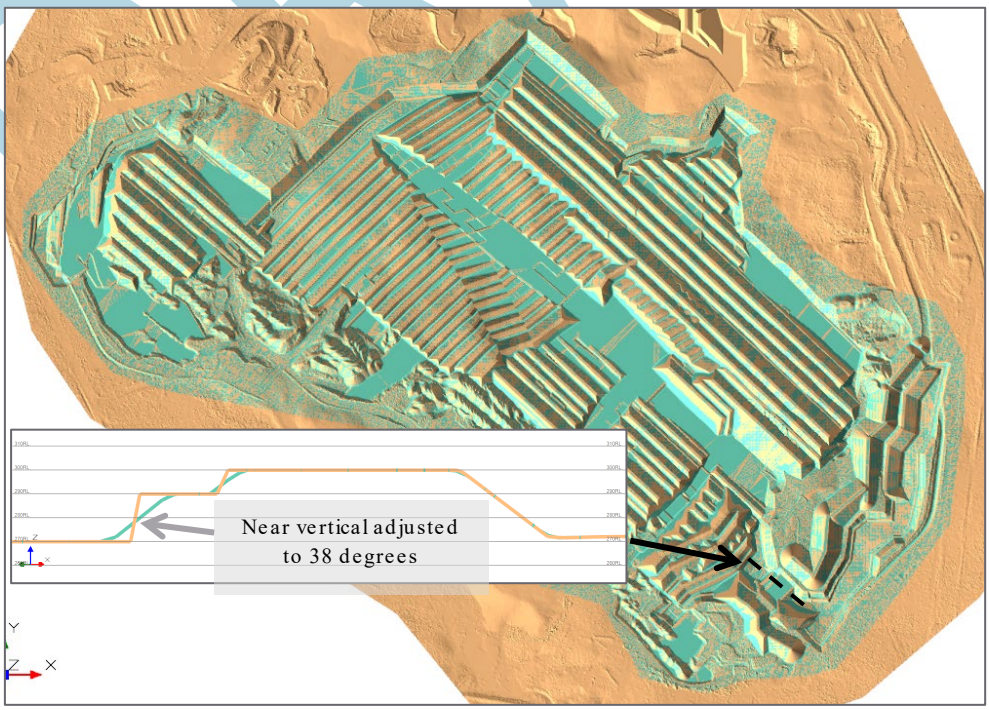


Figure 2-5 - Post Mining Surface Smoothed Area

2.4. RESHAPE MODEL SETTINGS

Each domain features a similar setup with settings added as required for each domain. The specific settings for each model domain can be found in APPENDIX A:.

Briefly the main setting controls include:

- 10m grid sizing (see Figure 2-6)
- 8.5degree grade constraint (see Figure 2-7)
- Use of sub areas to maximise cut fill balance of progressive reshaping areas (see Figure 2-8) identified in the initial reshape model (with no sub areas active).
- Use backfill surfaces (where required to cover tailings & reject dumps with minimum 3m cover)
- Output layers and settings (see Figure 2-9). Outputs generated are:
  - Reshaped surface for modelled area
  - Cut and Fill solids cropped up to 0.3m and minimum area of 100m2
  - Cut and Fill solids are split into blocks 50m x 50m x 5m thickness with solids less than 10m3 removed from the model. The following attributes are written to each solid to assist with reporting and dozer volume estimation:
    - ID
    - Bench
    - XBlock
    - YBlock

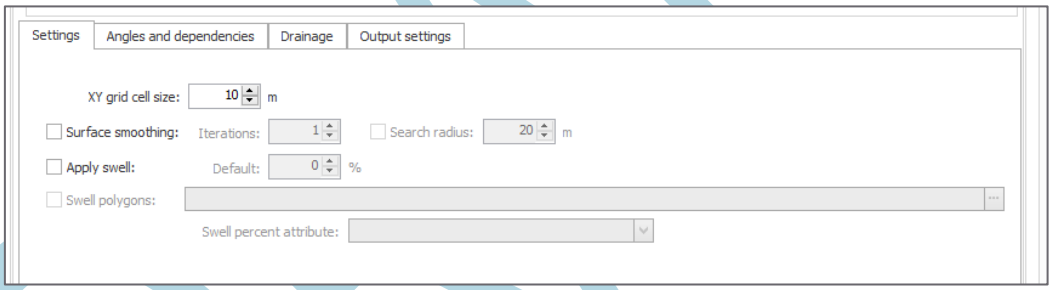


Figure 2-6 - Modelling Grid Size

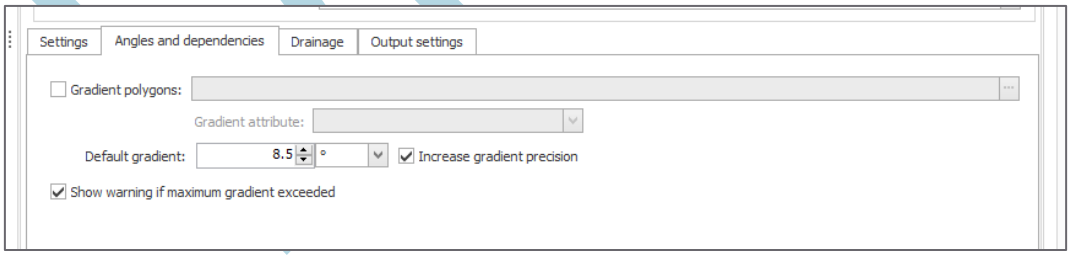


Figure 2-7 - Modelling Grade Constraint Settings

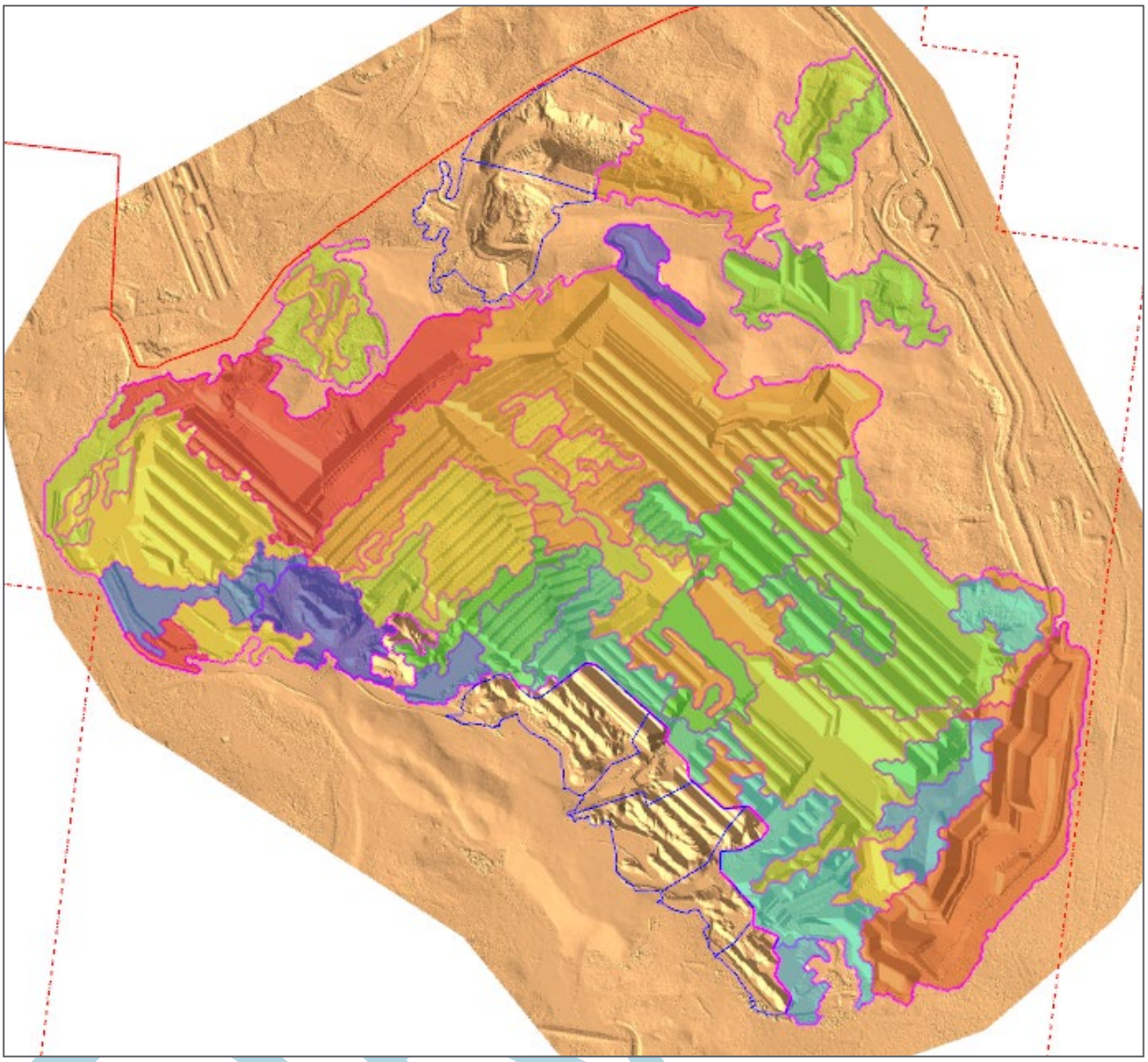


Figure 2-8 - Sub Areas

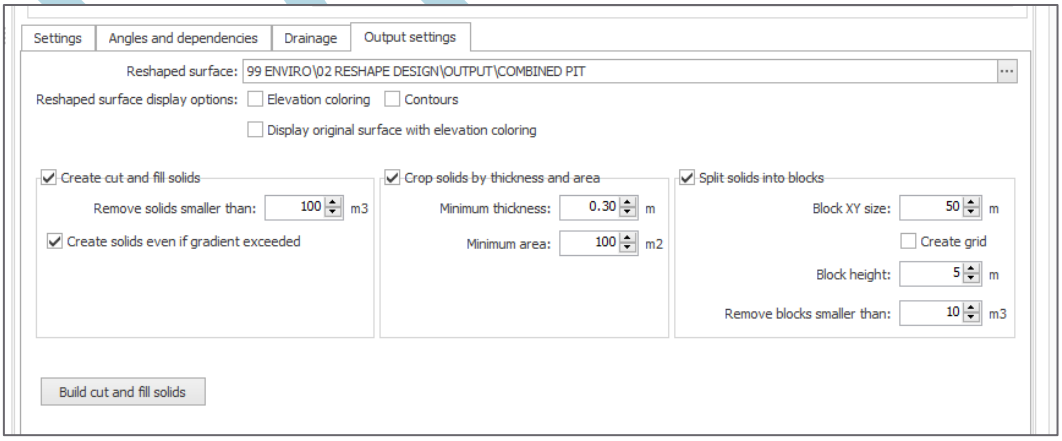


Figure 2-9 - Modelling Output Settings

2.5. DOZER MODELLING

Dozer push is estimated using the split solids generated from the reshape simulation, by connecting the Cut solids to the shortest Fill solid until either the Cut volume is depleted or the Fill volume in consumed and the next shortest fill block connected. Dozer push connectors are limited to 350m and 17degrees maximum push angle. The following fields are generated for reporting:

For Cut Solids

- Filled Blocks
- Dozer Volume Cut
- Dozer Total Distance
- Dozer Weighted Average Distance
- Dozer Weighted Average Grade %
- Fully Cut
- Total Volume Cut
- Other Equip Volume Cut
- Other Equip Total Distance
- Other Equip Weighted Average Distance
- Other Equip Weighted Average Grade %

For Fill Solids

- Volume Filled (Dozer)
- Fully Filled
- From Cut Blocks
- Volume Filled (Total)
- Volume Filled (Other Equip)

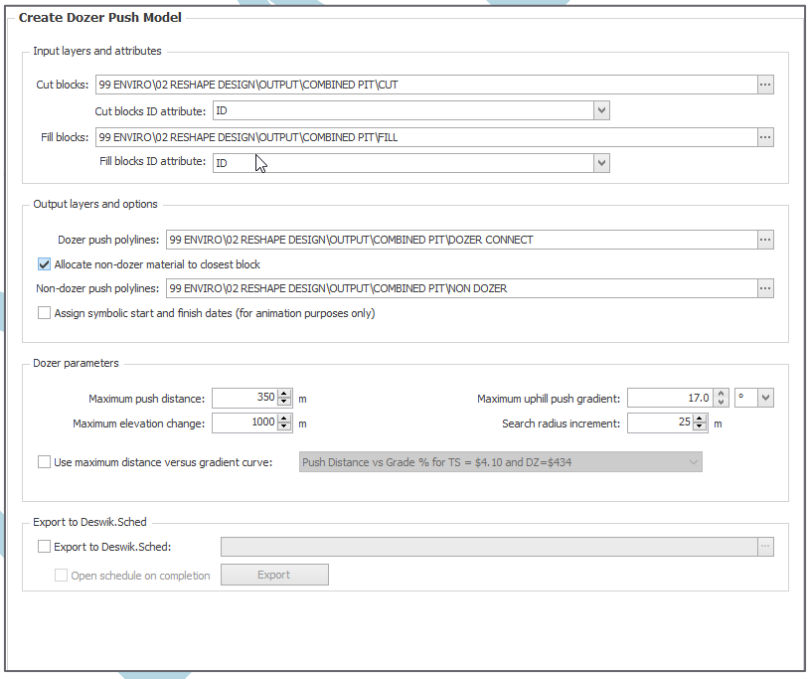


Figure 2-10 - Dozer Push Model Settings

3. MODEL OUTPUTS

Using the settings described in Section 2 of this report the following results can be reported, briefly:

- Table 3 below provides a summary of the quantities by reporting area.
- Figure 3-1 shows distribution of dozer push volumes by average distance
- Figure 3-2 provides an overview of the reshaping solids (Cut & Fill)
- Figure 3-3 illustrates a sectional view of a backfilled void
- Figure 3-4 illustrates a sectional view of a typical mining void
- Figure 3-5 displays the final reshaped landform by elevation
- Figure 3-6 indicates the final reshaped landform gradient

Table 3 – Final Reshape Quantities by Reporting Area

	Dozer/Dragline Total (lcm)	D/D Avg Dist (m)	D/D Avg Grade (%)	Exc Total (lcm)	Exc Avg Dist (m)
FAR WEST	4,166	114	-24%	1,058	1,017
RAMP 5	2,980	118	-18%	310	517
RAMP3	3,298	117	-26%	74	414
SOUTH	5,523	106	-28%	1,718	1,110
WEST	16,552	114	-27%	2,164	491
TOTAL	**32,519**	**113**	**-26%**	**5,324**	**796**

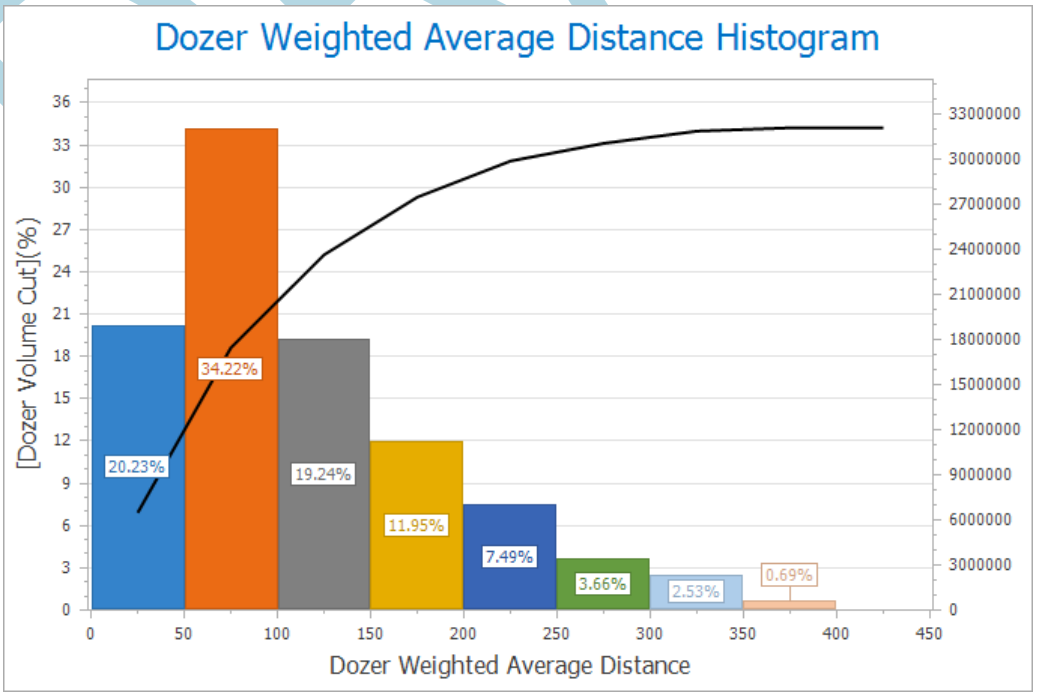


Figure 3-1 - Dozer Push distance distribution

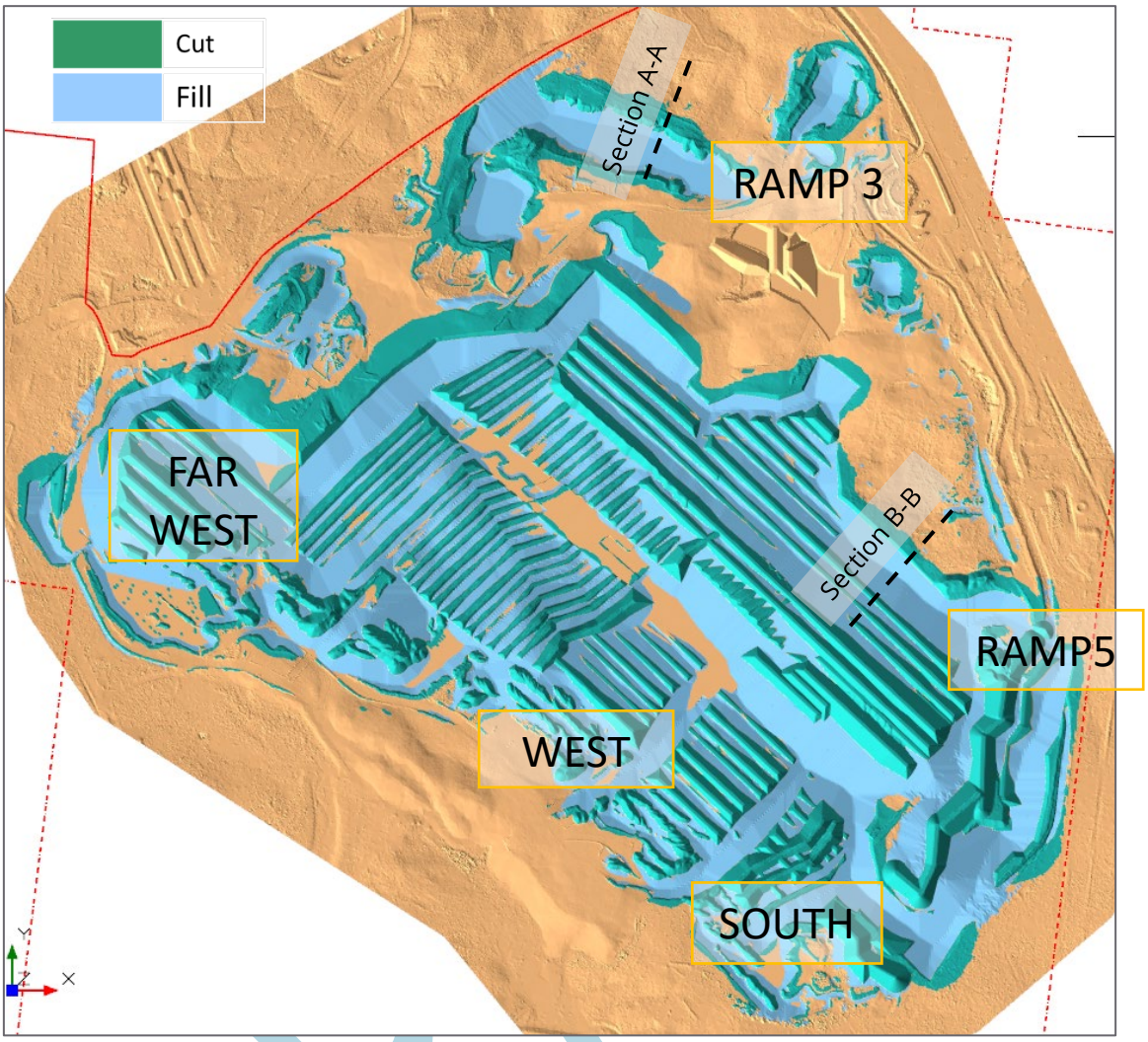


Figure 3-2 - Reshape Solids Overview

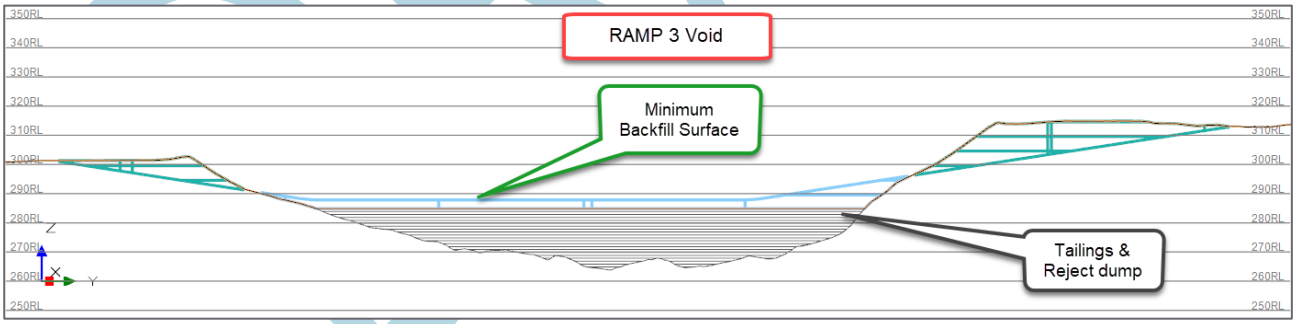


Figure 3-3 - Section A-A

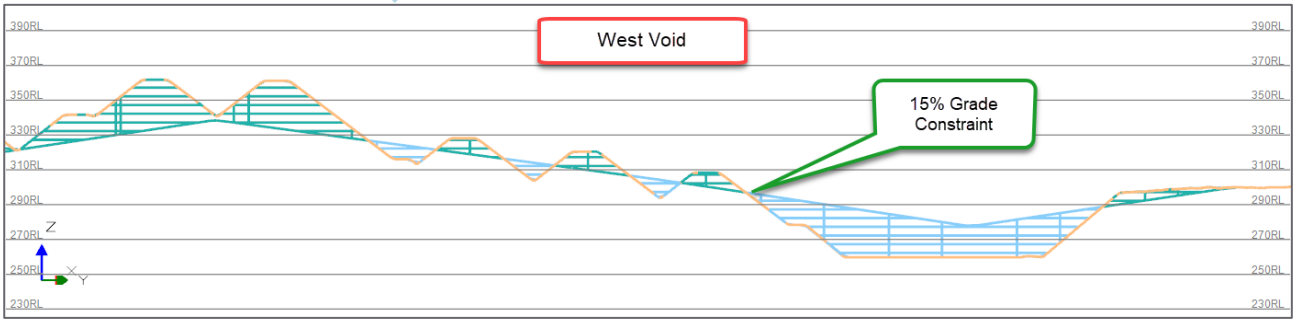


Figure 3-4 - Section B-B

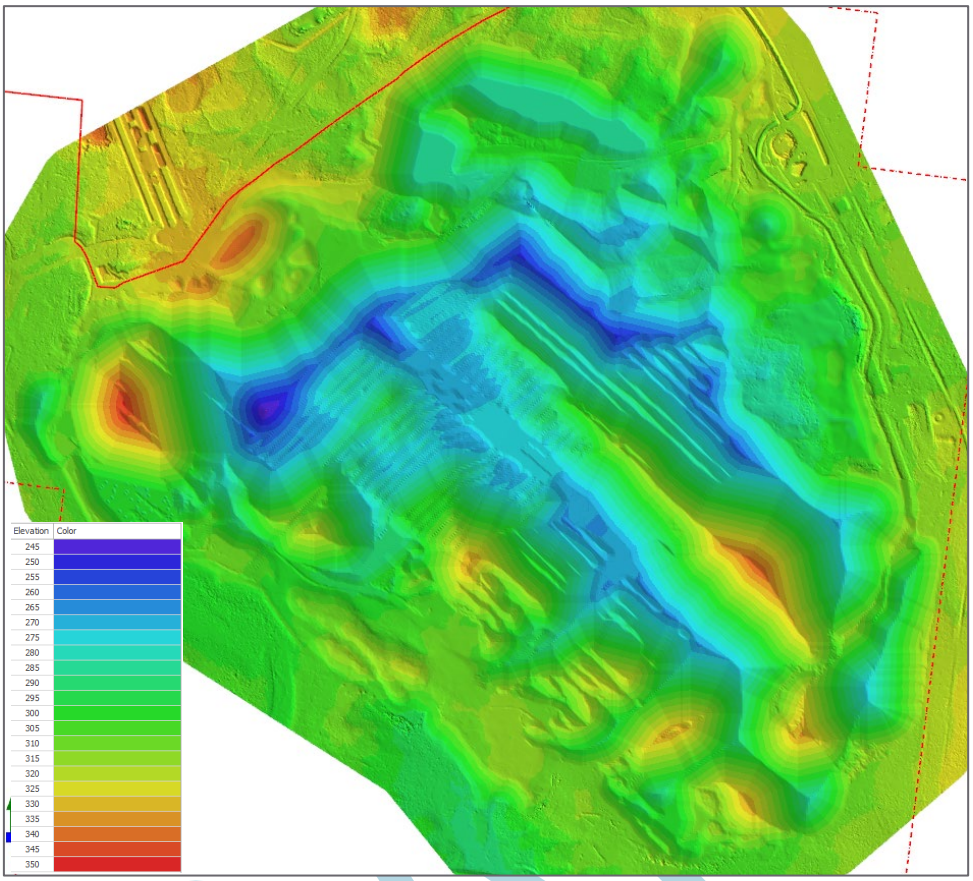


Figure 3-5 - Reshaped Landform Elevations

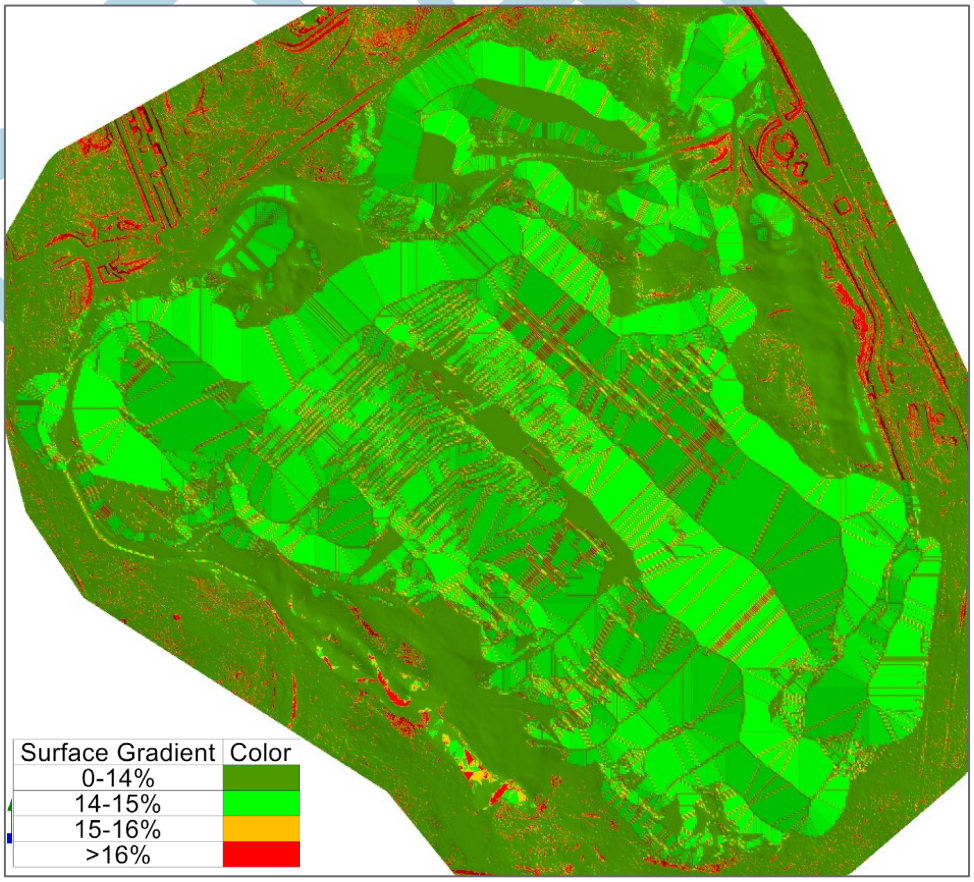


Figure 3-6 - Reshaped Landform Gradient

3.1. PROGRESSIVE RESHAPING ESTIMATION

Progressive areas for reshaping have been identified using annual polygons from the LHS model. Completed mining area and completed dumping area yearly dates were written to the Reshape Cut & Fill solids and used to constrain the availability of the reshaping solids. *It should be noted that the reshaping activities have been conceptually sequenced based on availability only and have not been specifically scheduled using equipment constraints.* The annual progressive reshape quantities are shown in Table 4, with the spatial progress displayed in Figure 3-7. All quantities stated per period are within the estimated production capacities of site equipment, as it is anticipated that site production equipment will be used on reshaping activities to maximise equipment utilization.

Table 4 - Progressive Reshape Quantities

Financial Year	Dozer Total (lcm)	Dozer Avg Dist (m)	Dozer Avg Grade (%)	Exc Total (lcm)	Exc Avg Dist (m)	Dragline Total (lcm)	Dragline Avg Dist (m)
FY22 - progressive	1,398	67	-25%	62	733	-	-
FY23 - progressive	1,398	91	-25%	22	1,024	-	-
FY24 - progressive	1,171	77	-23%	65	1,502	-	-
FY25 - progressive	1,398	99	-29%	222	834	-	-
FY26 - progressive	1,318	93	-27%	90	793	-	-
FY27 - progressive	1,398	94	-24%	28	428	-	-
FY28 - progressive	701	164	-28%	1	371	-	-
FY29 - progressive	1,088	173	-22%	188	492	-	-
FY30 - progressive	1,318	167	-21%	594	755	-	-
FY31 - progressive	1,498	167	-29%	96	560	-	-
FY32 -closure	1,977	145	-23%	550	576	4,308	82
FY33 -closure	4,831	168	-21%	3,406	848	8,717	86
Grand Total	**19,494**	**132**	**-24%**	**5,324**	**796**	**13,025**	**85**

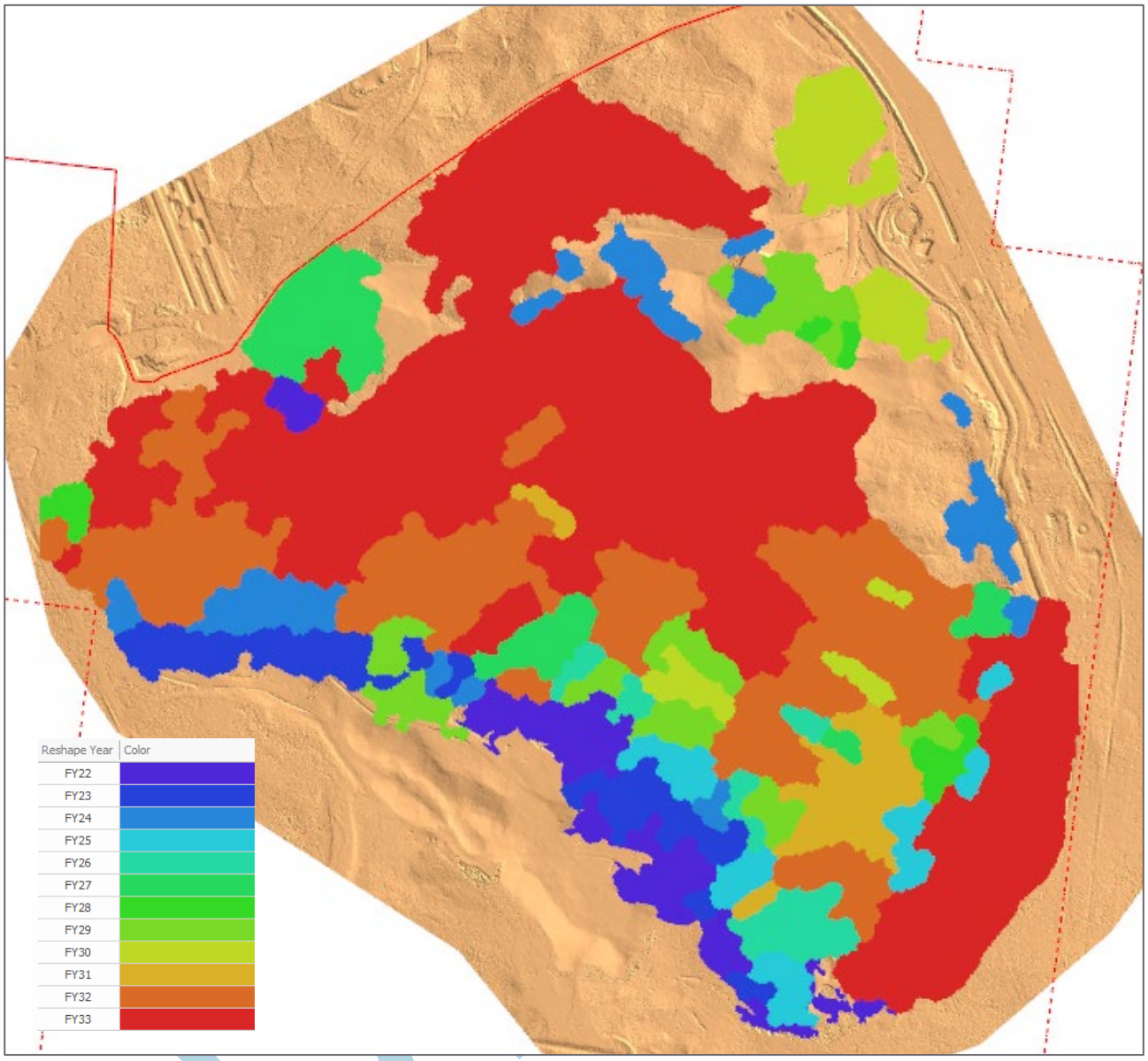


Figure 3-7 - Reshape Progress

3.2. ANNUAL CLOSURE ESTIMATE

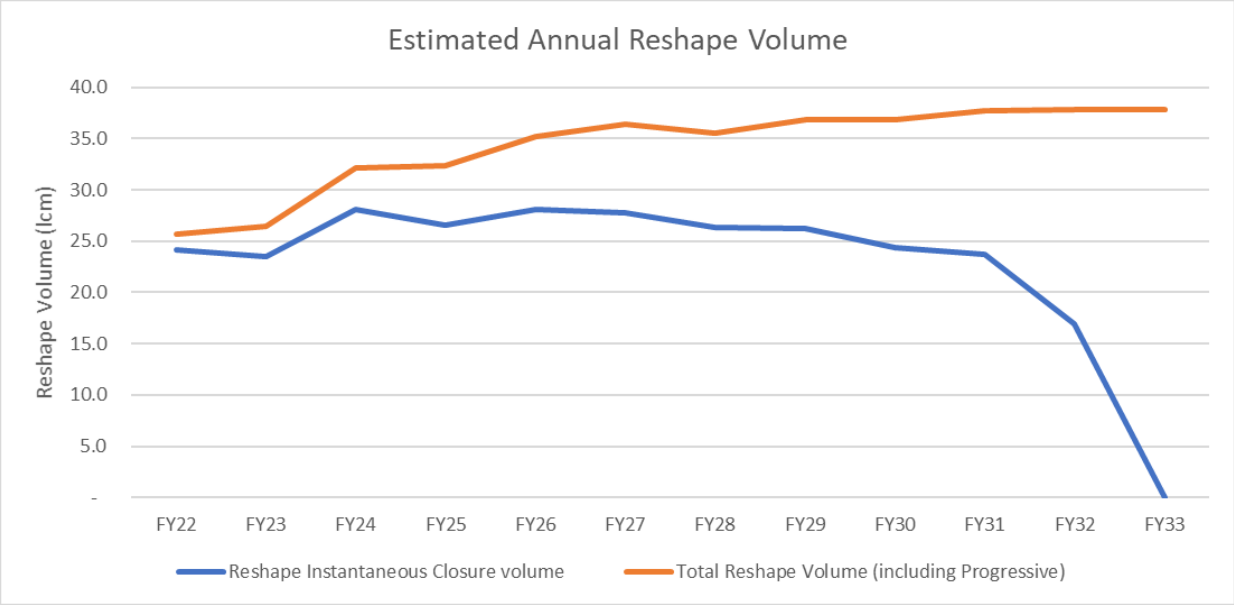
Additional reshape estimates captured at the end of each financial year have also been modelled. These reshape results have not been optimized to maximise dozer push and are used to indicate the evolution of instantaneous closure at any point of the mine life. Table 5 below supplies that estimated quantities for the reshape at the end of each financial year

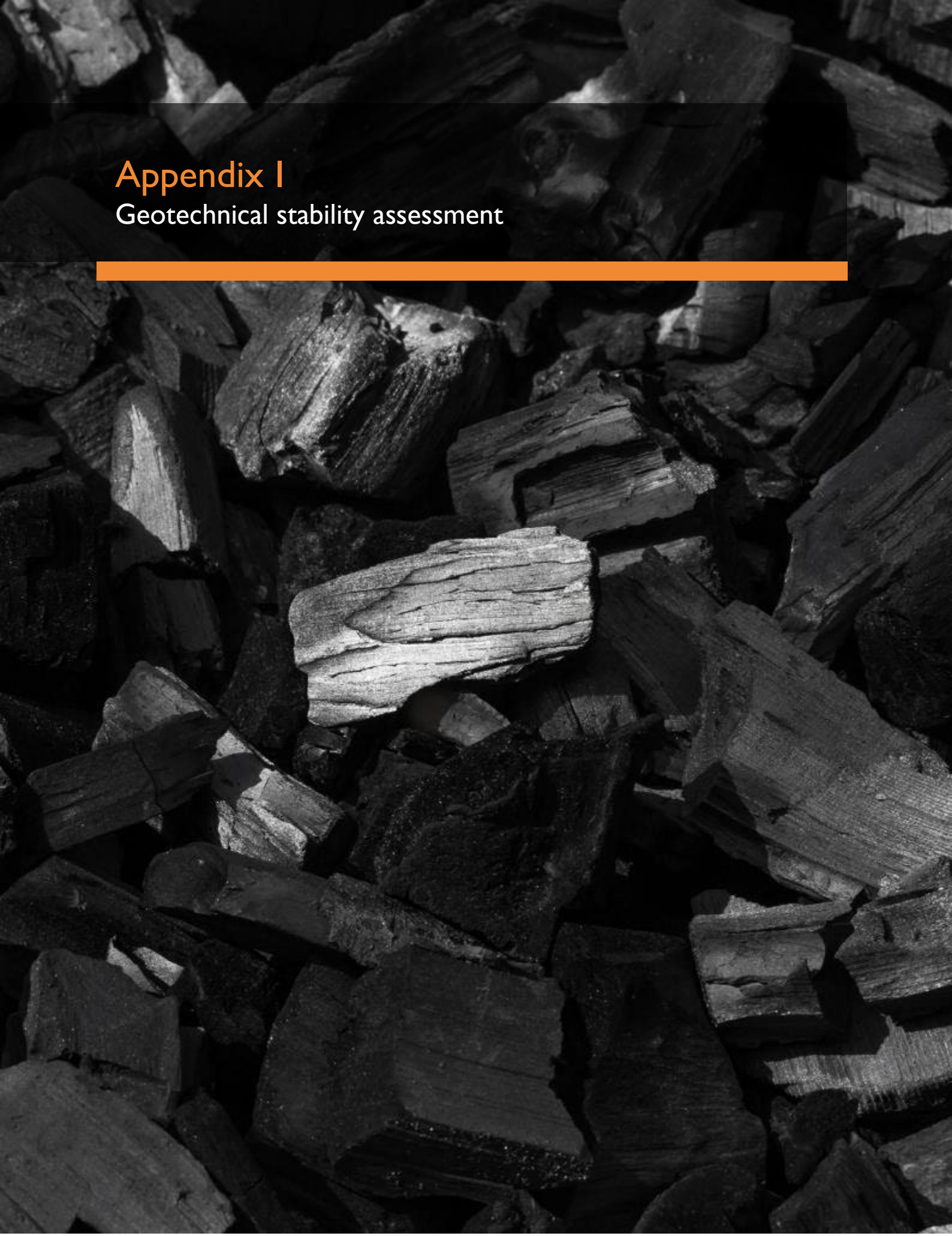
Table 5 - Annual Reshape Estimates

	Total Reshape Volume (mlcm)	Cumulative Progressive Reshape estimate (mlcm)	Cumulative Closure Reshape estimate (mlcm)	Reshape Instantaneous Closure volume (mlcm)
FY22	25.66	1.46	-	24.20
FY23	26.41	2.88	-	23.53
FY24	32.17	4.12	-	28.05
FY25	32.29	5.74	-	26.56
FY26	35.19	7.14	-	28.05
FY27	36.36	8.57	-	27.79
FY28	35.56	9.27	-	26.29
FY29	36.82	10.55	-	26.27
FY30	36.84	12.46	-	24.38
FY31	37.73	14.05	-	23.68
FY32	37.84	14.05	6.84	16.95
FY33	16.95	14.05	23.79	0.00

Figure 3-8 below indicates the trend of reshape estimates over the life of mine, with reshape volumes increasing during periods where mining alignments and/or dumping areas are modified.

Figure 3-8 - Annual Reshape Estimates





Appendix I
Geotechnical stability assessment

This page is intentionally blank.

TERRACOM AUSTRALIA

Blair Athol Coal Mine
Geotechnical Stability of Residual Voids

April 2023

DRAFT

henderson geotech pty ltd
11 Olive St
Morningside 4170
ph: 07 3399 5020

C O N T E N T S

1. INTRODUCTION 3

2. INPUTS TO ANALYSIS 3

2.1 Geotechnical Profile for Final Landform 3

2.2 Materials and geotechnical (strength) properties 5

2.3 Effect of weathering 6

2.4 Effect of long-term erosion 6

2.5 Effect of significant hydrological events 7

3. RESULTS OF STABILITY ANALYSES 7

4. ASSESSMENT OF GEOTECHNICAL STABILITY 12

5. REFERENCES 12

DRAFT

	By:	Date:	Signature:
Draft	S.Henderson RPEQ 4952	23/04/2023	

1. INTRODUCTION

In October 2022, SGM Environmental engaged Henderson Geotech Pty Ltd on behalf of Terracom Australia to provide an assessment of the geotechnical stability of a proposed post-mining landform for Blair Athol coal mine, near Clermont in central Queensland. The main purpose of the assessment is to support development of the void closure plan that is required to be included in the rehabilitation planning part of the progressive rehabilitation and closure plan (PRC Plan) for the mine.

Blair Athol is an open-cut thermal coal mine that has been operating almost continuously for more than a hundred years under various owners. The planned post-mining landform incorporates significant backfilling of the mined pits, leaving relatively gentle surface slopes and broad shallow depressions.

This report describes the methodology, inputs, and results of the geotechnical stability assessment for the planned residual void landform.

2. INPUTS TO ANALYSIS

Note that the term “geotechnical” refers to mechanisms involving physical strength of soil and rock at an engineering scale. That is, it addresses mass movement triggered by mechanical disequilibrium between strengths and loadings. General landform erosion, which is cumulative surface transport at the particulate scale, is a different process and is not addressed in this assessment.

In essence, geotechnical stability is governed by stratigraphy – the distribution of various soil and rock materials within the subsurface profile – and the strength of those materials under the load and moisture conditions occurring at the time.

2.1 Geotechnical Profile for Final Landform

Three Digital Elevation Models (DEMs) were provided of the proposed life-of-mine pit floor, current ground surface and the proposed post-mining landform (refer Figure 1, Figure 2, and Figure 3, respectively). Based on comparison of these, four cross-sections were chosen to cover: typical void geometry; highest pit wall (deepest excavated pit); and thicker and thinner spoil backfill.

Corresponding sections from each DEM were overlaid and geotechnical profiles were interpreted as follows:

- Below mined pit surface – unexcavated ground;
- Current topography higher than mined pit surface within current mined area – existing (old) spoil down to mined pit surface;
- Post-mining landform higher than current topography within current mined area and higher than mined pit surface beyond current mined area – future and/or rehandled (new) spoil down to the other relevant surface.

DRAFT

Figure 1: Final mined shell

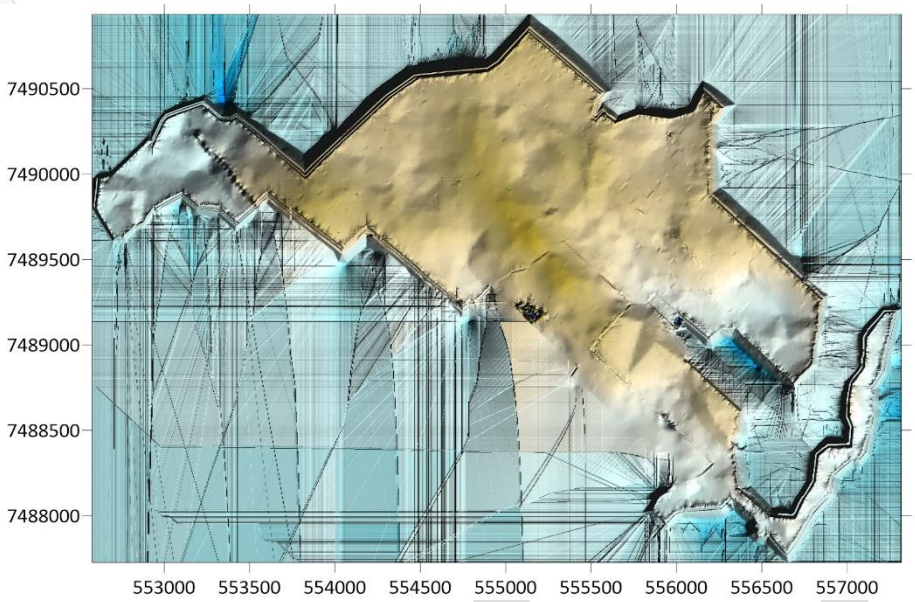


Figure 2: Current topographic surface

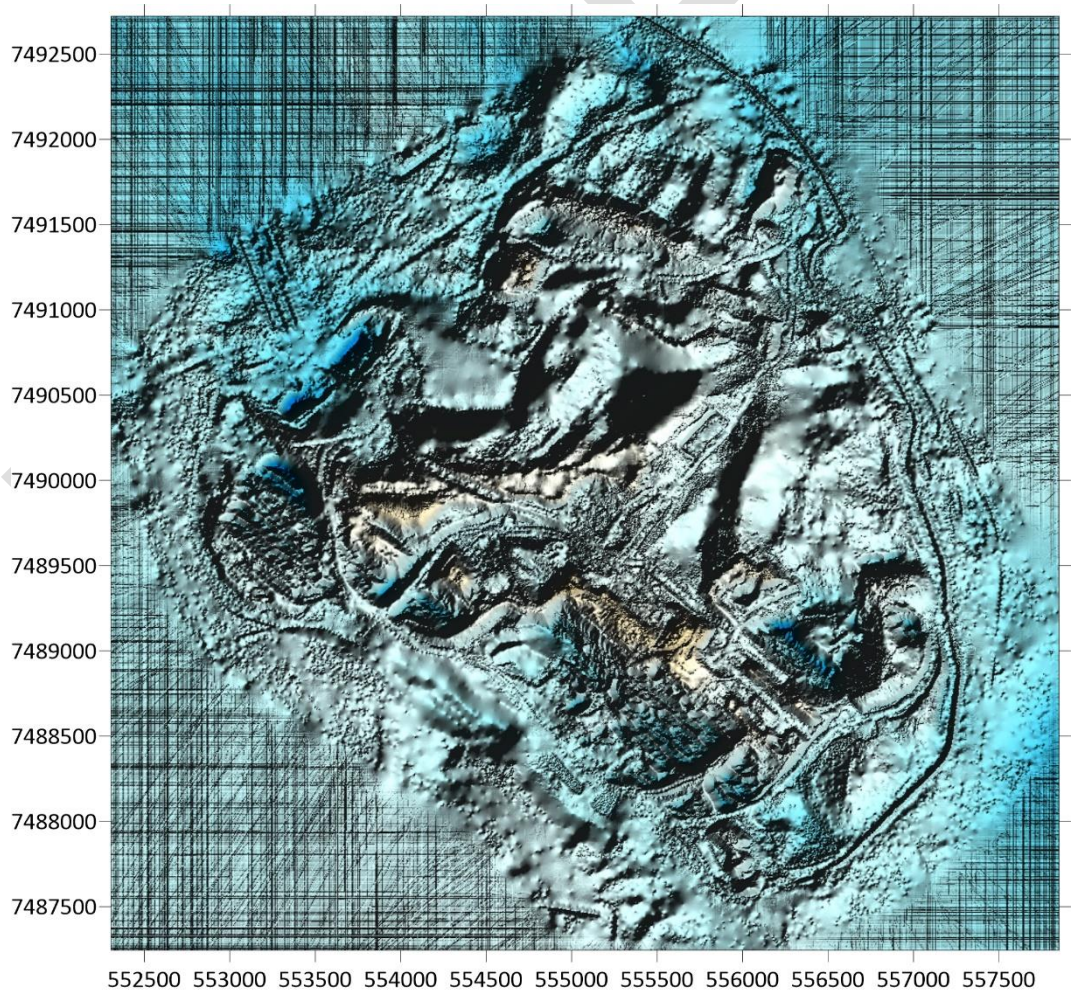
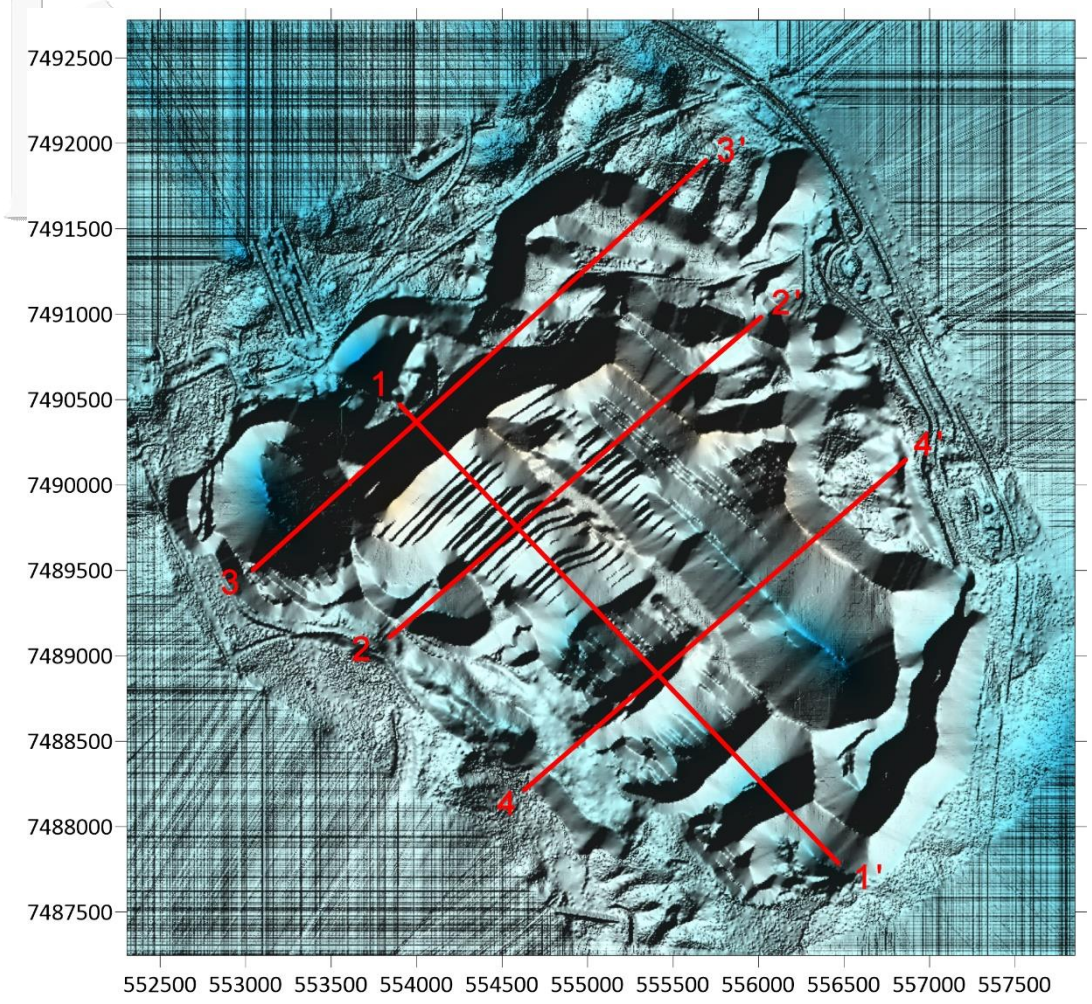


Figure 3: Final Landform



2.2 Materials and geotechnical (strength) properties

The Geotechnical Reference Report for Blair Athol Mine (Encompass Mining, 2020) described the spoil as being Category 1.5 to 2, with the lower categorisation (lower strength) associated with boxcut spoil and rehandled old spoil. However, stability analyses in the report mainly applied the strength properties of Category 2 spoil, except for a truck dump scenario for which three spoil categories were considered. For the purpose of residual void assessment, Category 1 strength properties were conservatively adopted for all spoil; because all analyses showed adequate geotechnical stability (refer Section 4), no refinement of this assumption was attempted.

The Geotechnical Reference Report provided strength properties for weathered Permian overburden (but not Quaternary & Tertiary overburden), fresh Permian overburden, and weak and strong pit floor. As geological model surfaces for Base of Tertiary and Base of Weathering were not provided, the strength properties of fresh Permian overburden were adopted for unmined ground, that is, all material below the final mined surface. The strength of unmined ground above Base of Weathering could be less than this; however, minimum factors of safety were associated with potential slip surfaces contained wholly within spoil and so this assumption regarding overburden strength was not critical. The geotechnical properties adopted for residual void stability analyses are summarised in Table 1.

Table 1: Adopted strength properties

	Unit weight (kN/m^3)	Cohesion c' (kPa)	Friction angle ϕ' (°)
New spoil – unsaturated	18	20	25
New spoil - saturated	20	0	18
Old spoil – unsaturated	18	20	25
Old spoil - saturated	20	0	18
Unmined ground	25	360	38

2.3 Effect of weathering

It is obvious that weathering affects the character and strength of rocks. However, weathering that occurred over geologic time before the void was excavated is automatically accounted for in the strength properties adopted for operational slope design. Hence, consideration of the effects of weathering on long-term stability should only relate to further weathering that will occur after closure.

There are two phases to weathering, physical degradation and chemical decomposition. Degradation involves the rock breaking into smaller fragments, usually due to differential swelling caused by adsorption of moisture. That is, it changes the physical character of the rock but not its mineralogy. Decomposition involves reactions of the actual rock minerals to form different (ultimately, clay) minerals, and again requires moisture but also other reactants including oxygen.

Both forms of weathering occur fastest in hot wet climates, and while Blair Athol mine is hot, the average annual rainfall of 550mm classifies it as dry and hence the expected rate of weathering is "very slight". It is acknowledged that spoil will weather more rapidly than intact rock given its greater exposed surface area; however, the adopted spoil strength properties were conservative and typical of already-weathered materials.

2.4 Effect of long-term erosion

Erosion is the detachment of solid particles from the soil or rock mass and the subsequent transport of those particles away from their initial location. Detachment occurs by mechanical means – such as raindrop impact – and chemical means in the case of dispersive material, while transport is largely by flowing water. Most runoff flow lines are approximately perpendicular to the slope crests and so erosion develops along the same orientation. By contrast, slip failures involve surfaces that are at least sub-parallel to the line of the slope and consequently, erosion does not often cause geomechanical instability.

In summary, erosion may be a significant issue for rehabilitation (depending partly on post-mining land use) but it is generally not a significant factor in void geotechnical stability.

DRAFT

2.5 Effect of significant hydrological events

In central Queensland coal mines, weathered overburden and spoil are often susceptible to softening when saturated, especially materials containing considerable amounts of clay. Most fresh coal measure rocks do not show significant strength loss on wetting. Some claystones/ mudstones are sensitive to moisture, but this becomes apparent as slaking well before closure and is addressed in the selection of strength parameters for long-term stability analysis.

After mine closure, water is expected to accumulate in the void, with the long-term water level dictated by balancing inflows from direct rainfall, catchment runoff and (possibly) groundwater, with outflows due to evaporation and water use. While not a "significant hydrological event" itself, water in the void can affect wall stability by saturating the spoil and overburden. The long-term water level has been estimated to range between RL 270m and RL 282m (WRM Water & Environment, 2022). For stability analyses, a water level of RL 276m was applied, with spoil below that treated as saturated.

The most serious potential impact of "significant hydrological events" (severe rainfall) would be inrush of floodwaters to the void. If it occurred, such inrush could scour a new creek channel that would direct future flows into the void. However, this geotechnical stability assessment has been undertaken within the context of flood risk having been addressed through final landform design, such that inundation of the final void will not occur.

3. RESULTS OF STABILITY ANALYSES

Limit equilibrium analyses were performed using the Slide2 software package. The Sarma vertical slice non-circular slip method was used with an auto-refine search and surface optimisation. This was used in preference to a circular slip surface method to better represent slips that were governed by interfaces between materials and saturation levels.

Given the length of each profile, once the geometry was set up in Slide2, several analyses were run with the slip surface search limits constrained to shorter sections of the profile. This was done to improve accuracy by reducing the vertical slice width and to allow ground slopes in both directions to be analysed. Results are presented in Figure 4, Figure 5, Figure 6, and Figure 7, for profiles 1 to 4 respectively. The lowest factors of safety found were 1.84 and 1.92, both for slopes along Profile 4. The planned final landform has no exposed excavated pit walls, and slip surfaces with computed minimum factors of safety within each sub-section of each profile were almost all contained within the spoil layers.

DRAFT

Figure 4: Factors of Safety along Profile 1

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
New Spoil unsat		18	20	25
Old Spoil unsat		18	20	25
Intact Ground		25	360	38
New spoil sat		20	0	18
Old Spoil sat		20	0	18

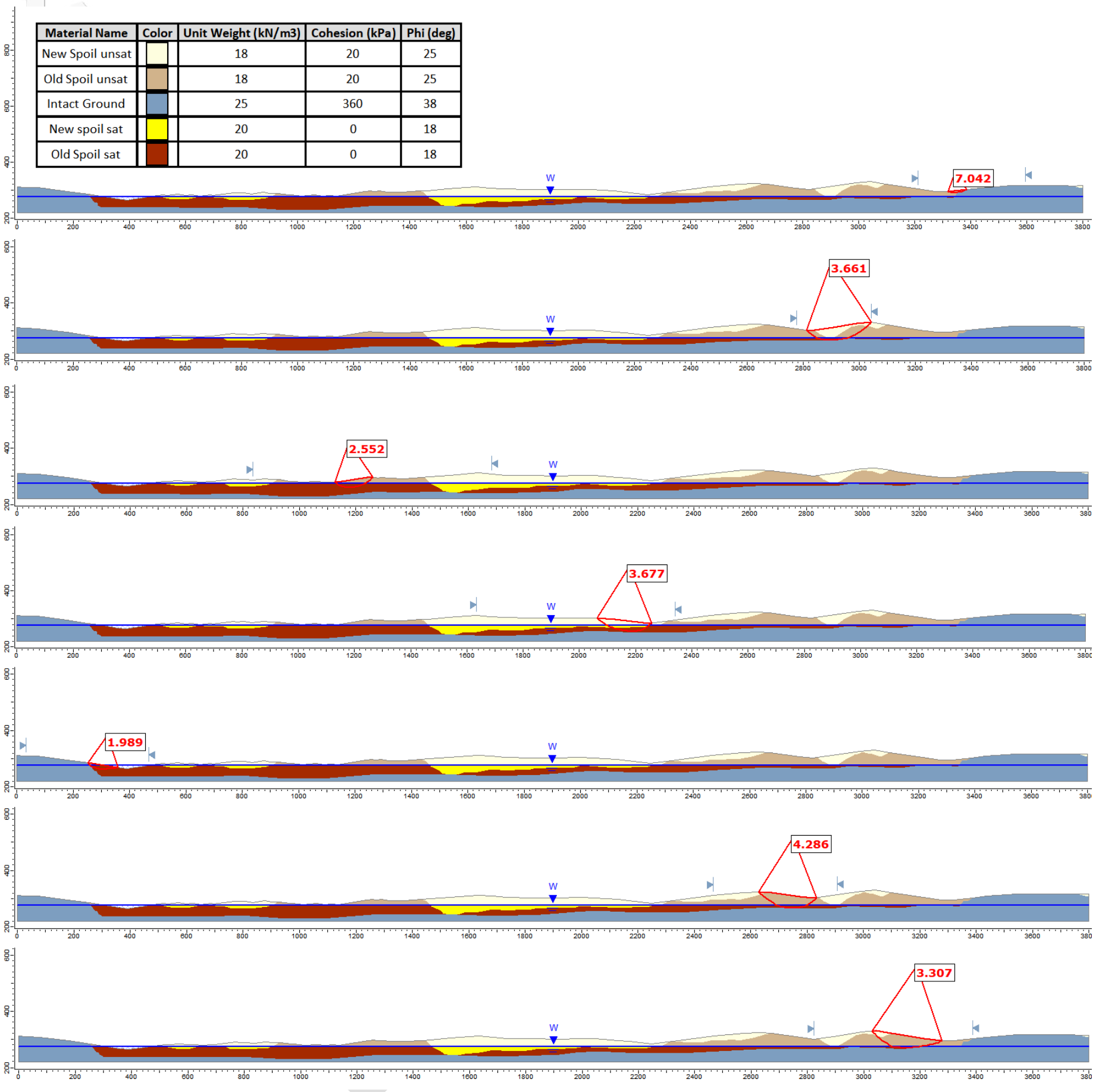


Figure 5: Factors of Safety along Profile 2

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
New Spoil unsat		18	20	25
Old Spoil unsat		18	20	25
Intact Ground		25	360	38
New spoil sat		20	0	18
Old Spoil sat		20	0	18

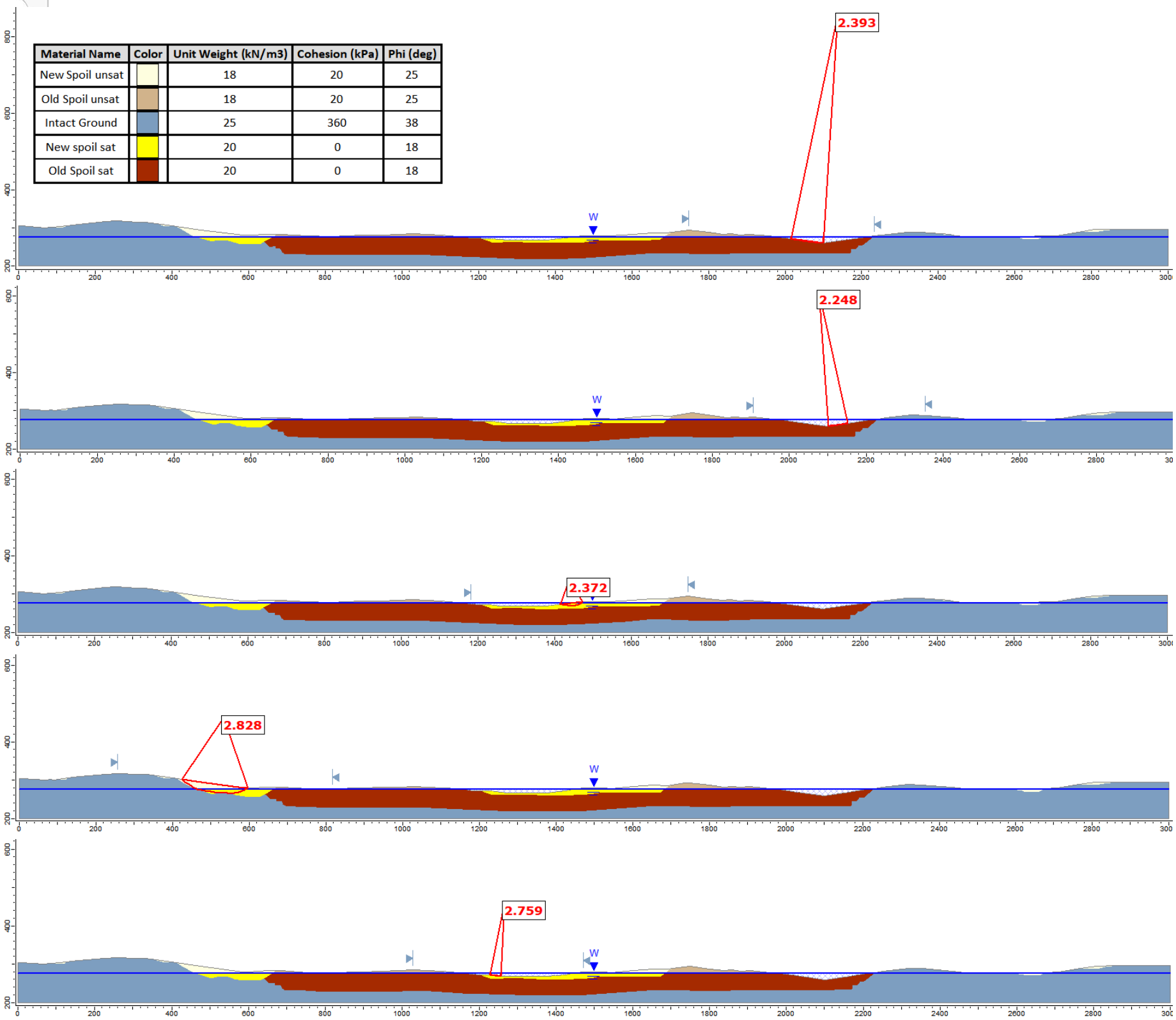


Figure 6: Factors of Safety along Profile 3

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
New Spoil unsat		18	20	25
Old Spoil unsat		18	20	25
Intact Ground		25	360	38
New spoil sat		20	0	18
Old Spoil sat		20	0	18

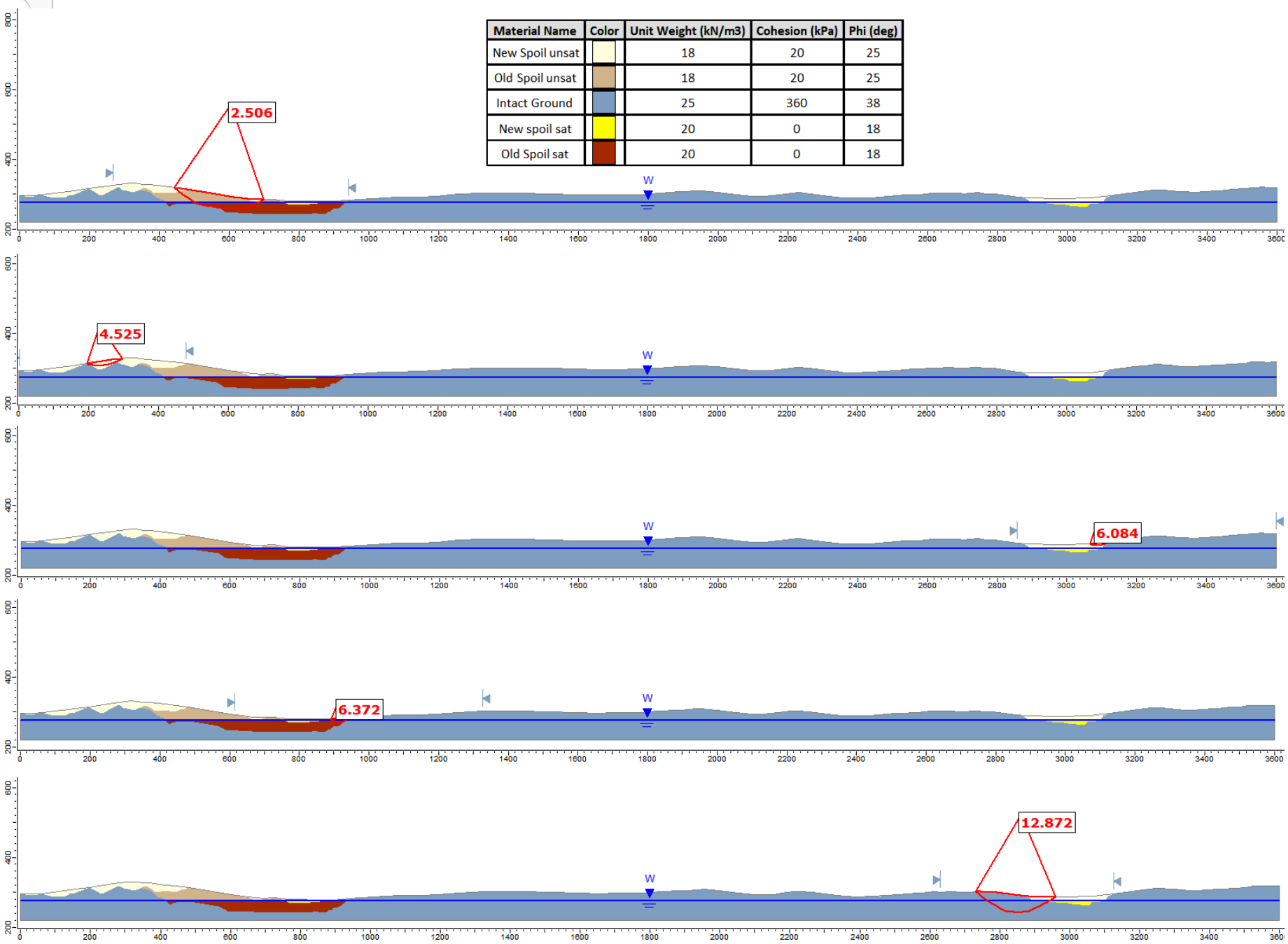
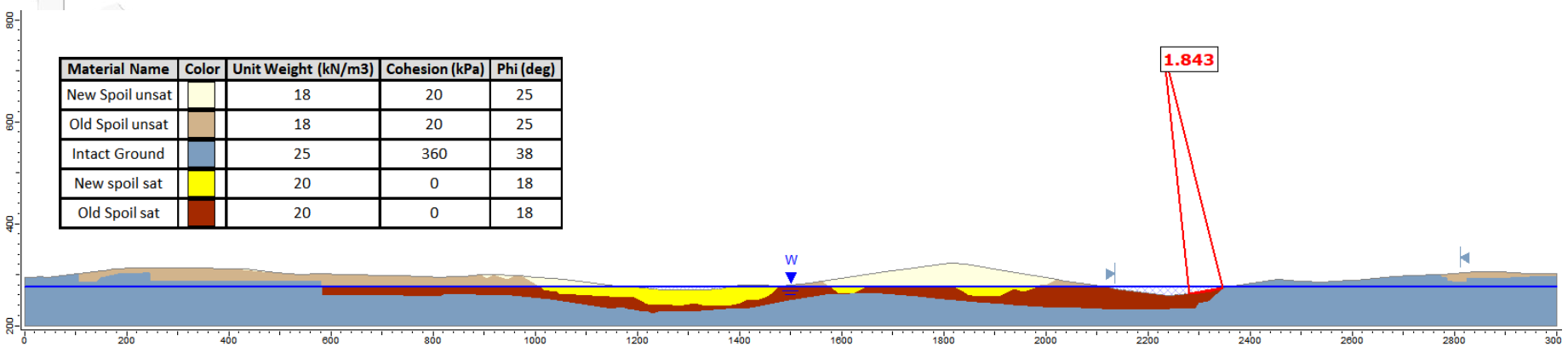
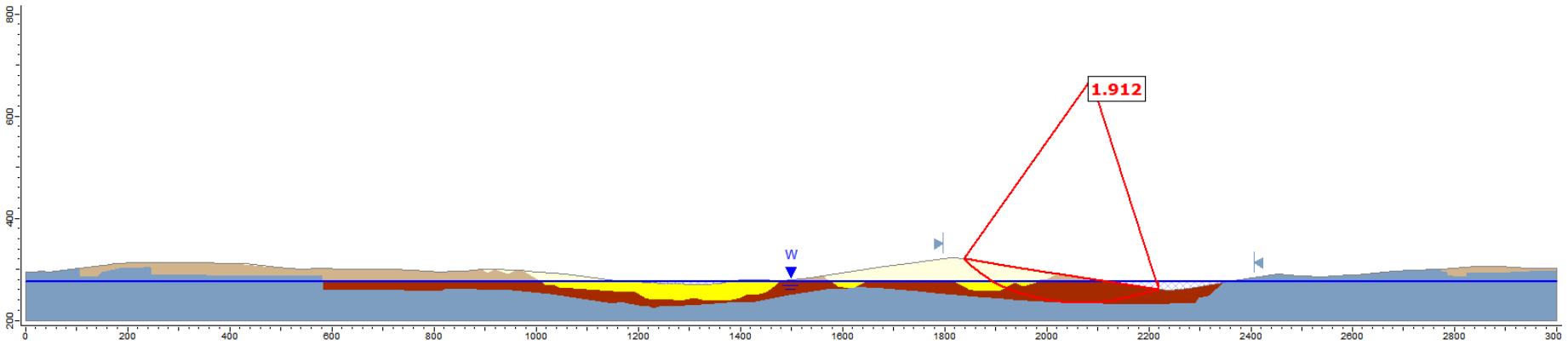
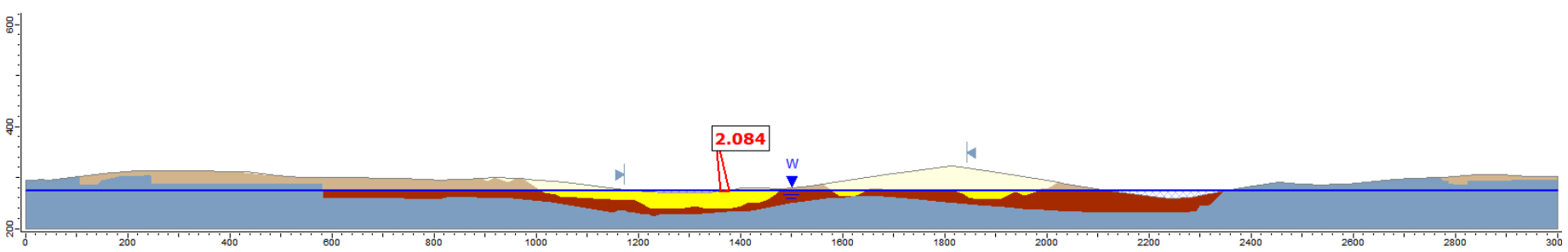


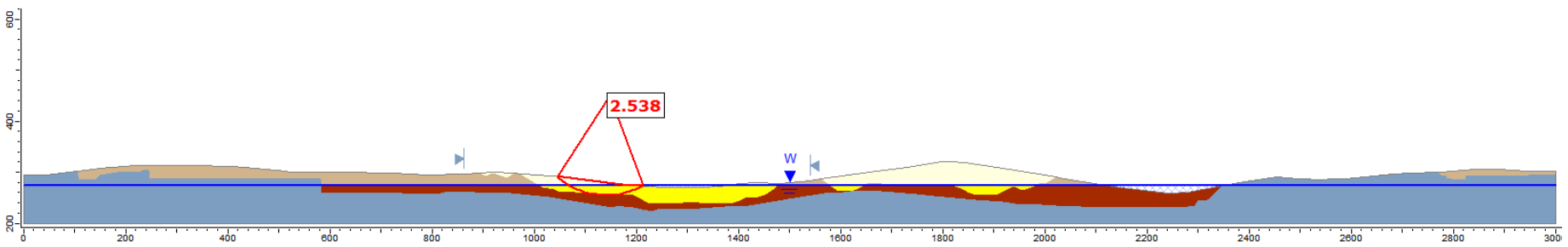
Figure 7: Factors of Safety along Profile 4

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
New Spoil unsat		18	20	25
Old Spoil unsat		18	20	25
Intact Ground		25	360	38
New spoil sat		20	0	18
Old Spoil sat		20	0	18









4. ASSESSMENT OF GEOTECHNICAL STABILITY

A minimum acceptable factor of safety of 1.5 is typically adopted for long-term slope stability. Results for all analyses exceeded this minimum by some margin and hence it is considered that the planned residual void at Blair Athol Mine has adequate geotechnical stability.

Note that this advice is provided subject to the limitations set out in Appendix A.

5. REFERENCES

Encompass Mining, 2020, TerraCom Blair Athol Coal Mine Geotechnical Reference Report.

WRM Water & Environment, 2022, Draft Final void hydrology report Blair Athol Coal Mine.

DRAFT

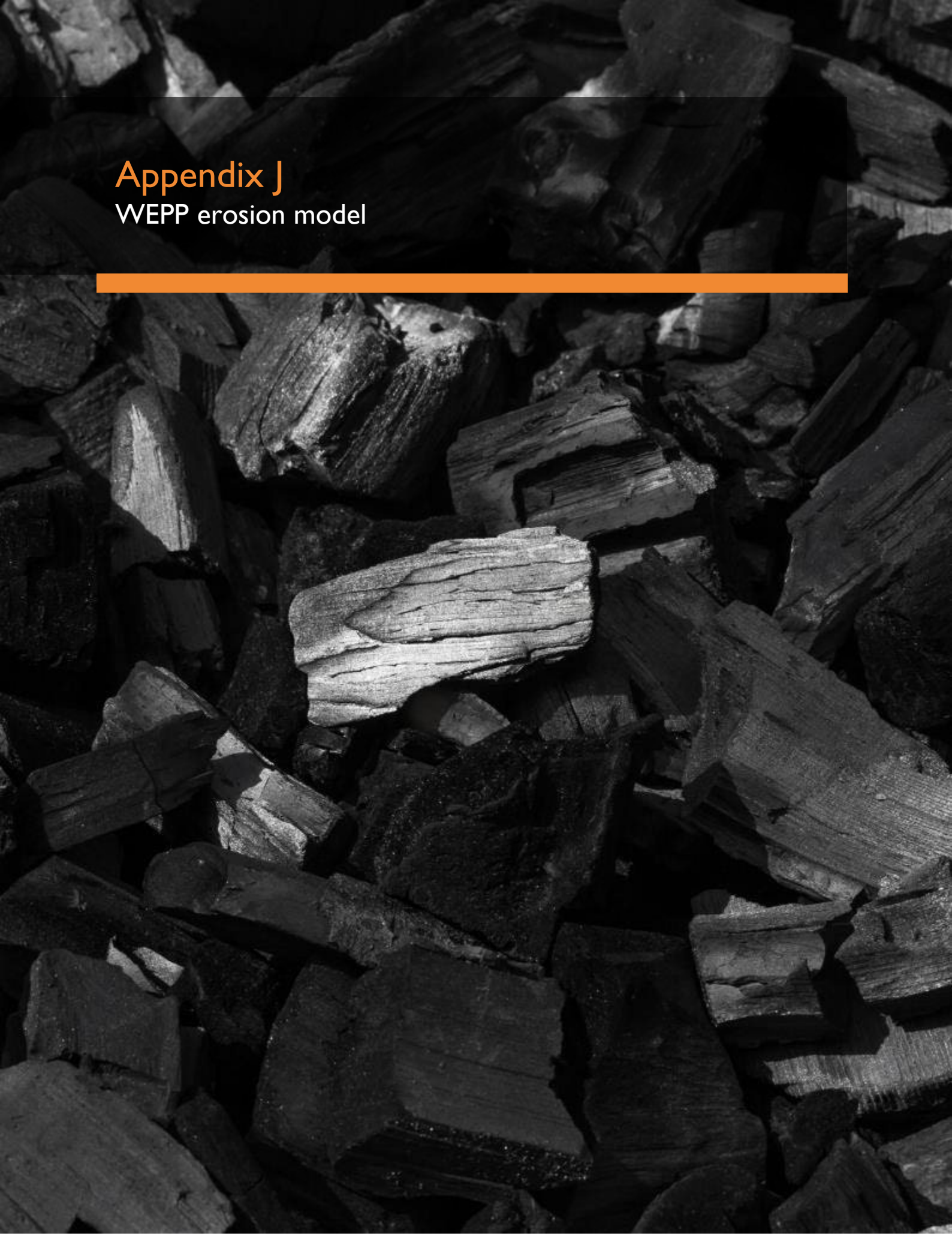
APPENDIX A

Limitation

This report has been prepared by Henderson Geotech Pty Ltd for SGM Environmental (Lead Consultant) on behalf of Terracom Australia (Client) for the purpose of supporting specific approval applications made to the Queensland Department of Environment and Science (DES). No parties other than the Lead Consultant, the Client and DES are authorised to rely on this report without the prior written consent of Henderson Geotech Pty Ltd.

This report is, in part, based on information provided by the Client or by other parties on behalf of the Client (Client-supplied information) in addition to data collected by Henderson Geotech Pty Ltd from the public domain. Henderson Geotech Pty Ltd has not always verified the accuracy of such information and makes no representations regarding its accuracy. Henderson Geotech Pty Ltd is not responsible for the consequences of any error or omission in Client-supplied information.

Henderson Geotech Pty Ltd has prepared this report in a manner consistent with the level of care, skill and diligence ordinarily provided by members of the same specialist field for projects of a similar nature and at the time and in the jurisdiction where the services were rendered. Henderson Geotech Pty Ltd makes no warranty, express or implied.



Appendix J
WEPP erosion model

This page is intentionally blank.

WEPP Modelling

Blair Athol Coal Mine

Prepared for TerraCom Limited| May 2024



TerraCom

SGMenvironmental

This page is intentionally blank

TerraCom

SGM environmental

WEPP Modelling

Blair Athol Coal Mine

Prepared for | 17 May 2024

Project number:	22B081
Document title:	WEPP Modelling | Blair Athol Coal Mine
Revision:	V2-3
Date:	17 May 2024
Client:	

Project manager:	D Borombovits
Author:	A Terry

Legal Name:	SGM Environmental Pty Limited		
Address:	PO Box 5622, Stafford Heights, Qld 4053		
ACN:	621 989 866	ABN:	65 621 989 866
Representative:	Tim Rohde	Phone:	+61 7 3148 6288
Email:	trohde@sgmenvironmental.com		



Honest | Trust | Innovation | Safety

This Report is provided to you the abovenamed Client (Client, you or your) in respect of the above Project and in accordance with our Standard Terms. Capitalised terms that are not specifically defined in this Report have the meanings given to them in our Standard Terms.

© Copyright 2023 SGM Environmental Pty Limited. The concepts and information contained in this document are the property of SGM Environmental Pty Limited. Use or copying of this document in whole or in part without the written permission of SGM Environmental Pty Limited constitutes an infringement of copyright.

Data / confidentiality: This report contains information and data that is confidential and / or subject to restrictions in respect of Intellectual Property Rights (IP). Readers agree to be bound by confidentiality and IP provisions contained in our Standard Terms and the obligation not to cause any damage or hardship to SGM Environmental Pty Limited or the Client.

Document history and status

Revision	Date	Description	By	Review	Approved
V0-1	14/08/23	Draft	A Terry	D Borombovits	T Rohde
V1-1	18/08/23	Draft	A Terry	TCL	T Rohde
V1-2	07/05/24	Final draft	A Terry	D Borombovits	T Rohde
V1-2	17/05/24	Final	D Borombovits	TCL	T Rohde

Table of contents

1.0 Introduction 8
1.1 Purpose 8
1.2 Scope 8
1.2.1 EPML00475513 8
1.2.2 Progressive rehabilitation and closure plan 8
1.2.3 Post-mining land use 8
2.0 Review 13
2.1 Regional 13
2.1.1 Climate 13
2.1.2 Topography 13
2.1.3 Hydrology 13
2.2 Material characterisation 13
2.2.1 Geochemistry of disposal areas 13
2.2.2 Spoil 14
2.2.3 Soil 15
2.3 The final landform 17
2.3.1 Finished surface level 17
2.3.2 Cover 17
2.3.3 Target erosion rate 17
3.0 Erosion measurement and modelling 18
3.1 Rainfall simulation 18
3.1.1 Equipment 18
3.1.2 Preparation 18
3.1.3 Rainfall simulator 18
3.1.4 Overland flow flume 18
3.1.5 Erodibility parameters 19
3.2 WEPP modelling 19
3.2.1 Overview 19
3.2.2 Model inputs 19
4.0 Results 24
5.0 Discussion 25
5.1 Impacts of groundcover 25
5.2 Erosion management 25
5.3 Limitations 26
6.0 Conclusions and recommendations 27
6.1 Recommendations 27
6.2 Landform design rules 27
6.2.1 Groundcover 27

6.2.2 Managing erosion risk during vegetation establishment 27
6.3 Summary 28
7.0 References 29
Appendix A Soil laboratory results 31
Appendix B Expanded method statement 32

Figure

Figure 1 Mining Lease 9
Figure 2 Average monthly rainfall comparison 20
Figure 3 Average recurrence interval comparison 21
Figure 4 Final landform section 23

Table

Table 1 Scope related EA conditions 10
Table 2 EA conditions related to rehabilitation requirements 12
Table 3 Spoil fertility 14
Table 4 Spoil erosion results 15
Table 5 Soil fertility 16
Table 6 Soil erosion results 16
Table 7 Material parameters 21
Table 8 Slope parameters 22
Table 9 Annual erosion rate 24
Table 10 Maximum erosion rate 24

Important note about your report

This Report is provided for the exclusive use of the Client pursuant to the Scope of Works dated 12 October 2022, which requires us to provide Services relating to water erosion prediction project (WEPP) modelling.

This Report is provided to the Client on the terms and conditions set out in the Standard Terms of SGM Environmental Pty Limited (SGME, we, us or our).

We derive data in this Report from information (or confirmation of the absence thereof) sourced from the Client, designated laboratories and / or information that has been made available in the public domain at the time or times outlined in this Report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the WEPP model and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this Report.

SGME has prepared this Report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to any applicable standards, guidelines, procedures and practices outlined in the Scope of Works as at the date of issue of this Report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this Report, to the extent permitted by law.

This Report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by SGME for use of any part of this Report in any other context.

Reporting of the WEPP model are based on a desktop assessment of data that has been measured by SGME and other third parties.

SGME does not accept any Liability whatsoever for, or in respect of, any use of, or reliance upon this Report by any person contrary to the above or our Standard Terms.

1.0 Introduction

Blair Athol Coal Mine (the Mine) is an open-cut coal mining operation owned and operated by TerraCom Limited (TCL). The Mine was previously operated by Blair Athol Coal Pty Limited, a subsidiary of Rio Tinto, in the 1980s until it was put into care and maintenance in 2012. Small scale mining operations date back to the 1890s.

TCL via its subsidiary bought the Mine grant of title transfer from the Queensland Government in 2017. Acquisition of the Mine means that TCL can efficiently reshape and restore one of Queensland's oldest coal mines while cost effectively retrieving remnant resources.

The Mine operates under environmental authority (EA) EPML00876713 and resides in mining lease (ML) ML1804 (Figure 1).

1.1 Purpose

SGM environmental Pty Limited (SGME) has been engaged by TCL to prepare a calibrated erosion model to assess long-term stability of the Mine's final landform.

1.2 Scope

1.2.1 EPML00475513

How this report addresses EPML00876713 is in Table 1.

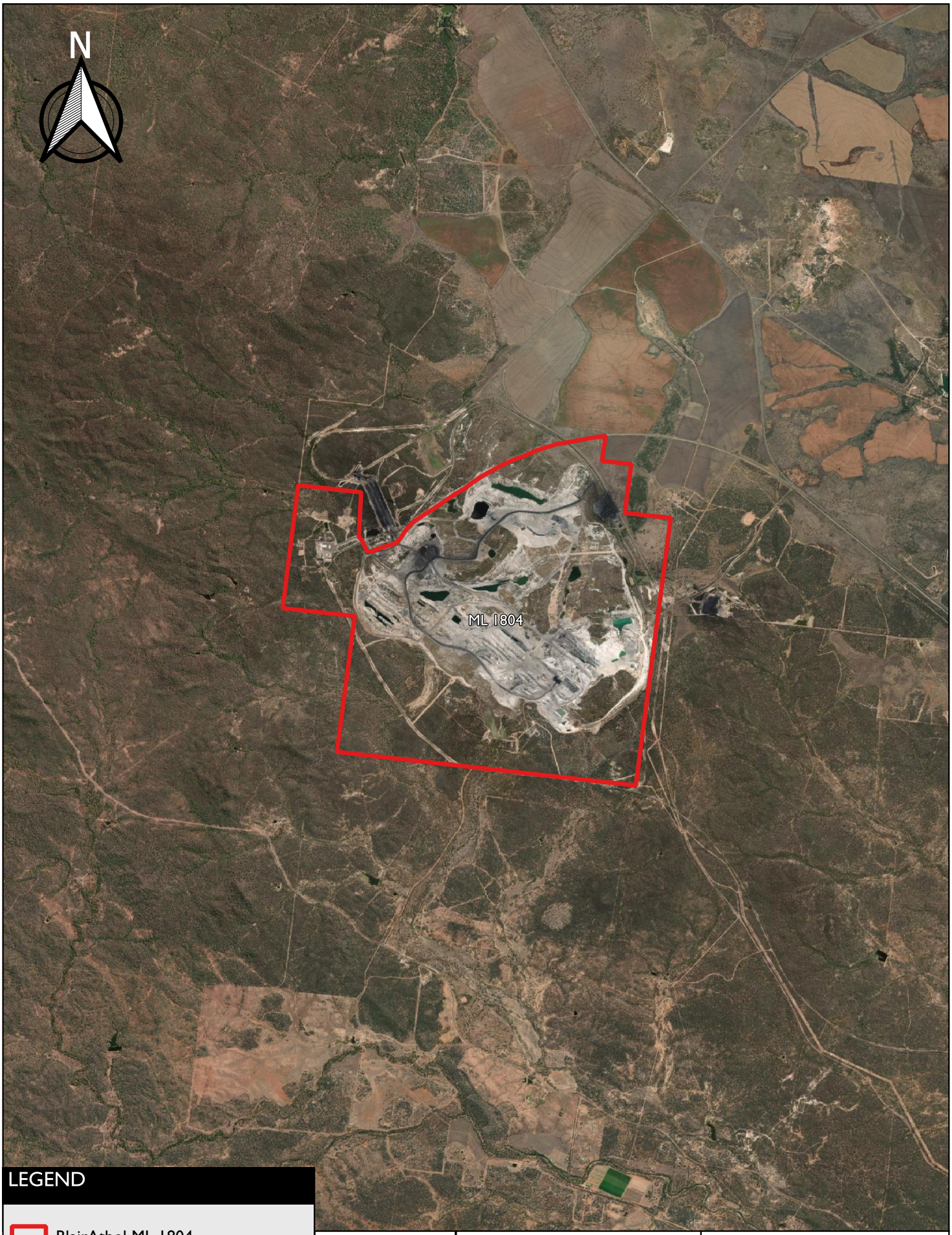
The EA states land must be rehabilitated in accordance to a detailed rehabilitation plan, how this report addresses the rehabilitation requirements is in Table 2.

1.2.2 Progressive rehabilitation and closure plan

It is noted that the requirements do not explicitly direct TCL to provide a landform evolution model (LEM); nor does *Guideline: Progressive rehabilitation and closure plans (PRC plans)* (the PRC plan guideline) describe it as a mandatory action. Therefore, a calibrated WEPP model has been prepared.

1.2.3 Post-mining land use

The post-mining land use (PMLU) for disturbance domains excluding voids is light-grazing pasture.



LEGEND

BlairAthol ML 1804

Scale 1 : 60,000

0 1 2 3 km

SGMenvironmental	Client: Terracom Limited	Project: 21B031 Blair Athol	
	Design: SGM Environmental Pty Ltd 16.06.2023 Scale: 1 : 60,000 CRS: AGD84 / AMG zone 55	Title: Minning Lease	Figure: 1

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

Table 1 Scope related EA conditions

Condition	Description	Action	Reference
F2	Where a surrogate material (growth media) is proposed to be used for rehabilitation either in combination with, or instead of, topsoil, it must be demonstrated as being suitable for rehabilitation at the completion of rehabilitation trials.	Do a material characterisation of spoil and soil to describe their potential to cause contamination.	Section 2.0-4.0
F4	Rehabilitation landform criteria; All areas disturbed by mining activities must be rehabilitated in a manner that ensures it is: a. safe for humans and wildlife; b. stable; c. able to sustain vegetation; and d. non-polluting.	Do a material characterisation to describe their potential to: • cause contamination; • describe fertility characteristics; • describe their potential to erode, and whether the described rate of erosion poses a risk to the receiving environment; and • define the maximum erosion rate.	Section 2.0-6.0
F5	All land disturbed by mining activities must be rehabilitated in accordance with the rehabilitation landform designs detailed in the *Rehabilitation Management Plan* described in condition F13.	Refer to Table 2.	
F6	Rehabilitated landform slope angles are not to exceed 15%, with the exception of Ramp 3 cut through competent rock.	Provide sections of the rehabilitated area.	Section 4.0

Condition	Description	Action	Reference
F7	Successfully rehabilitated land must have no active gully erosion. Erosion must be assessed by annual documented inspections. Gully dimensions must be quantitatively assessed for a minimum of two years both containing a minimum of two rainfall events of more than 25 millimetres in less than three hours.	Describe the potential for the final landform to erode, and whether the rate poses a risk to the receiving environment. Provide accurate simulations using local climate and rainfall data.	Section 3.0-4.0

Table 2 EA conditions related to rehabilitation requirements

Rehabilitation requirement[1]	Acceptable	Action	Section
Slope greater than (>) 15%	Stable	Describe the potential for the final landform to erode, and whether the rate poses a risk to the receiving environment. Define the maximum erosion rate.	4.0
Slope less than (<) 15 %	Stable	Describe the potential for the final landform to erode, and whether the rate poses a risk to the receiving environment. Define the maximum erosion rate.	4.0
Presence of active gully erosion	No	Define the maximum erosion rate.	4.0-6.0
Stable or stabilising gullies	Yes	Define the maximum erosion rate.	4.0-6.0
Groundcover abundance requirement (% cover)	>50%	WEPP model to provide erosion rates for a range of potential groundcovers.	4.0-6.0

1. EPML00876713 condition F13

2.0 Review

2.1 Regional

2.1.1 Climate

The climate is classified as subtropical using the Bureau of Meteorology (BoM) modified Köppen classification system (BoM 2016). These climates tend to experience hot humid summers and a cool to mild winter.

Rainfall data was taken from Winvic (BoM 2023 station number (035094)). There is a distinct wet and dry season. The wet season generally falls between December and March with approximately (~) 60% of the region's rainfall occurring then (BoM 2023). The dry season is generally between April and September. Temperature data was taken from Moranbah waste water treatment (BoM 2023 station number (034038)). With temperatures ranging from 6.4-24.1 degrees Celsius (°C) in winter to 19.8-34.0°C in summer.

2.1.2 Topography

The Mine is located on relatively flat lying terrain at ~317 m above sea level. It is typical of an open-cut coal mine with spoil stockpile high and low local topography associated with open-cut pits. Undisturbed topography consists of gently sloping country derived from metamorphosed sedimentary rocks intersected by volcanic intrusions mostly to the north of the mining lease. Human development of the landscape is typical of Central Queensland, where large areas have been cleared for low intensity grazing and broad acre field crops. Only small remnant areas of native woodland vegetation remain, mostly on upper slopes and along watercourses. The final landform (of the Mine) has very few areas that will erode to the external environment, all disposal areas are designed to erode internally, and only small areas of disturbed land erode externally,

2.1.3 Hydrology

The Mine is located at the top of Bath Creek, a tributary of Sandy Creek, in the foothills of the Drummond Range. Sandy Creek is a sub-catchment within the Theresa Creek part of the Nogoa River catchment in the north-western corner of the Fitzroy Basin.

Diversions of Bath, Washpool and Breaker Creeks have been constructed around the Mine. Historical mine workings have created a depressed landform, where the majority of land drains internally.

2.2 Material characterisation

2.2.1 Geochemistry of disposal areas

Historically, mineral wastes generated at the Mine include (SGME 2020):

- spoil (waste rock);
- interburden;
- coal rejects and fine tailings from the coal wash plant; and
- backfill material from underground workings.

It should be noted that once delivered to a landform spoil, overburden and interburden become intermingled and are the same unit from a rehabilitation perspective.

2.2.1.1 Risk

SGME (2020) did a risk assessment of the mineral waste and determined the risk of acid mine drainage (AMD) as very low. Results from the assessment indicate that:

- Spoil is a low-risk mineral waste with low sulfur content (average 0.05% sulfur) and low to high acid neutralising capacity (ANC).
- Coal rejects are a high-risk mineral waste but do not contain enrichment of metals. With a previous study also indicating that approximately equal portions of the samples tested indicated potential to either form or not form AMD. Coal rejects also have potential to be a medium-risk mineral (where there is limited AMD potential).
- Tailings are a high-risk mineral waste.

2.2.2 Spoil

2.2.2.1 Fertility

Fertility results from SGS are in Table 3 and Appendix A.

The results indicate:

- moderately alkaline;
- restricted plant growth from elevated exchangeable sodium (Na);
- there is limited calcium and potassium (Ca, K) exchangeable cations;
- exchangeable magnesium (Mg) and Na cations are excessive and plant performance may be hindered;
- cation exchange capacity (CEC) is low, indicating potential fertility issues; and
- base saturation indicates negligible past leaching.

Table 3 Spoil fertility

Analyte	Units	Fertility criteria[1]	Result
pH (1:5)	pH units	6.0-7.5	8.1
EC (1:5)	microSiemens per centimetre (µS/cm)	-	670.0
Exchangeable cations			
Ca	milliequivalents per 100 grams (meq/100g)	>5.00	2.9
Ca	% of CEC	65.00-80.00	25.3
Mg	meq/100g	>1.60	5.6
Mg	% of CEC	10.00-15.00	49.0
K	meq/100g	>0.50	0.26
K	% of CEC	1.00-5.00	2.3
Na	meq/100g	<0.10	2.7
Na	% of CEC	0.00-1.00	23.4
CEC	meq/100g	12.0-25.0	11.0

Analyte	Units	Fertility criteria[1]	Result
Base saturation (BS)[2]	%	60.00-80.00	104.18
Chloride (Cl)	milligrams per litre (mg/L)	<800	680.0
Sulfate (SO_4)	mg/L	-	410.0

1. Agricultural industry benchmarks sourced from Rayment & Bruce 1984, Baker & Eldershaw 1993, Department of the Environment and Resource Management (DERM) 2011, Hazelton & Murphy 2016 and Peverill, Sparrow & Reuter 1999.
2. BS = (Ca + Mg + K + Na)/CEC

2.2.2.2 Erosion potential

Erosion potential results are in Table 4 and Appendix A.

The results indicate:

- Spoil is dominated by Mg and is Ca deficient — soil has potential for dispersion;
- ESP is > 6 indicating potential for slaking and dispersion;
- the ESP result is supported by the Emerson class number (dispersive).

Table 4 Spoil erosion results

Analyte	Units	Erosion criteria[1]	Result
Emerson class number	-	>4	2
ESP	%	<6.0	23.4
Ca:Mg	-	>2.0	0.52

1. Agricultural industry benchmarks sourced from Rayment & Bruce 1984, Baker & Eldershaw 1993, Department of the Environment and Resource Management (DERM) 2011, Hazelton & Murphy 2016 and Peverill, Sparrow & Reuter 1999.

2.2.3 Soil

2.2.3.1 Fertility

Fertility results are in Table 5 and Appendix A.

The results indicate:

- moderately alkaline;
- restricted plant growth from elevated exchangeable Na;
- restricted plant growth from elevated exchangeable Mg;
- there is limited Ca exchangeable cations;
- there is limited K exchangeable cations;
- exchangeable Ca % is dominated and cation exchange capacity (CEC) are outside of the desirable range;
- there is enough CEC indicating stored inherent fertility; and
- base saturation indicates negligible past leaching.

Table 5 Soil fertility

Analyte	Units	Fertility criteria[1]	Minimum-maximum (median)
pH (1:5)	pH units	6.0-7.5	8.0
EC (1:5)	µS/cm	-	210
Exchangeable cations			
Ca	meq/100g	>5.00	9.7
Ca	% of CEC	65.00-80.00	62.0
Mg	meq/100g	>1.60	5.0
Mg	% of CEC	10.00-15.00	31.9
K	meq/100g	>0.50	0.16
K	% of CEC	1.00-5.00	1.0
Na	meq/100g	<0.10	0.79
Na	% of CEC	0.00-1.00	5.1
CEC	meq/100g	12.0-25.0	16.0
BS[2]	%	60.00-80.00	124.75
Cl	mg/L	<800	64
SO_4	mg/L	-	16

2.2.3.2 Erosion potential

Erosion potential is in Table 6 and Appendix A

The results indicate:

- soil is dominated by Mg, and Ca is low — soil has potential for dispersion;
- ESP is <6 indicating it is non-sodic and unlikely to be dispersive; and
- Emerson class number suggests it maybe sodic and dispersive.

Table 6 Soil erosion results

Analyte	Units	Erosion criteria	Minimum-maximum (median)
Emerson class number	-	>4	4
ESP	%	<6.0	5.1
Ca:Mg	-	>2.0	1.94

2.3 The final landform

2.3.1 Finished surface level

Disturbed areas will be rehabilitated to a condition that is stable and non-polluting (ie limited erosion potential) in accordance with condition F4 of EPML00876713.

Disturbed areas will be shaped to the final surface level during mining operations. After mining has ended, a soil cover (the cover) will be built to provide an environment favourable for plant growth, limiting potential erosion and supporting a PMLU of light grazing pasture — meeting conditions F4 and F13 of EPML00876713

2.3.2 Cover

The proposed final cover is 0.15 m of soil across all disturbed areas. Waste characterisation (Section 2.2.1) indicates that landform that could erode into surrounding environments are non-acid forming (NAF) and acid consuming (AC), therefore an engineered cover is not needed. Groundcover of at least 50% is required — meeting condition F13 of EPML00876713

2.3.2.1 Material selection justification

In accordance with *Environmental Management Overview Strategy* (EMOS) (Blair Athol Project 1992) a 0.15 m thick layer of soil was determined to be suitable for the Mine. Based on the layer thickness the required volume of soil can be calculated using the total area of soil and strip placement (784.0 and 165.8 ha respectively). The total volume of soil required for rehabilitation is 1,300,350 cubic metres (m^3) (1,176,000 and 124,350 m^3 for soil and strip placement respectively).

SGME (2023) provided information on available soil balances; the mine has ~1,122,492.93 m^3 of soil available for rehabilitation. The volume of soil required is greater than the volume available, mixing of low-risk spoil into some cover areas will be utilised to balance the difference. Areas eroding into the surrounding environment should be limited to covers of soil only.

2.3.3 Target erosion rate

There is currently no broad agreement on what constitutes an 'acceptable' rate of erosion on a rehabilitated landform. The *Prediction of Sheet and Rill Erosion Over the Australian Continent: Incorporating Monthly Soil Loss Distribution* (Lu et al 2001) has reported that:

- the average Australian soil erosion rate is 6.3 tonnes per hectare per year (t/ha/y);
- a low rate of erosion is defined as <0.5 t/ha/y; and
- a high erosion rate is defined as >10 t/ha/y.

Landloch (2013) have shown that rehabilitated mine slopes have a low tendency to rill with an average erosion rate of <5 t/ha/y. The elimination of rilling will largely reduce the potential of channelised flow that can result in gully erosion. Therefore, avoiding rill formation will reduce the potential for landform instability and reduce the likelihood of excessive erosion.

It is important to note that average erosion rates can vary from year to year depending on climatic conditions. Therefore, the maximum annual erosion rate should be used as a secondary performance indicator.

EPML00876713 does not describe criteria for the final landforms erosion rates. Only that they abide by the relevant conditions set. Target average and maximum erosion rates of <5 t/ha/y and <10 t/ha/y have been adopted for the final landform. This is a conservative approach in agreeance with peer-reviewed literature and industry examples; whereby erosion rates below and / or within the adopted threshold are considered acceptable for long-term stability and surface water erosion.

3.0 Erosion measurement and modelling

3.1 Rainfall simulation

Studying hydrological processes such as runoff, erosion and infiltration usually require the use of field plots under natural rainfall or field scale rainfall simulators. Laboratory scale rainfall simulators are a convenient and cost-effective method that have been proven to be effective in predicting hillslope erosion rates and deriving site-specific erodibility parameters for mining landforms (Evans et al 1997, Sheridan et al 2000, Landloch 2010 & So et al 2018). These calibrated parameters can be used in conjunction with erosion models (ie the WEPP model) to assess the long-term stability of the final landform.

3.1.1 Equipment

Mhaske et al (2019) provides a detailed design of the rainfall simulator used in this report. The simulator can be divided into four key parts:

1. a water supply system connected to a pressurised full cone nozzle to produce simulated rainfall;
2. a supporting steel frame to mount the water supply system and canvas windshields;
3. a hydraulic jack attached to a tilting table for slope adjustment; and
4. a perforated plot (eg erosion plot and overland flow flume) to hold the sample to be tested and simulate runoff, infiltration or overland flow.

3.1.2 Preparation

Soil was collected and transported in intermediate bulk containers (IBCs) to the SGME laboratory. The material was uniformly mixed and placed into an erosion plot and an overland flow flume achieving a bulk density that is representative of a trafficked landform (~1.3-1.5 tonnes per cubic metre (t/m^3)).

3.1.3 Rainfall simulator

Interrill erosion was measured by applying a simulated storm (ie 100 millimetres per hour (mm/h)) to a plot 0.50 m wide and 1.00 m long. The plot was set to a gradient of 20% and the storm event run for 30 minutes. Rainfall was applied until steady state runoff was reached; then timed runoff and infiltration samples were collected at five minute intervals. The runoff samples collected after steady state was achieved were dried and weighed to measure the interrill erosion rate. Rainfall is measured by rain gauges and accounted for in the calculation of interrill erosion.

3.1.4 Overland flow flume

Rill erosion was measured by applying various rates of overland flow to a flume 0.75 m wide and 2.00 m long. The flume is set to a gradient of 20° and consecutive rates of overland flow (measured with a flow meter) are applied for three minute intervals. Flow rates are increased until the maximum possible flow is achieved or until rills cut to the base of the flume (rills through). For each applied flow rate, three runoff samples are collected at one minute intervals. The samples were dried and weighed with the mean used to measure the rill erosion rate. No rainfall is applied during the overland flow simulation. If the process rills through it is repeated with the gradient of the flume set to 10% (5.71°). If it does not rill through, the gradient is adjusted to 30% (16.70°) this is to assess erosion processes and rates of runoff for a series of landform options.

3.1.5 Erodibility parameters

The erosion process in the WEPP model requires the following erodibility parameters (the parameters) to assess erosion processes and rates of runoff in response to changes in landform design and land management:

- interrill erodibility (KI);
- rill erodibility — detachment parameter (Kr);
- critical shear stress for rill initiation (c); and
- effective hydraulic conductivity (Ke).

An expanded method statement and equations are in Appendix B.

3.2 WEPP modelling

3.2.1 Overview

The WEPP model is a continuous simulation erosion prediction model, initially developed for agricultural purposes by the United States Department of Agriculture (USDA). The WEPP model integrates hydrology, vegetation science, hydraulics and soil mechanics to simulate the erosion process (both detachment and transport) at a two-dimensional hillslope scale.

The WEPP model is a daily time step model that simulates daily runoff and erosion for a given slope shape, based on initial material hydrological conditions, characteristics of the rain event and material erodibility and infiltration parameters on each day. The WEPP model can also be used to assess the erosion potential for extreme rainfall events.

The WEPP model has been used in the design of landforms for mines across Australia. Howard and Roddy (2012) have shown that observed cumulative erosion rates for mined landforms in Western Australia show good agreement with the WEPP model's predictions.

3.2.2 Model inputs

The WEPP model was used to simulate final landform stability predictions for a 100-year period including data for rainfall, runoff, and sediment loss for the final landform. The WEPP model was also used to determine reductions in erosion rates from increasing groundcover.

WEPP model inputs can be broken up into four key components: climate, material properties, topography (landform design) and surface conditions.

3.2.2.1 Climate

A 100-year synthetic climate file was generated using CLIGEN stochastic weather generator. CLIGEN has been widely used and validated in Australia (Yu 2003). The following data was imported into CLIGEN to generate this file:

- 57 years of patched daily temperature (maximum and minimum), rainfall and solar radiation sourced from the Bureau of Meteorology (BoM) SILO data drill (the SILO data drill) Winvic (35094) ~48.2 km north of the mine; and
- 100 years of pluviography (six-minute rainfall intensity) data from the BoM's Mooranbah Water Treatment Plant (034038), ~111 km north of the mine.

Different parameters were then adjusted in the generated climate file to match the inputted data more accurately. These included average rainfall on a wet day, maximum 30-minute rainfall intensity and time to peak rainfall intensity.

a Validation

The CLIGEN climate file has been compared to the SILO data drill to verify the accuracy of the WEPP model. The CLIGEN climate file and the SILO data drill show a good level of agreement for monthly rainfall totals (Figure 2) and design storm events (Figure 3). From the validation, the CLIGEN climate data file is appropriate for use in the WEPP model.

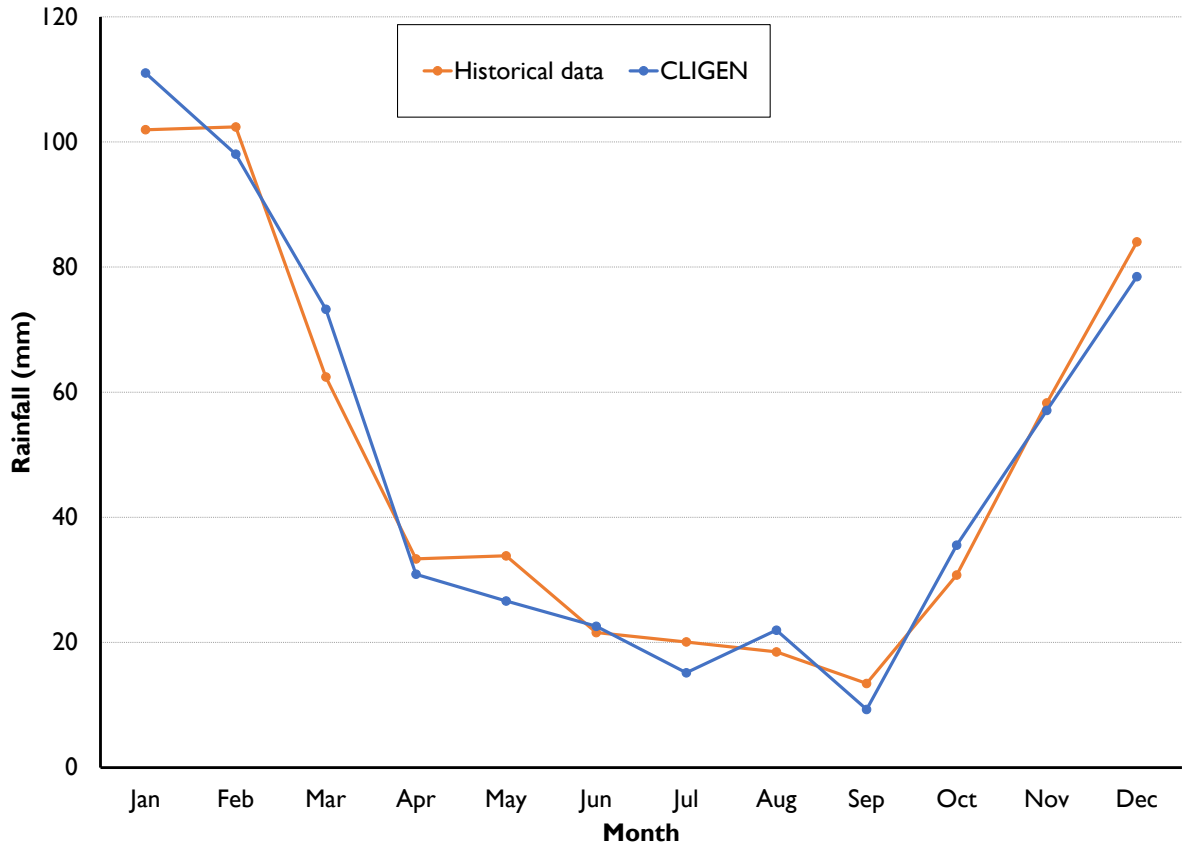


Figure 2 Average monthly rainfall comparison

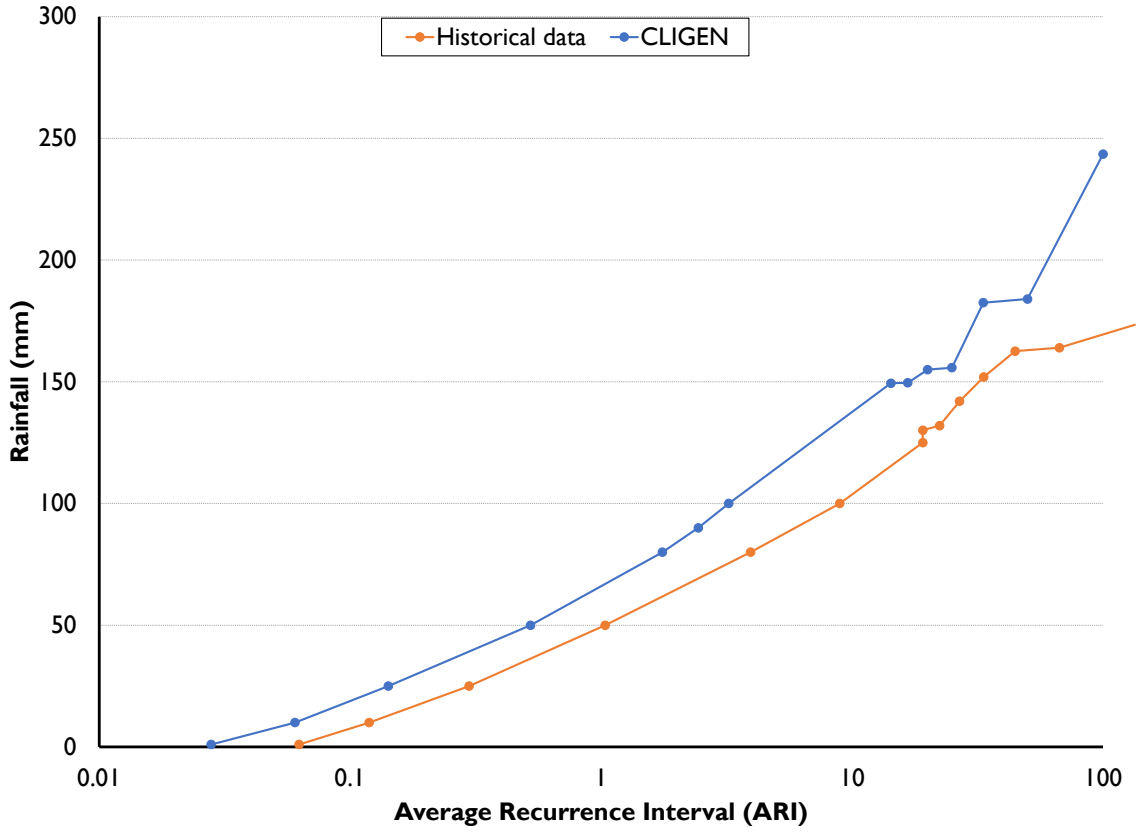


Figure 3 Average recurrence interval comparison

3.2.2.2 Material properties

The WEPP model has been run using average particle size distribution values derived from laboratory physical and chemical data (Appendix A). Results are in Table 7.

Table 7 Material parameters

Material type	Sand	Clay	Rock	Organic matter (OM)	CEC
	%	%	%	%	meq/100g
Soil	47	22	7	4.3	16.0
Spoil	45	15	21	7.2	11.0

The following erodibility parameters were used to model erosion processes and rates of runoff in response to changes in the final landform;

- Soil:
  - interill erodibility — 8.99 x 10^{3} (Kg s m^{-4});
  - rill erodibility — 0.0294 (s/m);
  - critical shear stress for rill initiation — 5.404 (Pa); and
  - effective hydraulic conductivity— 2.41 x 10^{-5} (mm/h).
- Spoil:
  - interill erodibility — 7.53 x 10^{6}(Kg s m^{-4});
  - rill erodibility — 0.0041 (s/m);

- critical shear stress for rill initiation — 15.7805 (Pa); and
- effective hydraulic conductivity — 1.44×10^{-5} (mm/h).

3.2.2.3 Landform design

This section describes the slope parameters for the final landform design. Slope cross sections in the WEPP model were run as:

- Section 1 — (Table 8);
- Section 2 — (Table 8);
- Section 3 — Section 3.0, Section 3.1, Section 3.2 (Table 8); and
- Section 4 — (Table 8).

Sections are also in Figure 4.

Table 8 Slope parameters

Section	Length (m)	Angle (%)
Section 1	336	0.89
Section 2	850	2.35
Section 3.0	390	2.56%
Section 3.1	190	0%
Section 3.2	440	2.27
Section 4	140	2.14

3.2.2.4 Surface conditions

The WEPP model was run for a series of surface conditions:

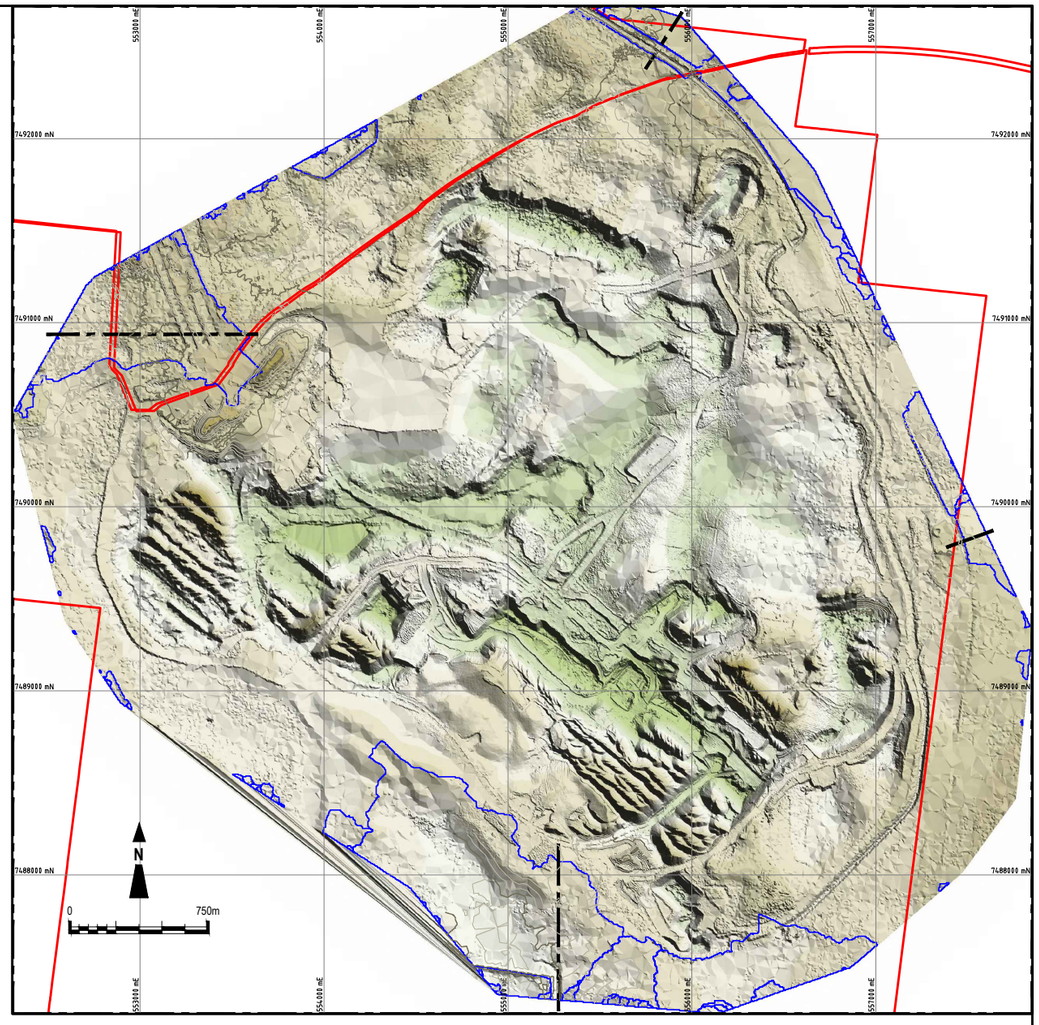
1. bare surface — assumed 0% groundcover (worst case);
2. 30% covered surface — assumed 30% groundcover;
3. 50% covered surface — assumed 50% groundcover; and
4. 80% covered surface — assumed 80% groundcover (best case).

Rill spacing in the WEPP model represents the distribution of flows in which runoff is concentrated. Wide spacing between rills correlates with increased flows in individual rills, increases the potential for critical shear to be exceeded and has a major impact on predicted erosion rates.

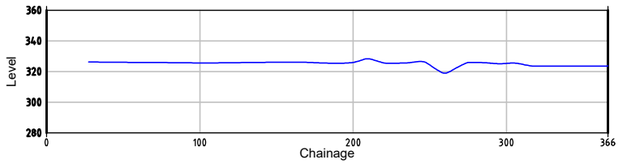
Previous works to predict erosion rates have adopted 1 m rill spacing for spoil, 2 m for clay wastes and 5 m for soil (Landloch 2010). To account for less concentrated flows as the groundcover increases, rill spacing can be modified by adopting 5 m for bare soil, 3 m for 50% groundcover and 2 m for 75% groundcover (Landloch 2019).

As a conservative measure, rill spacing was set to 3 m and surface roughness was set to 0.03 m. This simulates the surface that would develop after exposure to multiple rain events. Appropriate surface roughness also reduces flow velocity and promotes infiltration.

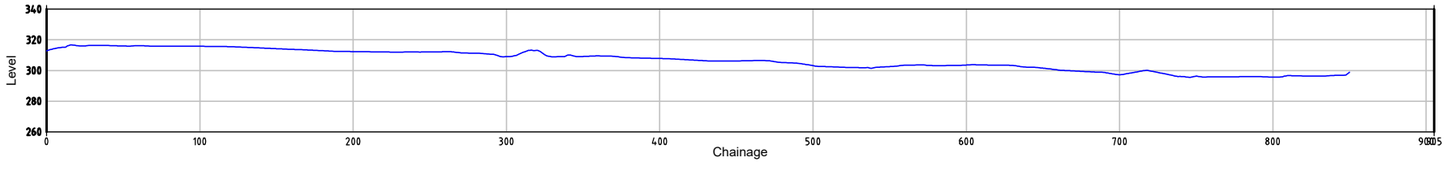
Bare surface simulates a 'worst-case' scenario and no groundcover. It provides initial data from which erosion of covered surfaces was determined. 80% groundcover simulates a 'best-case' scenario.



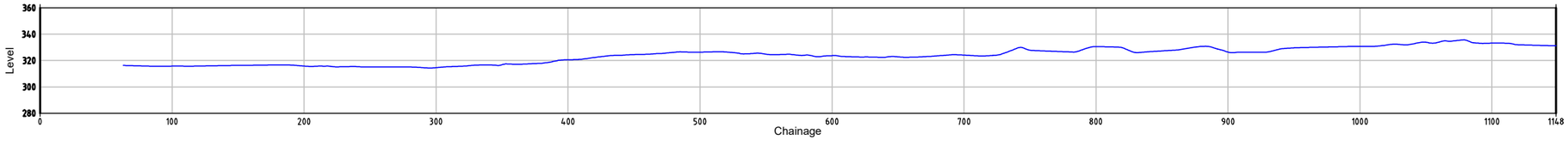
SECTION 1 | Viewed Looking East



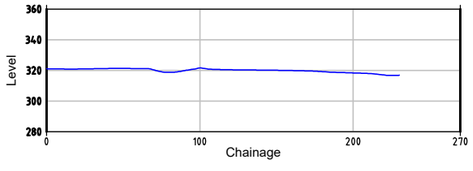
SECTION 2 | Viewed Looking East



SECTION 3 | Viewed Looking North



SECTION 4 | Viewed Looking North



LEGEND

Current Surface

Scale 1:4000

0 120m

Minserve

SGM Environmental
Blair Athol Coal Mine

Design	Minserve
Drawn	RA
CAD File	SGM_BAC_01.DWG
Date/Rev	13/6/23

Existing Landform Cross Sections

Figure 4

4.0 Results

The maximum and average annual erosion rates (t/ha/y) are in Table 9 and Table 10 respectively. The results were obtained from 100 years of predicted rainfall data and under various surface conditions.

Table 9 Annual erosion rate

Slope ID	0% groundcover	30% groundcover	50% groundcover	80% groundcover
Section 1	0.16	0	0	0
Section 2	**7.80**	0.78	0.21	0
Section 3	**7.20**	0.78	0.23	0
Section 4	3.70	0.01	0	0

Bold — > target erosion rate

Table 10 Maximum erosion rate

Slope ID	0% groundcover	30% groundcover	50% groundcover	80% groundcover
Section 1	0.96	0	0	0
Section 2	**15.95**	2.12	0.95	0
Section 3	**17.23**	1.88	0.9	0
Section 4	**11.55**	0.09	0	0

Bold — > target erosion rate

5.0 Discussion

5.1 Impacts of groundcover

Initial simulations demonstrate that groundcover can significantly reduce erosion. It is one of the most effective forms of erosion control because it increases surface roughness, slows overland flow velocity, protects the ground surface from rain splash impact and improves ground condition ie infiltration capacity (IECA 2008).

Erosion modelling shows predicted erosion rates for all landforms were within the adopted threshold (ie average and maximum erosion rate <5 t/ha/y and <10 t/ha/y) and stable. Erosion rates were above recommended rates at 0% groundcover for sections two, three and four. For these sections to meet erosion rate thresholds they must achieve a minimum of 30% groundcover, it is an EA requirement that final landforms meet ≥50%.

Ground preparation and management is important for landform stability and achieving ≥50% groundcover. Erosion modelling assumed ground preparation followed best practice guidelines ie IECA 2008 and that vegetation establishment was uniform across the entire landform.

Generally, groundcovers such as grasses can reduce the formation of sheet, rill and gully erosion. Ideally, grass species used should be native to the area (ie local provenance), appropriate to the position in the landscape, able to compete with exotic / introduced species and support the PMLU.

It is noted that annual runoff and maximum annual erosion loss is predicted to exceed the erosion rate threshold on bare surfaces with no groundcover for sections two, three and four. This is because runoff from rain splash impact is generally independent of land slope (IECA 2008).

5.2 Erosion management

When placing materials in a final landform profile, it is critical to understand the relative erodibilities of the different materials. Soil is non-sodic (<6% ESP) and unlikely to erode and disperse; however, an imbalance in the Ca:Mg ratio has potential to cause erosion.

Erosion rates at any point on the slope that exceed the threshold are considered high-risk with management and mitigation measures needed ie erosion and sediment controls (ESCs). Erosion potential and predicted runoff rates should be managed with appropriate ESCs to reduce erosion potential during vegetation establishment (if needed). Dispersive materials should be selectively placed under non-dispersive materials (ie not surface exposed) and / or treated (ie gypsum) prior to revegetation.

Maximum slope lengths were used to model erosion for a series of landform options. Continuous slopes were assumed with no slope breaks (ie catch drains, benches). Controlling erosion on continuous slopes is an important strategy for revegetation success and minimising other environmental impacts. Site specific slope breaks such as temporary earth or mulch berms, banks and diversion drains may be used to reduce flow velocity and formation of concentrated flow. Erosion of medium grade slopes (ie 10-25%) may require protection from rain splash impact and concentrated flow ie rill forming runoff. Loose organic surface mulch or vegetative debris may be appropriate.

Surface roughness should be applied / maintained to increase water retention on the slope, increase infiltration, reduce runoff volume and flow velocity. Compaction and over-working should be avoided to minimise impacts to soil properties.

5.3 Limitations

The WEPP model was run using desktop data, calibrated erodibility parameters and current landform designs to validate the final landform, and assess potential erosion rates for a 100 year period. It is important to note the model has limitations that may apply in this instance:

- it does not predict deposition patterns;
- it does not adjust hillslope elevation in response to erosion;
- it does not consider gully and tunnel erosion; and
- it does not account for weathering, surface armouring and pedogenesis.

This report does not seek to provide landform design parameters. It seeks to validate the final landform for long-term stability and surface water erosion.

Modelled erosion rates for a 100-year period are considered 'long-term' for the purpose of this report.

The effects of climate change on future rainfall event intensities, durations and / or frequencies may also affect the predictions made by the WEPP model, and any conclusion relating to final landform validation and surface water erosion.

6.0 Conclusions and recommendations

The purpose of this report was to do calibrated erosion modelling to assess the long-term stability of the final landform.

To satisfy the abovementioned, the strategy was to:

- derive measurements from simulated rain and overland flows to enable calculation of erodibility parameters required for the WEPP model; and
- use the WEPP model to validate the final landform for long-term stability and surface water erosion.

Final landform validation was made on the basis of cover options achieving erosion rates below and / or within the target erosion rate threshold over a 100-year period.

Initial outputs demonstrate that vegetation cover had the greatest influence on landform stability ie runoff and soil loss. Increased surface cover reduces rain splash impact to the soil surface and potential for rill forming runoff and promotes infiltration.

6.1 Recommendations

6.2 Landform design rules

The purpose of this report was to do calibrated erosion modelling to satisfy the information requirements from the PRC plan guidelines and assess long-term stability of the final landforms.

To satisfy the information requirements from the PRC plan guidelines, the strategy was to:

- derive measurements from simulated rain and overland flows to enable calculation of erodibility parameters needed for the WEPP model; and
- use the WEPP model to assess erosion processes and rates of runoff for a series of landform options.

Recommended landform design rules are discussed in the Section 6.2.1 and Section 6.2.2.

6.2.1 Groundcover

Initial outputs demonstrate that groundcover had the greatest influence on predicted runoff and erosion loss. Increased groundcover reduces rain splash impact to the ground surface, rill forming runoff and promotes infiltration.

Establishing 50% groundcover is a minimum requirement of the EA for the landform. Further groundcover establishment is recommended to decrease overall erosion rates. Achieving the cover targets for the final landform is shown to reduce erosion risk and impacts to landform stability.

Establishing / maintaining a high surface contact cover such as grass should be the focus initially for the final landform. This should be done in accordance with relevant legislative requirements (EPML00876713 conditions / completion criteria).

6.2.2 Managing erosion risk during vegetation establishment

Managing erosion risk during vegetation establishment should include the use of temporary ESC measures. Benches / berms and catch drains can be effective in managing erosion risk. However, stabilisation and control of water pathways are of primary importance to avoid pooling and tunnel erosion. Temporary earth or mulch

berms are generally more effective in reducing flow velocity and formation of concentrated flow on vegetative slopes (IECA 2008). Mulching can also help retain resources such as seeds and organic matter up slope.

Monitoring and inspections of landforms to identify any erosion formation and effectiveness of ESC measures should be regular and occur pre- and post-rainfall.

To minimise erosion potential the construction of catch drains or benches is recommended, the structures will greatly decrease flow significantly decreasing erosion potential. This is recommended but not necessary if groundcover objectives are achieved.

6.3 Summary

This report aimed to demonstrate that the current landforms will be safe and structurally stable. Recommended actions and a summary from the simulations include:

- landforms are considered safe and structurally stable in terms of erosion rates and are suitable for long-term safety;
- the WEPP model predicted erosion rates were <10 t/ha/yr with a minimum 30% groundcover;
- the EA requires a groundcover target of ≥50%;
- predicted runoff and erosion loss were below or within the adopted erosion rate threshold above which a landform will erode at an unacceptable rate (average and maximum erosion rates of <5 t/ha/y and <10 t/ha/y);
- erosion modelling showed an increased risk of runoff and erosion loss on bare surfaces for all landform options prior to achieving the groundcover targets;
- the use of temporary ESC measures should be considered (ie earth / mulch berms, vegetative debris and surface mulch) to manage erosion risk prior / during vegetation establishment;
- leaving current landforms as constructed is not expected to result in unacceptable runoff and erosion loss above that of the surrounding landscape or be unsuitable for human and / or animal trafficking, provided the groundcover targets are met for all landforms; and
- monitoring and inspections of all landforms should be done to identify any erosion formation and / or effectiveness of any ESCs measures used.

7.0 References

ANZECC & ARMCANZ, 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Canberra, ACT.

Australian Government 2023, Bureau of Meteorology, viewed 14 June 2023, http://www.bom.gov.au/?ref=logo

Australian Government 2023, SILO Australian Climate data from 1889 to yesterday, viewed 14 June 2023 https://www.longpaddock.qld.gov.au/silo/point-data/

Baker & Eldershaw 1993, *Interpreting soil analyses — for agricultural land use in Queensland*, Department of Primary Industries.

DERM 2011, *Protecting Queensland's Strategic Cropping Land: Guidelines for Appling the Proposed Strategic Cropping Land Criteria,* Department of Environment and Resource Management.

DES 2021, Guideline: Progressive rehabilitation and closure plans (PRC plans), Department of Environment and Science.

Blair Athol Coal Project 1992, *Environmental Management Overview Strategy*, prepared for Blair Athol Coal Project.

DSITI & DNRM 2015, *Guidelines for Agricultural Land Evaluation in Queensland*, Department of Science, Information Technology and Innovation (DSITI) and the Department of Natural Resources and Mines.

Blair Athol Coal Project 1992, *Environmental Management Overview Strategy*, prepared for Blair Athol Coal Project.

Evans, K G, Saynor, M J, Willgoose, G R & Riley, S J 2000, Post-Mining Landform Evolution Modelling: 1. Derivation of Sediment Transport Model and Rainfall-Runoff Model Parameters, Earth Surface Processes and Landforms, 25, pp. 743-763.

Greeves, G, Cresswell, H, Murphy, B & Chartres, C 1995, *Productivity and sustainability from managing soil structure in cropping soils of southern NSW and northern Victoria with lighter texture surfaces*, CSIRO Division of Soils, NSW Department of Land and Water Conservation.

Hazelton, P & Murphy, B 2016, *Interpreting Soil Test Results: What do all the numbers mean?*, CSIRO Publishing, Collingwood.

Howard, E J & Roddy, B P 2012, Evaluation of the water erosion prediction project model — validation data from sites in Western Australia, paper presented in Proceedings of the Seventh International Conference on Mine Closure, Australian Centre for Geomechanics, Perth, pp. 81-92.

International Erosion Control Association (IECA) 2013, *Best Practice Erosion and Sediment Control – Book 1-3*.

Landloch 2010, Rehabilitation of Waste Landforms: Woodie Woodie Manganese Operation, prepared for Consolidated Minerals Limited by Landloch Pty Ltd.

Lu, H, Gallant, J, Prosser, I P, Moran, C & Priestly, G 2001, Prediction of Sheet and Rill Erosion Over the Australian Continent: Incorporating Monthly Soil Loss Distribution, CSIRO Land and Water, Canberra, Australia.

Mhaske, S, Pathak, K & Basak, A 2019, A comprehensive design of rainfall simulator for the assessment of soil erosion in the laboratory, Department of Mining Engineering, Indian Institute of Technology, Kharagpur, India.

Peverill, K, Sparrow, L & Reuter, D 1999, Soil Analysis: An Interpretation Manual, *Catena* 39(2000), pp. 301-303.

Rayment, G E & Bruce, R C 1984, *Soil testing and some soil test interpretations used by the Queensland Department of Primary Industries*, Department of Primary Industries.

SGME 2020, *Disposal Plan: Overburden, Interburden, Spoil, Coal washery Coarse Rejects and Tailings,* Prepared for TerraCom Limited by SGM environmental Pty Limited.

SGME 2023, *Soil and capping material assessment,* Prepared for TerraCom Limited by SGM environmental Pty Limited.

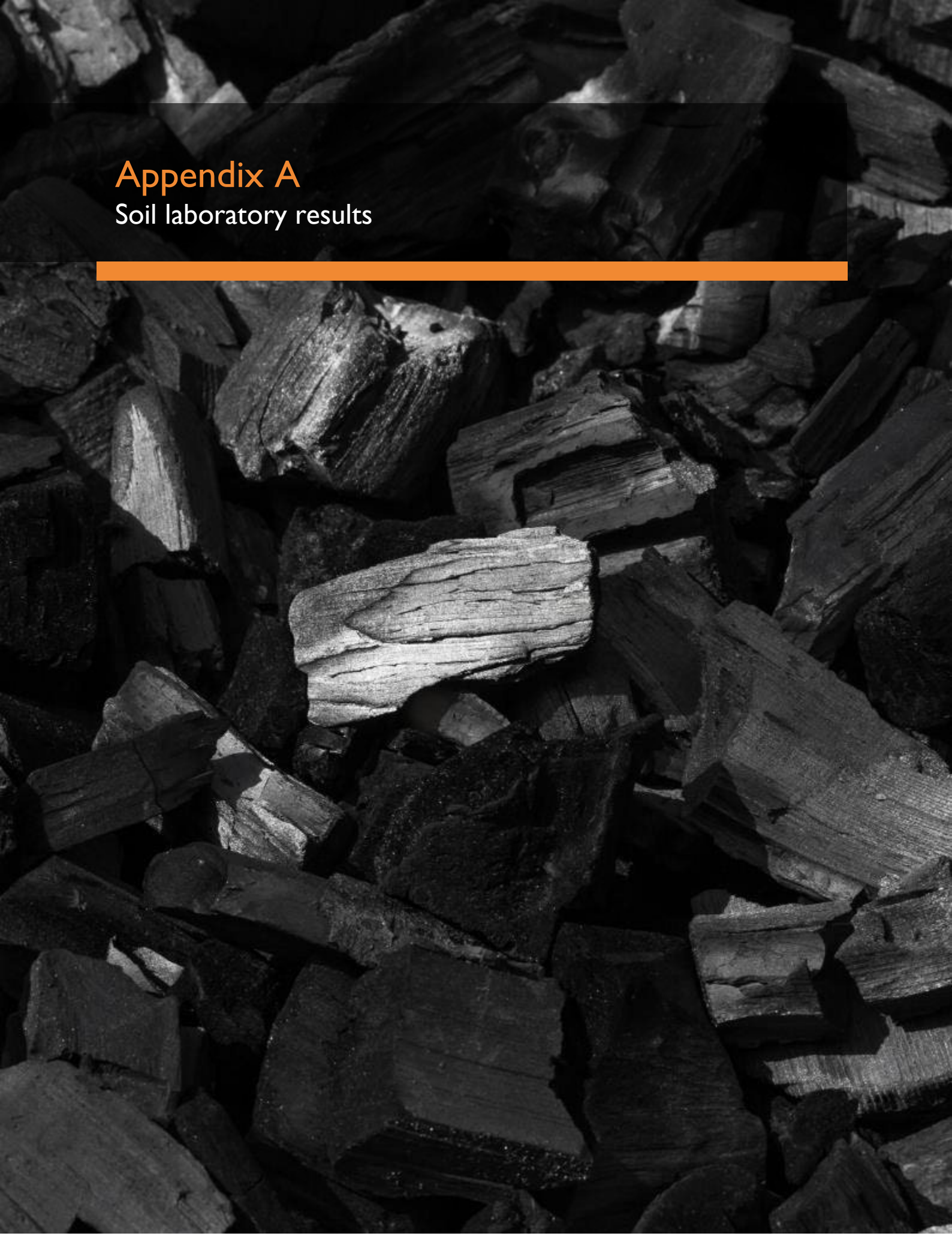
Sheridan, G, Loch, R & So, H 2000, Use of laboratory-scale rill and interrill erodibility measurements for the prediction of hillslope-scale erosion on rehabilitated coal mine soils and overburdens, Australian Journal of Soil Research, 38, pp. 285-97.

So, H, Khalifa, A, Yu, B, Caroll, C, Burger, P & Mulligan, D 2018, MINErosion 3: Using measurements on a tilting flume-rainfall simulator facility to predict erosion rates from post-mining landscapes in Central Queensland, Australia, PLoS ONE 13(3).

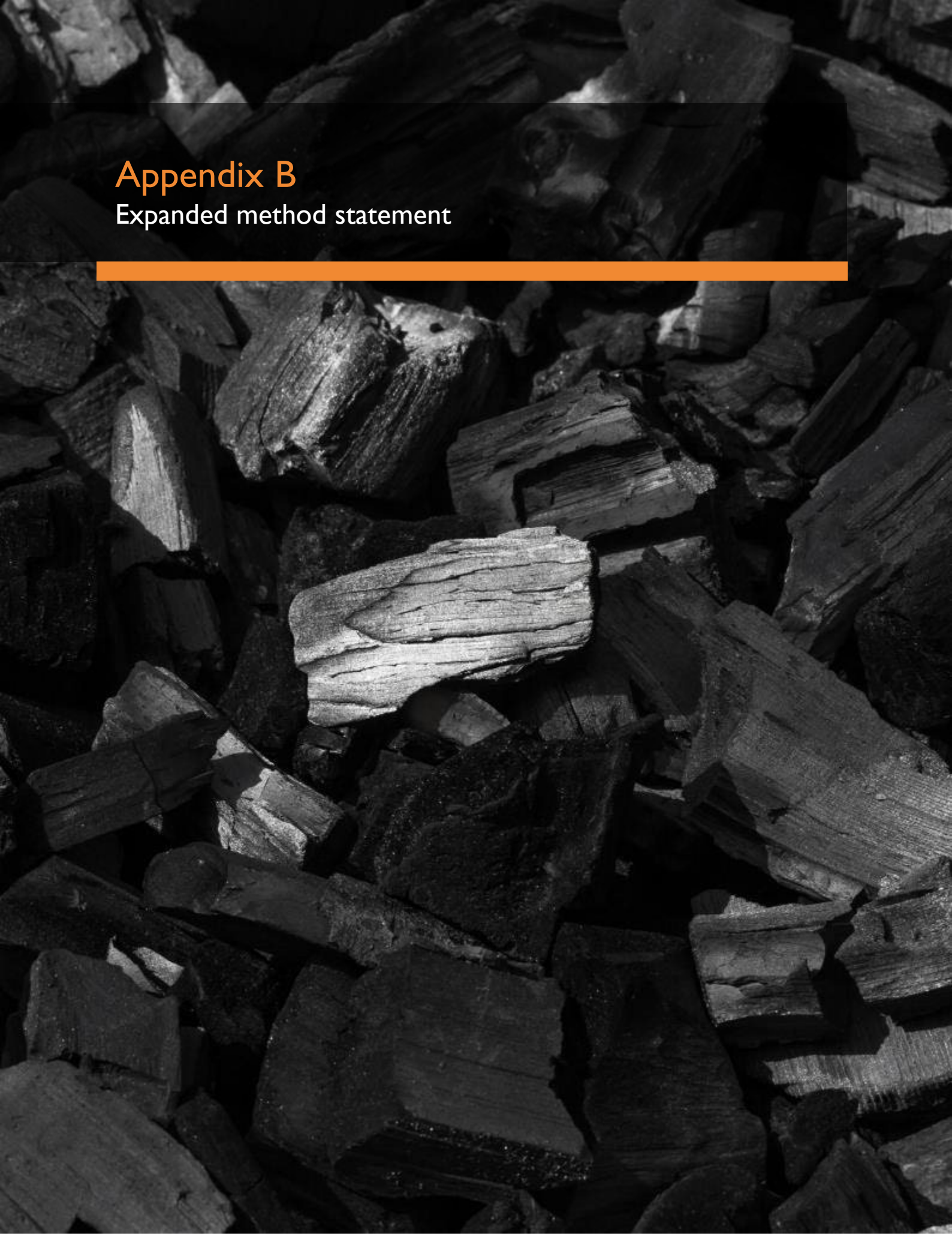
TerraCom 2017a, *Coal Handling and Preparation Plant – CHPP Management Report*, prepared for TerraCom Limited.

USDA ARS 1985, The Water Erosion Prediction Project (WEPP) Model, United States Department of Agriculture, Agriculture Research Centre.

Yu, B 2003, An assessment of uncalibrated CLIGEN in Australia, Agricultural and Forest Meteorology, 119(3-4), pp. 131-148.



Appendix A
Soil laboratory results



Appendix B
Expanded method statement

Rainfall and overland flow simulations

B.1 Equipment and design

The simulator is divided into four main parts:

5. a water supply system connected to a pressurised full cone nozzle to produce simulated rainfall;
6. a supporting steel frame to mount water supply system and canvas windshields;
7. a hydraulic jack attached to a tilting table for slope adjustment; and
8. a perforated plot (eg erosion plot and overland flow flume) to hold the sample to be tested and simulate runoff, infiltration or overland flow.

B.1.1 Water supply system and full cone nozzle

Irrigation pipes made of polyvinyl chloride (PVC) are used for the water supply system. A flow meter placed between two control valves is used to monitor and control the flow rate.

Full-cone spray nozzles from Spraytech Systems Pvt Limited (Spraytech) are used to simulate rainfall. The spray angle of the nozzles is 45°. Spray nozzles of four different orifice sizes are used to simulate different rainfall intensities:

- DA13.250 — 1.9 mm (orifice diameter);
- DA13.350 — 2.2 mm;
- DA13.650 — 3.1 mm; and
- DA23.100 — 3.8 mm.

B.1.2 Steel frame

A supporting steel frame was constructed to attach the water supply system and canvas wind shields. The frame is 3.0 m long, 2.0 m wide and 3.5 m high. The spray nozzle is attached centrally at the top of the frame to ensure adequate coverage (~3 m diameter spray area).

B.1.3 Tilting table with hydraulic jack

A 1.2 m high tilting table holds the erosion plot / overland flow flume and allows adjustment of the slope angle by a manual hydraulic jack fixed at the bottom of the table.

B.1.4 Rainfall simulator

A 0.5 m wide and 1.0 m long erosion plot secured to the top of the tilting table is used to hold the cover material and collect runoff and infiltration samples. The plot is divided into two sections by a perforated sheet that allows the infiltration of water. The upper section holds the cover material and allows for runoff generation and collection, the lower section allows for infiltration through the plot and sample collection. This allows for both runoff and infiltration to be collected simultaneously.

B.1.5 Overland flow flume

A 0.75 m wide and 2.00 m long flume is used to simulate overland flow and assess rill and interrill erosion. A hose is attached to the rainfall simulator's water supply system (to make use of the flow meter) and is discharged into a feeder tank that is located at the top of the flume to ensure a steady and even flow across the flume.

B.1.6 Calibration

Rainfall intensity is an important factor in accurate rainfall simulations. The rainfall simulator was calibrated for the four cone nozzles, each of which produces a different rainfall intensity. Rain gauges were positioned at different locations beneath the cone nozzles and their readings averaged to calculate the rainfall intensity.

B.2 Rainfall and runoff calculations

Uniformly mix samples were sieved to remove rock >5 centimetres (cm) in diameter.

B.2.1 WEPP equations

The parameters are taken from the rainfall simulator and equations sourced from Ândrea et al (2010), Elliot et al (1989), Flanagan & Nearing (1995), Franco et al (2010), Sheridan, Loch & So (2000b), So et al (2018), and Reichert & Norton (2013).

B.2.1.1 Interrill erosion

a Interrill detachment rate:

$$D_i = K_i I^2 S_f \quad (1)$$

Ei = interrill detachment rate (kg/m2 s); Ki = interrill erodibility factor (kg s/m4); I = rainfall intensity (m/s); Sf = slope steepness factor.

b Interrill erodibility factor (WEPP)

$$K_i = 2{,}728{,}000 + 19{,}210{,}000\ vfs \quad (2)$$

Ki = interrill erodibility factor (kg s/m4); vfs = very fine sand fraction.

B.2.1.2 Rill erosion

a Rill detachment rate (per rill)

$$D_r = K_r(\tau - \tau_c) \quad (3)$$

Dr = rill detachment rate (kg/m2 s); Kr= rill erodibility factor (s/m); τc= critical shear stress (Pa); τ= hydraulic shear stress (Pa).

b Rill erodibility factor

$$K_r = 0.00197 + 0.030vfs + 0.03863e^{-1840M} \quad (4)$$

Kr= rill erodibility factor (s/m); vfs = very fine sand fraction; OM = organic matter fraction.

c Critical shear stress

$$\tau_c = 2.65 + 6.2clay - 5.8vfs \quad (5)$$

τc= critical shear stress (Pa); clay = clay fraction; vfs = very fine sand fraction.

B.3 Laboratory calculations

Rainfall was applied at 100 mm/hr to plots of 5, 10, 15, 20, and 30%. Timed (10 sec) runoff samples were taken at eight intervals (3, 5, 8, 12, 16, 20 and 25 minutes) during the 30-minute simulation. The mean of the runoff measurements after steady state is achieved are used to calculate the erosion rate.

B.3.1 Interrill erosion

B.3.1.1 Interrill erosion rate

$$E_i = \frac{Mss}{AD} \tag{6}$$

Ei = interrill erosion rate (kg/m2 s); Mss = soil dry mass (kg); A = plot area (m2); D = time of sampling (s).

a Adjusted erosion rate

$$E_A = \left(\frac{I_D}{I_M}\right)^2 \times E_M \tag{7}$$

EA = adjusted erosion rate (kg/m2 s); ID = design rainfall intensity (100 m/s); IM = measured rainfall intensity (m/s); EM = measured erosion rate (kg/m2 s).

B.3.1.2 Slope steepness factor

$$S_f = 1.05 - 0.85e^{-4sin\theta} \tag{8}$$

Sf = slope steepness factor; θ = slope angle (radians).

When the slope is greater than or equal to 100% (45˚) then Sf = 1.0. Equation 2 is stable in that, for any positive slope, it will never give a value less than 0.2 or greater than 1.05.

B.3.1.3 Cover factor

$$C_f = e^{-2.5C} \tag{9}$$

Cf = cover factor; C = rock (>2 mm) fraction.

B.3.1.4 Interrill erodibility factor

$$K_i = \frac{E_i}{IS_f} \tag{10}$$

Ki = interrill erodibility factor (kg s/m4); Ei = interrill erosion rate (kg/m2 s); I = rainfall intensity (m/s); Q = steady-state runoff rate (m/s); Sf = slope steepness factor; Cf = cover factor.

B.3.2 Rill erosion

Consecutive overland flow with discharge rates between 0.5 to 3.0 L/s (depending on erodibility of soil) are simulated. Each flow rate is held constant for 3 min with the mean of three runoff samples used to measure erosion. Flow rates are increased until maximum possible flow is attained or until rills cut to the base of the flume.

Measured erosion is plotted against hydraulic shear values. The slope of the regression line is erodibility, and the intercept with the horizontal axis is critical shear.

B.3.2.1 Rill erosion rate

$$E_r = \frac{Mss}{AD} \tag{11}$$

Er = rill erosion rate (kg/m2 s); Mss = soil dry mass (kg); A = rill bed area (m2); D = time of sampling (s).

B.3.2.2 Hydraulic shear stress

a Open channel flow (no rill)

$$\tau = yDs \tag{12}$$

τ = hydraulic shear stress (Pa); y= specific weight of water (9,806 kg/m2 s2); D= average flow depth (m); s= hydraulic gradient (≈ flume slope).

Flow depth: Flow velocity was determined with the dye tracing technique and a correction factor of 0.77 was used to estimate the mean flow velocity. Flow width was measured at the upper and lower ends and middle of the rills using a ruler, and flow depth was estimated by dividing the total discharge by the product of measured flow velocity and flume width.

$$D = \frac{Q}{vm} \tag{13}$$

D = average flow depth (m); Q = total discharge (m3/s); v = measured mean flow velocity (m/s); m = flume width (m).

Flow in rill

$$\tau = yrs \tag{14}$$

τ = hydraulic shear stress (Pa); y= specific weight of water (9,806 kg/m2 s2); r= hydraulic radius (m); s= hydraulic gradient (≈ rill slope).

B.3.2.3 Rill erodibility factor

a Slope of regression line

$$K_r = r\frac{SD_{E_r}}{SD_\tau} \tag{15}$$

Kr = rill erodibility factor (s/m); r = correlation coefficient; SDEr = standard deviation of Er (kg/m2s); SDτ = standard deviation of τ (Pa).

b Calculation

$$K_r = \frac{E_r}{q_r^{1.60} S_r^{2.40}} \tag{16}$$

Kr = rill erodibility factor; Er = rill erosion rate (g/s); qr = flow rate (L/min); Sr = rill slope.

B.3.2.4 Critical shear stress

a X-intercept of regression line

$$\tau_c = -\frac{E_{r(0)}}{K_r} \quad (17)$$

τc= critical shear stress (Pa); Er(0) = rill erosion rate at regression line intercept (kg/m2 s); Kr= rill erodibility factor (s/m).

B.3.3 Miscellaneous

B.3.3.1 Flow parameters

Flow velocity was determined with the dye tracing technique and a correction factor of 0.77 was used to estimate the mean flow velocity. Flow width was measured at the upper and lower ends and middle of the rills using a ruler, and flow depth was estimated by dividing the total discharge by the product of measured flow velocity and flume width.

B.3.3.2 Total runoff

$$Q_T = (I - I_r)D \quad (18)$$

QT = total runoff (mm); I = rainfall intensity (mm/hr); Ir = steady state infiltration rate (mm/hr); D = duration of rainfall event (hr).



Appendix K
Water management plan

This page is intentionally blank.

TerraCom

Environment & Community Management System

Water Management Plan

Revision Approvals			
	Name	Position	Date
Originator:	Toni Ward	Environmental Superintendent	30/4/2020
Reviewer:	Nicholas Baillieu	Technical Services Manager	
Approver:	Shaun Lucas	General Manager	

TABLE OF CONTENTS

1. INTRODUCTION 7
1.1 Purpose 7
1.2 Objectives 7
1.3 Related documents 8
1.4 Water regulations 8
2. CATCHMENT HYDROLOGY AND ENVIRONMENTAL VALUES 9
2.1 Drainage Network 9
Social Implications 9
2.2 Climate 10
2.3 Receiving Environment 10
2.4 Environmental values 11
2.5 Aquifers 11
2.6 Risks & Hazards 13
Inundation 13
Drought 13
3. CONTAMINANT SOURCE STUDY 14
3.1 Overview 14
3.2 Surface water types 15
3.3 Surface water characteristics 15
Mine Affected Water 15
Surface Water 15
Diverted Water 16
External water 16
3.4 Geology and soils 18
3.5 Saline Drainage and Acid Rock Drainage Prevention & management Measures 18
Overburden 18
Rejects 18
Management 19
3.6 Sediment & Erosion 19
4. WATER MANAGEMENT SYSTEM 20
4.1 Roles and Responsibilities 20

Inspections 20
4.2 Clermont Coal 20
4.3 Mining Activities 20
Pumps & Pipelines 20
Tailings Storage Facility 20
4.4 Coal Handling and Preparation Plant 22
4.5 Mine Infrastructure Area 22
Fire Water System ..... **Error! Bookmark not defined.**
Oily Water Separator 22
Sewage Treatment Plant 22
4.6 Site Water Balance MODEL 22
Interpretation of results 22
Dam spill risk 23
Active pit inundation risk 23
Total site inventory 24
5. MONITORING & REVIEW 25
5.1 Monitoring Equipment 25
5.2 Sampling 25
5.3 Surface Water Monitoring 26
Mine Affected Water 26
5.4 Groundwater Monitoring 26
5.5 Regional Environment Monitoring Program (REMP) 26
5.6 Infrastructure 26
Diverted water / MAW separation 27
Tailings Storage Facility 27
Environmental Dam 27
Diversions 27
Surveillance 28
6. REPORTING 29
6.1 Data Management & Records 29
6.2 Internal 29
Blair Athol 29
TerraCom 29

6.3 External 29
Clermont Coal 29
Annual Returns 29
Community 29
7. Emergency & Contingency Planning 30
7.1 Incident Reporting & Management 30
8. WMP Auditing & Review 31
9. REFERENCES 32

Term	Definition
Acid rock drainage	Low pH drainage derived when sulphide minerals are exposed to air and water.
AEP - Annual Exceedance Probability	The probability of an event of a given size (or larger) occurring on average in any one year. When used in relation to water storages, it is expressed as the probability that a defined volume of a storage facility will be exceeded in any one year.
Annual Review	Annual review of performance of conditions within the water schedule
Background	Background conditions are defined as those required to quantify impact - for example: upstream conditions in a watercourse, or upwind conditions for air quality, or measurements where reference sites with monitoring data are available.
Baseline	A clearly defined starting point (point of departure) from where implementation begins, improvement is judged, or comparison is made. For existing Operations, the temporal datum for baseline shall be regarded as background conditions where suitable reference sites with monitoring data are available.
Brackish water	Water with elevated salinity
Consequence Category	A category, either low, significant or high, of dam as assessed in accordance with the *Manual for assessing consequence categories and hydraulic performance of structures (DES, 2016)*
DES	The Department of Environment and Science – the relevant government authority for environmental authority and water release / discharge matters.
Design Storage Allowance (DSA)	Minimum storage allowance required in a dam at the first November each year in order to meet the hydraulic performance requirements.
Discharge	Uncontrolled flow where water including mine affected water leaves site via a spillway or dam overflow
Disturbed areas	Areas disturbed during mining activities. Includes permanent and temporary access roads, shaped and unshaped overburden emplacements and recently rehabilitated areas.
Diverted Water	Run-off from undisturbed areas or rehabilitated areas that meets quality standards.
Downstream Limits	Water quality criteria measured at the nominated downstream monitoring point(s).
EC	Electrical Conductivity – a water quality measure of the salinity of water (µS/cm).
End of Pipe	From the actual location of release / discharge to the receiving waters.
Environmental Authority (EA)	Site environmental license to operate.
ESP - Exchangeable Sodium Percentage	The percent of available sodium ions in a soil or rock material. A high ESP is an indication of a sodic soil.
Geochemical characterisation	Definition of the chemical properties of geological material.
Hazard	In relation to a dam as defined, means the potential for environmental harm resulting from the collapse or failure of the dam to perform its primary purpose of containing, diverting or controlling flowable substances.

Hydraulic performance	The capacity of a regulated dam to contain or safely pass flowable substances based on a probability (AEP) of performance failure specified for the relevant hazard category in accordance with the *Structures which are dams or levees constructed as part of environmentally relevant activities (DES, 2019)*
Inventory	The quantity of water stored within a storage at any point in time.
Mandatory Reporting Level (MRL)	A warning and reporting level determined in accordance with the *Structures which are dams or levees constructed as part of environmentally relevant activities (DES, 2019)*
Mine affected water	Water that has been in contact with sediments, salts or other contaminants as a result of mining activities. It is directed to a site storage for used within the operation
Mining areas	Where active mining is taking place such as access ramps, exposed coal and pit floor surfaces, overburden benches and any active or inactive spoil emplacement where surface flows cannot be diverted away from the pit.
Monitoring	All monitoring to comply with the EA, including telemetry real sampling.
Natural Flow	The flow of water through waters caused by natural events.
Potentially Acid Forming (PAF)	Material that when exposed to oxygen and water can result in the leaching of sulphuric acid.
Potentiometric surface	A surface representing the hypothetical level where groundwater would rise if not trapped in a confined aquifer. The potentiometric surface is equivalent to the water table in an unconfined aquifer.
Raw water	Water of suitable quality for treatment as potable water.
Regulated Dam	A dam with a consequence category of High or Significant
Release	Active initiation where water including mine affected water leaves site via a pipe, valve or pipe.
Release Points	A licensed point at which mine affected water can be released in compliance with EA conditions.
Sedimentation dam	Dams designed to collect and store run-off from disturbed areas (i.e. spoil dumps) where the only contaminate is sediment, to allow sediments suspended within the water to settle out before offsite discharge or reuse.
Water use	Includes water used on site for any purpose connected with operation of Blair Athol.

1. INTRODUCTION

Blair Athol (BA) coal mine encompasses the mining lease (ML) ML1804. An adjacent lease which was formally part of BA, ML1881, includes the rail loop and rail loadout, water storages and coal stockpiles. The ML1881 area was sold to the Clermont Coal Joint Venture (CCJV) and the boundaries of ML1804 and ML1881 were realigned to separate the train load out facilities and associated infrastructure from BA.

The water management system was designed and operated for the integrated project across both mining leases. Therefore, with the resumption of mining on the BA lease, several cooperative arrangements with CCJV are in place. These are detailed within this plan and include diversion maintenance and monitoring, mine affected water, surface water, potable water supply and sewage treatment. The "Water Deed" contains the commercial details and expectations between parties to enable both mining operations to operate effectively and efficiently.

1.1 PURPOSE

This Water Management Plan (WMP) has been prepared to meet the requirements of Condition C24 of the Environmental Authority EPML00876713 for BA (effective from the 11 January 2018).

The BA WMP defines the operating framework to enable compliance with regulatory, legislative and TerraCom requirements and applies to all water managed by BA and personnel responsible for and associated with the management of water.

The WMP addresses all issues relevant to the importation, generation, use, and management of water at BA to minimise the quantity of water that is contaminated and released by BA.

The actual and potential risks of environmental harm to natural water flows posed by mining activities have been identified and management actions that will effectively minimise these risks have been presented.

1.2 OBJECTIVES

The WMP defines the drivers, targets and controls at BA to enable the management of water to comply with the following key objectives:

- Achieving compliance with regulatory and legislative requirements
- Reduction of business risks and costs associated with business water requirements and usage including the potential impacts of climatic variability
- Prevent, or otherwise minimise adverse impacts on water quality and quantity
- Develop and maintain an appropriate understanding of the cumulative demands and impacts being placed on surrounding water resources and ecosystems
- Implement appropriate measures to address current and future water requirements and concerns of key upstream and downstream users and stakeholders

The WMP will be reviewed annually, or as required, such as after a significant change to the water management system or to cater for changes to regulatory or design criteria.

1.3 RELATED DOCUMENTS

This WMP should be read in conjunction with the following reports and management plans:

- Water Balance Model Report (WRM, 2020);
- Receiving Environment Monitoring Plan;
- Erosion and Sediment Control Plan; and
- Groundwater Monitoring Program.

1.4 WATER REGULATIONS

The following legislation and standards are to be considered with the application of site practices and development of procedures and other documentation for the purposes of water management:

- Environment Protection Act 1994;
- Environmental Protection (Water) Policy (2009);
- Environmental Protection Regulations 2008;
- Fisheries Act 1994;
- Plumbing and Drainage Act 2002;
- Sustainable Planning Act 2009;
- Sustainable Planning Regulation 2009;
- Environmental Authority EPML00876713;
- Queensland Coal Mining Safety and Health Act 1999;
- Code of Environmental Compliance for Environmental Authorities for High Hazard Dams Containing Hazardous Waste;
- Water Act 2000;
- Water Regulation 2002; and
- Water Supply (Safety and Reliability) Act 2008.

2. CATCHMENT HYDROLOGY AND ENVIRONMENTAL VALUES

2.1 DRAINAGE NETWORK

The Drummond Range is located to the north and west of Blair Athol and it forms the watershed between the Burdekin drainage system in the north and the Fitzroy system to the south. Figure 3.1 shows the local watercourses, drainages and diversions in the vicinity of Blair Athol.

The mine is located at the top of the Bath Creek, a tributary of Sandy Creek, in the foothills of the Drummond Range. Sandy Creek is a sub-catchment within Theresa Creek section of the Nogoa River catchment in the north-western corner of the Fitzroy Basin.

Diversions of Bath, Washpool and Breaker Creeks have been constructed around the BA mining areas. Washpool Creek has been diverted around the east of the mining area by the Northern Boundary Drain, along the Eastern Diversion which flows off-lease downstream into Bath Creek. Breaker Creek flows around the west of the mining area and joins Bath Creek West downstream of the Western Diversion, which flows off-lease and into Bath Creek approximately 1.6km downstream of the mining lease.

The historical mine workings at BA have created a “depressed landform”, where the majority of disturbed areas drain internally. This means there is a very low risk of release of contaminants from BA.

The receiving environment is defined in the EA as the waters of Bath Creek and connected or surrounding waterways within 12km downstream of the release and must include any sensitive receiving waters or environmental values that will potentially be directly affected by an authorised release of mine affected water.

Under the definitions of water types in the 2009 Queensland Water Quality Guidelines (DEHP, 2013), the REMP area is defined as “Upland Freshwater”. The programme area sits above 150m elevation which is used to define Upland Freshwater from Lowland Freshwater systems. The watercourses are considered ephemeral and flow infrequently.

Social Implications

The BA mining lease intersects several ephemeral creek systems that have been diverted around mining areas (from Breaker, Bath and Washpool Creeks). Flows in these watercourses are infrequent and variable due to rainfall patterns.

Water use immediately downstream of BA is largely for agricultural purposes (stock watering) and environmental benefit, with the water feeding Sandy and Theresa Creeks before entering the Nogoa River near Emerald, then the Fitzroy River prior to emptying into the Coral Sea. It is approximately 200km before any surface water from BA reaches a reservoir used as a supply for drinking water (Blackwater).

2.2 CLIMATE

Long term daily climatic data for BA is available from the Queensland Government, SILO Data Drill service (DES, 2019). Monthly rainfall and evaporation totals are provided in Table 2.1 and Table 2.2.

Note annual values are based on annual totals, not sums of the monthly values.

Table 2.1. Rainfall

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Max	483	426	286	273	218	331	228	173	167	177	243	477	1292
90th %ile	234	255	171	85	76	73	59	51	56	76	127	185	959
Median	98	76	43	19	18	17	9	7	5	25	40	69	575
10th %ile	24	17	1	0	0	0	0	0	0	0	2	15	334
Min	0	0	0	0	0	0	0	0	0	0	0	1	187

Table 2.2. Evaporation

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Max	240	208	204	152	115	94	101	142	171	218	228	244	1989
90th %ile	225	193	189	144	108	87	96	125	161	200	217	231	1896
Median	206	170	169	133	101	79	90	117	151	189	204	216	1814
10th %ile	175	147	151	122	92	73	82	109	141	174	184	189	1732
Min	128	123	120	96	78	60	76	21	118	163	124	146	918

2.3 RECEIVING ENVIRONMENT

The environmental values of the Blair Athol Mine receiving environment are influenced by the historical and current land uses and the ephemeral and unpredictable nature of the region's waterways. Agricultural development within the region has significantly impacted the habitat and water quality of streams. Biodiversity is low, with only macro-invertebrate and fish species that are tolerant of the varying and harsh conditions. No rare or threatened species of aquatic fauna have been recorded in the Sandy Creek Sub-catchment.

Infrequent and unreliable rainfall patterns result in episodic flows preceded by long dry periods. Downstream water use is used for stock watering and ecosystem function. Cattle and wildlife use water from several waterholes that exist intermittently along Bath Creek in the dry season.

In accordance with Environmental Authority conditions, BA has updated a Receiving Environment Monitoring Program (REMP). The aim of the REMP is to develop the knowledge of the receiving environmental values and identify adverse impacts on these values from BA off-site discharges.

2.4 ENVIRONMENTAL VALUES

The Queensland Water Quality Guidelines and Environmental Protection (Water) Policy establish environmental values (EVs) and water quality objectives (WQOs) for natural waters in Queensland. EVs for the site have been prescribed in the "Draft environmental values and water quality guidelines: Fitzroy Basin fresh, estuarine and marine waters, including Keppel Bay" (DSITI, 2017). BA is located within the Lower Nogoa/Therese Creek sub-basin, which is part of the Mackenzie River basin. Identified environmental values for the Lower Nogoa River/Therese Creek sub-basin are:

- Aquatic ecosystems;
- Irrigation;
- Stock watering;
- Aquaculture;
- Primary and secondary recreation;
- Visual appreciation;
- Industrial use; and
- Cultural and spiritual values.

2.5 AQUIFERS

Mining activities have the potential to impact on the beneficial use of aquifers. Changes in groundwater quality and levels may adversely affect groundwater users, groundwater dependent ecosystems as well as quality of underlying and/or overlying aquifers.

A basalt aquifer touches the mining area in the north eastern part of the lease. Local landholders in the north use this aquifer for livestock water. The closest extraction point (< 1km) is Curtis Windmill Bore and is monitored routinely by BA. The mining pit has intercepted the fractured basalt aquifer that fringes the north and east of the mine.

The coal measures also form an aquifer. Preliminary modelling of the post mining landform (JBT Consulting, 2012) has shown that a new ground water aquifer will form within the rehabilitated spoil, due to the nature of the final landform basin floor. This aquifer will fill from rainfall and at times will present itself as ponding within low points of the rehabilitated landform.

Historical groundwater studies by Coffey & Partners Pty Ltd (1983) indicated limited potential for mining activities to affect groundwater supplies outside the Blair Athol mining area. More recent investigations by MatrixPlus Consulting (2004 and 2005) have shown that:

- there is no expected impact on groundwater to the south of the mining tenures based on eight piezometers drilled to a depth of 120 metres that did not intersect groundwater
- bores to the east and north, located in basalt, have shown no impacts related to the adjacent mining.

Based on the current understanding of groundwater systems and void hydrology it is expected that the void will not impact local groundwater quality from contaminant leaving site, as the void will act as a sink.

It is expected that groundwater would continue to seep from the intercepted basalt aquifer to the north and east at a rate equivalent to current levels (approximately 350 to 1300 kilolitres per day). Flows from the void into downstream shallow alluvial groundwater systems are unlikely as the standing void water level will be significantly lower than the aquifer with no connectivity (JBT Consulting, 2012).

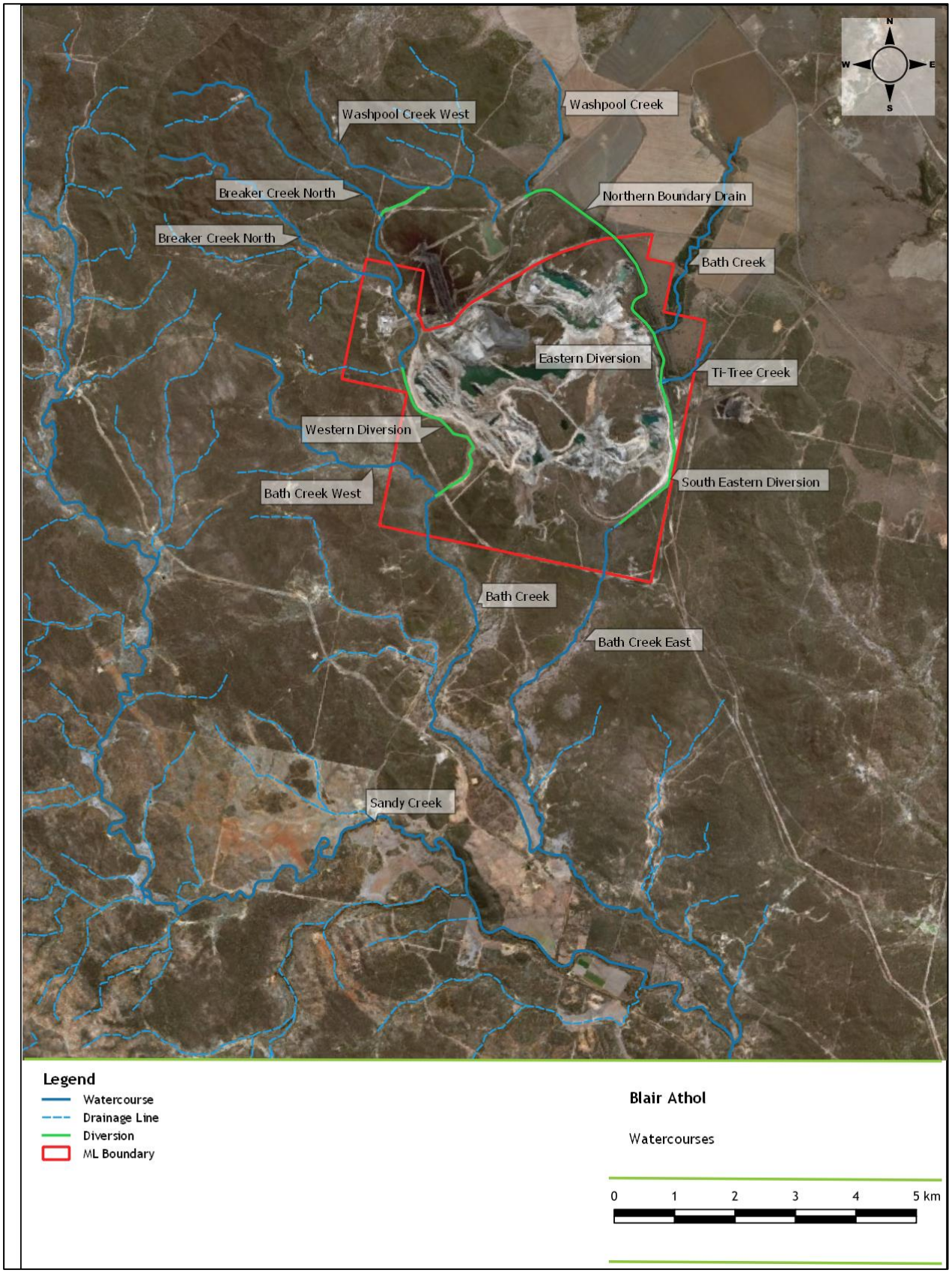


Figure 2.1. Blair Athol watercourses

2.6 RISKS & HAZARDS

The management of water in and around the lease has potential water hazards associated with the BA operation. This WMP is intended to provide the reader with a high-level understanding of the potential operational aspects and impacts on the environment and to inform the BA formal risk assessment process.

Inundation

Inundation of parts of BA may occur due to short-term stormwater runoff or long-term accumulation of water with the voids and active mine area. The accumulation of water within the BA mining lease represents a significant business risk when pit access is restricted due to impounded water. The BA water balance model (WBM) is used to assess the risk of pit inundation (see Section 4.6).

Risks from inundation include both within lease issues (sub-catchments) i.e. storm runoff damaging access / haul roads, inundating pumps and overtopping dams as well as external lease issues. External implications (flooding) include damage to diversions, culverts and crossings, and discharges off lease. The effect on personnel with road closures and travel restrictions can impact on site resources. The BA flood risk is documented in the Blair Athol Flood Study.

Drought

The BA water balance model is used to forecast the operational water requirements for the site. The model results (Section 4.6) indicate there is very low risk to water supply within the next 2.5 years.

3. CONTAMINANT SOURCE STUDY

3.1 OVERVIEW

This section of the water management plan describes the activities on the BA lease that could potentially generate contaminants that may impact on the environmental values of the receiving waters, if not managed. Table 3.1 shows the operational areas at BA and that could potentially generate contaminants.

Table 3.1. Blair Athol contaminant sources

Operational Area	Contaminant
Overburden Dumps – active	Salinity, altered pH, sediment, dissolved metals, TSS, TDS, altered Turbidity
Overburden Dumps – topsoil, seeded	Sediment, weed seeds
Overburden Dumps – rehabilitated	None
Pits and Ramps	Salinity, altered pH, sediment, hydrocarbons, TSS, TDS, altered Turbidity
Topsoil stockpiles	Sediment, weed seeds
ROM / Coal Stockpiles	Salinity, altered pH, dissolved metals, TSS, TDS, altered Turbidity
Topsoil stripped areas	Sediment, TSS, TDS, altered Turbidity
Cleared areas	Sediment, weed seeds, TSS, TDS, altered Turbidity
Undisturbed	Weed seeds
Mine affected water dams	Elevated salinity, algae, hydrocarbons, altered pH, sediment, dissolved metals, TSS, TDS, altered Turbidity
Sediment Dams	Elevated salinity, algae, weed seeds, altered pH, sediment, TSS, TDS, altered Turbidity
Coal reject material	Altered pH, salinity, hydrocarbons, ARD, dissolved metals, TSS, TDS, altered Turbidity
Diversions	Salinity, sediment, altered pH, algae, TSS, TDS, altered Turbidity
Dragline substation / transformers	Hydrocarbons
Transportable fuelling stations	Hydrocarbons

3.2 SURFACE WATER TYPES

The surface water generated on the mine site is categorised into types, based on water quality. The BA storages and catchments by water type are shown in Figure 3.1. The water types at BA include:

- '**Diverted Water**' – water from areas that are unaffected by mining operations. Diverted water includes runoff from undisturbed areas and any rehabilitated areas.
- '**Surface Water**' – water from areas that are disturbed by mining operations (including out-of-pit overburden dumps and haul roads). This runoff may contain high sediment loads, but does not contain contaminated material or high electrical conductivity (EC). Typically, EC below 2,000 µs/cm is managed as surface water. Surface water is managed in accordance with the Erosion and Sediment Control (ESC) Plan.
- **'Mine affected Water' (MAW)** – water that has generally come in contact with coal or the open cut pit. This water may contain high EC or metals above values that represent fresh water as defined by ANZECC & ARMCANZ (2000). MAW includes water from areas potentially containing hydrocarbons or chemicals of various types. Release of MAW to the receiving environment is subject to the BA EA release conditions. MAW is used on site for operational purposes, such as in the CHPP and for haul road dust suppression.
- '**External Water'** - water sourced external to the mining operations, external water may be MAW or 'raw water' which is potable quality (after treatment).

3.3 SURFACE WATER CHARACTERISTICS

Mine Affected Water

MAW at BA is generated from runoff within active mining areas, coal stockpiles, workshop/industrial areas and tailing/rejects storages. Water sampling from MAW storages on site indicates the following MAW quality:

- EC of 2,000 to 4,400 μS/cm
- pH of 7.8 to 9.6

Water quality sampling of groundwater from the Basalt Aquifer indicates an EC typically around 735 μS/cm, which is considered fresh and therefore is not MAW.

Surface Water

Water sampling from the Environment Dam (April 2019) indicates the following water quality:

- EC of 257 μS/cm
- pH of 7.8
- Total suspended solids of 25 mg/l
- Turbidity of 49 NTU

The water quality from the Environment Dam is similar or better water quality than the receiving environment. Note this is based on runoff water quality only. When MAW is pumped to the Environment Dam, it shall be treated as a MAW storage.

Diverted Water

Water quality in the receiving environment is monitored in accordance with the EA and the REMP. Recent monitoring (2019 REMP samples) indicated the following median water quality in the receiving waters of BA:

- EC of 90 to 180 μS/cm
- pH of 7 to 7.8
- Total suspended solids of 120 to 981 mg/l:
- Turbidity of 670 to 767 NTU;

External water

External water is supplied from two sources, including:

- MAW from Clermont Mine to Ramp 1 Transfer / Ramp 3 North Void; and
- Potable water is supplied from Clermont Mine water treatment plant.



Figure 3.1. Blair Athol water storages and catchments

3.4 GEOLOGY AND SOILS

BA is mining through previously mined areas and only a small area of "natural" ground. The material being mined through is classed into the following types:

- Natural soil
- Rehandled topsoil from rehabilitated areas
- Rehandled spoil from previously mined areas
- Remnant Seam 3 coal
- Interburden between the Seam 3 (mined by Rio Tinto) and the Seam 4
- Overburden to Seam 4
- Seam 4 coal

The rehandled topsoil and spoil have been mixed and so can only be broadly classed as topsoil and spoil. The interburden between Seam 3 and 4 has been assessed, as detailed in the following sections.

3.5 SALINE DRAINAGE / ARD PREVENTION AND MANAGEMENT MEASURES

Saline, Neutral and Acid Rock Drainage (ARD) is managed through a variety of mechanisms with primary characterisation of mineral wastes for ARD potential undertaken. Trends of water quality results are also monitored to indicate any changes to background or existing water quality.

Overburden

Overburden and interburden types tested by Dames and Moore (1983) during the EIS were assessed as having a "low" ARD risk, apart from a conglomerate interburden between Seam No. 4 upper and lower seams that was assessed as "medium" risk. The interburden between Seam No. 4 upper and lower will only be removed in the southern part of Ramp 1 South Pit. In other areas where Seam No. 4 is to be mined the upper and lower seams are not separated by interburden.

ARD analysis of overburden and interburden from the 2005 exploration drilling program was undertaken of samples from holes in the Seam No. 4 pits. EGi (2006) identified that most of the overburden material was non-acid forming and unlikely to be a concern with respect to ARD or element toxicity. The study however did identify that materials associated with the roof and floor of the Seam 3 and Seam 4 coals were potentially acid forming. These materials contained pyrites and would require selective handling and blending within the overburden to control the ARD potential.

Rejects

Testing of coarse and fine rejects by EGi (2004, 2006, 2008, and 2010) found that the materials present in the tailings dam were both potentially acid forming and non-acid forming.

The original tailings storage facility (TSF) was capped with spoil and rehabilitated over 2018 and 2019. Seepage modelling undertaken by URS (2008) suggests seepage rates through the embankment will be minimal in the latter operational/decommissioning stages.

The long-term prediction from URS (2008) is that the most seepage will be through the TSF floor into the underlying spoil, and into the sandstone/conglomerate aquifer. The rate of water movement through the TSF floor is expected to decrease post-closure as the tailings dewater and the TSF cap reduces rainfall recharge. Seepage chemistry suggests that seepage beneath the TSF embankments is still pH neutral, indicating that the inherent buffering capacity of the rejects and tailings to self-neutralise may be occurring (Terrenus 2009).

Regular assessment of the rejects and fines generated from the coal washing process will be completed by Blair Athol to assist in disposal management processes.

Management

The management and controls of mineral wastes are distinguished by the classification of the ARD potential (low or high risk). The *Mineral Waste Management Guideline* and the *Mineral Waste Management Procedure* identifies the strategies to manage mineral waste with ARD potential.

Low ARD potential material is managed through the following strategies:

- backfill material to be dumped as close as possible to the pit floor;
- dozing interburden into a slot rather than trucking to an elevated waste dump;
- dumping waste coal as close to pit floor as practical to ensure the maximum amount of capping with spoil is possible;
- volumes and locations of all materials are to be recorded and mapped in the site Mineral Waste Inventory; and
- Waste coal should not be dumped in a manner to limit the chance of spontaneous combustion.

Management of mineral waste with high ARD potential requires specific dumping and management strategies which should be incorporated into mine planning. The basic concepts for management of high ARD potential mineral wastes are the containment and encapsulation.

3.6 SEDIMENT & EROSION

Surface water runoff is managed in accordance with the BA Erosion and Sediment Control Plan to avoid excess sediment movement throughout the mine site. There are several methods used by BA to reduce water velocities and subsequent erosive potential of stormwater. These include design considerations such as:

- landform gradients;
- spoil characteristics;
- sediment retention structures; and
- ensure landforms can meet EA requirements related to safe, stable and sustainable conditions.

In doing so, the risk of increased sediment loading entering watercourses is managed to an acceptable level.

4. WATER MANAGEMENT SYSTEM

The water management system (WMS) is described in detail in the Blair Athol Water Balance Model (WRM, 2020). This section gives an overview of the management strategies for the WMS (Figure 4.1).

4.1 ROLES AND RESPONSIBILITIES

Inspections

The three dams at BA (TLO Dam, Industrial Dam and Environment Dam) shall be inspected as part of routine monitoring. Any damage to the walls or spillways shall be documented and maintenance actions undertaken.

4.2 CLERMONT COAL

Clermont Coal operates the following infrastructure associated with the BA WMS:

- West Dam supplies raw water to the Clermont water treatment plant, which then supplies potable water to BA;
- The Stockpile Dam, part of the Clermont train load out facility, is the transfer point between BA and Clermont.
  - The Industrial Dam is de-watered to the Stockpile Dam, then to the water tanks and Transfer Dam;
  - If Clermont requires water supplied from BA, water is pumped from Transfer Dam to Stockpile Dam.

Under the Water Requirements Plan, Clermont Mine can transfer water to BA and demand water from BA. Under this agreement, Clermont Mine is entitled to:

- Demand up to 100 ML/month from BA
- Transfer up to 200 ML/month to BA

The forecast water demand/transfers for the next 2 years are incorporated in the BA water balance model (WBM), using the predicted modelled demand/transfer rates provided by the Clermont WBM.

4.3 MINING ACTIVITIES

Pumps & Pipelines

Link Mining Services manages of all the site's pumps and pipelines to meet the mining and operational requirements. CCJV have accountability for the pumps and infrastructure associated with the transfer and demand from/to the Clermont Mine.

Tailings Storage Facility

The prediction from the URS (2008) investigation was that most seepage will be through the TSF floor into the underlying spoil. The rate of water movement through the TSF floor is expected to decrease post-closure as the tailings dewater and the TSF cap reduces rainfall recharge.

Investigations by EGi (2009) reported that the time lag for potentially acid forming (PAF) rejects to generate acid was likely to be within a few weeks, whereas the time lag for PAF tailings to generate acid was expected to be much longer, around 2 years. Water sampling at Ramp 1 Transfer, which is located below the TSF show neutral to alkaline pH, therefore no impact from the TSF.

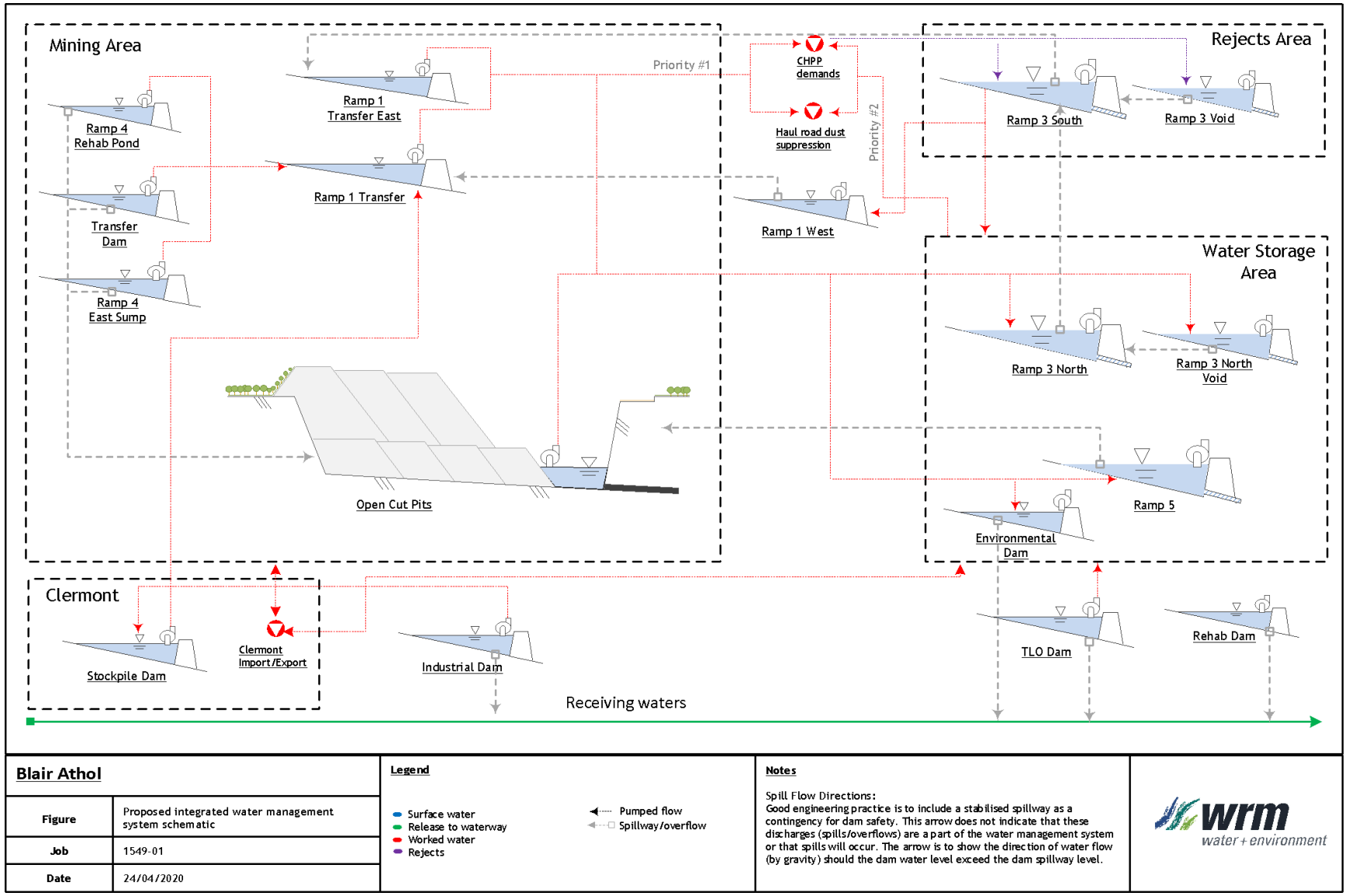


Figure 4.1. Blair Athol WMS schematic

4.4 COAL HANDLING AND PREPARATION PLANT

Tailings are pumped to Ramp 3 Void for in-pit disposal. Dewatering cells that were previously used for tailing disposal have been decommissioned, with 1 cell left as a back up system for potential plant issues. A Decant Dam temporarily stores drainage water off the remaining dewatering cell (when in use). The Decant Dam is an elevated "turkeys' nest" with no external runoff reporting to it. The Decant Dam only stores water when the CHPP is operating, the decant Dam is continuously de-watered to Ramp 1 Transfer and therefore is not considered an active storage in the WMS.

4.5 MINE INFRASTRUCTURE AREA

Oily Water Separator

Drainage from the workshop maintenance hardstand and wash-down bays reports to the Industrial Dam after passing through an oily water separator.

Sewage Treatment Plant

The sewage treatment plant is located on ML1804 close to the main entry to the site. Effluent is contained with the Effluent Dam and removed via evaporation.

If required, CCJV transports sewage from tanks located at the Rail Loadout facility for treatment.

4.6 SITE WATER BALANCE MODEL

The BA water management system was assessed using a water balance model based on the OPSIM (Operational Simulation) software (WRM, 2020). The model has the capability to simulate the operation of the site's water management system on a daily time step basis whilst keeping account of all site water volumes and representative water quality, including:

- climatic variability – rainfall and evaporation;
- catchment runoff;
- pit dewatering and inundation risk;
- CHPP and haul road dust suppression demands;
- pump transfers between storages;
- predicted groundwater inflows;
- water storage filling, spilling, evaporation and leakage; and
- the spill risk from key storages.

The site WBM comprises a collection of functional nodes, each representing a specific operational feature of the mines water management system. Details of the storages, catchments and operating rules are provided in the WBM repot (WRM, 2019).

The WBM was used to assess the impact to the WMS from water stored within the backfilled spoil. As this investigation is still ongoing, the WMP will use the current base case assumption that about 5% of the spoil volume holds water. It is assumed that the water level within the spoil is the same as the water level within Ramp 1 Transfer and Ramp 1 Transfer East, which are the primary water storages on site.

Interpretation of results

In interpreting the results of the WBM assessment, it should be noted that the results provide a statistical analysis of the WMS performance over the seven-and-a-half years of mine life, based on 123 different climatic sequences, referred to as realisations.

The model results are presented as a probability of exceedance. For example, the 10th percentile (10P) 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.

The forecast results have been presented as percentiles to represent different climate conditions as follows:

- The 1%ile (P1) results represents very wet climate conditions;
- The 10%ile (P10) results represent wet climate conditions;
- The 50%ile (P50) results represent median climate conditions;
- The 90%ile (P90) results represent dry climate conditions; and
- The 99%ile (P99) results represent very dry climate 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.

Dam spill risk

Dam spill risk was predicted at three dams including the TLO Dam, Environment Dam and Industrial Dam. These three dams spill externally from the mine site rather than internally to the mine workings.

The spill risks predicted from the WBM are as follows:

- If Environmental Dam is operated as a sediment dam, it does not spill under any climate conditions. If operated as a MAW dam, the Environmental Dam shall maintain a freeboard of approximately 375 ML to achieve an annual spill risk of less than 1%;
- The Industrial Dam does not spill under any climate conditions. The Industrial dam shall be dewatered after each rain event;
- Under all scenarios, the TLO Dam has a spill risk of at least 1% with an average annual spill volume of about 8.1 ML. The TLO shall be dewatered after each rain event.

Note that the modelling assumes that there is fixed pump infrastructure.

Active pit inundation risk

Pit inundation risk was modelled for the active pits. If the pit is inundated by more than 50 ML, it is assumed this may impact mining operations at the coal floor. The pit dewatering rate is 75 L/s.

Table 4.1 shows the annual average number of days of pit inundation with the assumed pit dewatering rate of 75 L/s. An alternate pump rate of 100 L/s was also assessed to show the impact of pump rate on pit inundation risk. The following is of note:

- There are no days of pit inundation predicted for 50%ile (median) climatic conditions;
- Increasing the pit dewatering rate from 75 L/s to 100 L/s lowers the average annual number of days of pit inundation by:
    - 56 days per year for 10%ile conditions;
    - 88 days per year for 1%ile conditions.

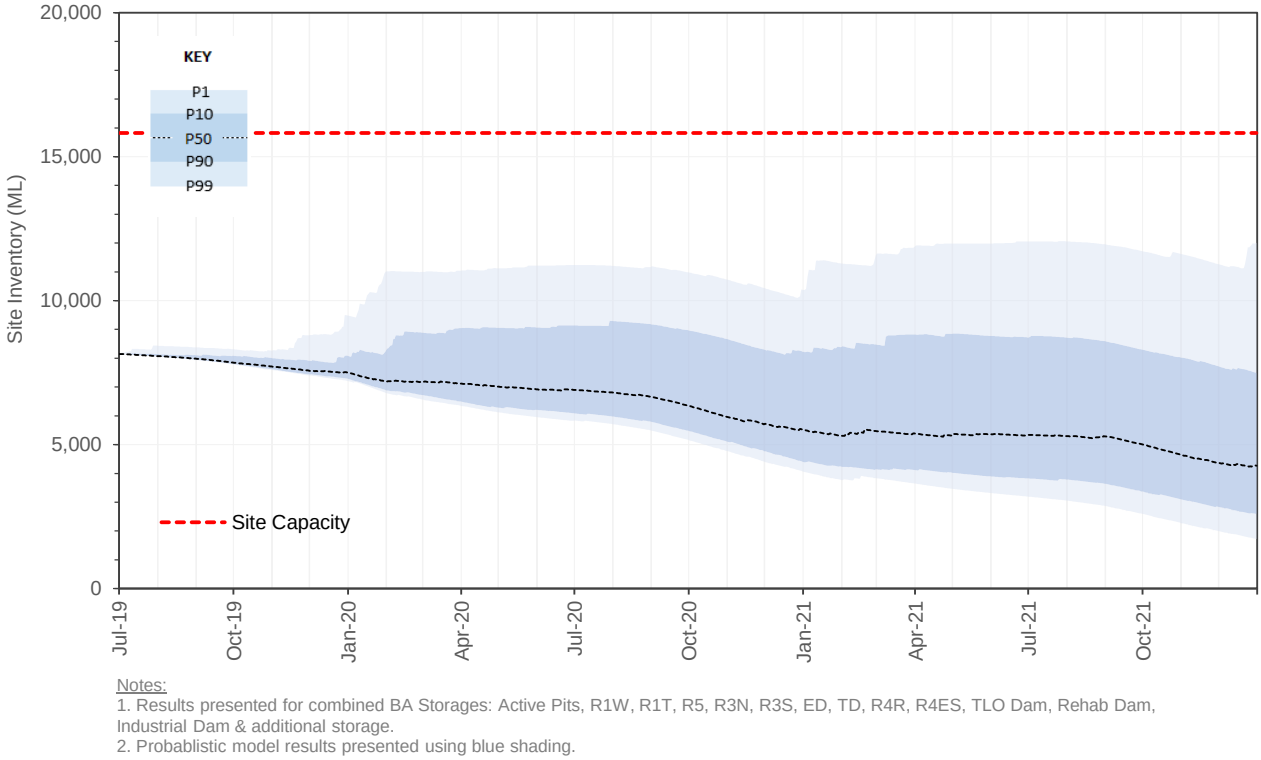
Table 4.1. Annual average number of days of pit inundation

Adopted dewatering pump rate (L/s)	Annual average days of pit inundation		
	1%	10%	50%
75	233	71	0
100	145	15	0

Total site inventory

The total site inventory was forecast over a 2.5-year period (mid 2019 to end 2021) to predict impacts to site inventory due to different climate conditions. The forecast model should be reviewed yearly to ensure the model is accurately representing changes to the site inventory. In respect to the total site inventory (assuming 5% spoil storage), the following is of note:

- BA is not predicted to run out of water under any climate conditions;
- Under 1%ile (very wet) climate conditions, site inventory will not exceed the storage capacity of the MAW storages (15,826 ML);
- Under 50%ile (median) climate conditions, BA site inventory lowers by approximately 4,000 ML.



Notes:
1. Results presented for combined BA Storages: Active Pits, R1W, R1T, R5, R3N, R3S, ED, TD, R4R, R4ES, TLO Dam, Rehab Dam, Industrial Dam & additional storage.
2. Probablistic model results presented using blue shading.

Figure 4.2. Total site inventory forecast from July 2019 to December 2021

5. MONITORING & REVIEW

Routine and non-routine water monitoring is conducted at Blair Athol. Routine monitoring is undertaken at a defined frequency (i.e. monthly, annually). Non-routine monitoring may occur in response to a rainfall event, locally or regionally, that triggers flow, regulatory (government) request or community complaint.

Data gathered through the monitoring programs demonstrates the effectiveness of the Environmental Management System (EMS) at managing environmental harm and risk. Monitoring will be conducted by a suitably qualified and competent person(s).

5.1 MONITORING EQUIPMENT

Gauging stations with automatic samplers are installed at the following monitoring locations:

- Washpool Creek (upstream);
- Bath Creek (upstream);
- Western Diversion (downstream);
- Environment Dam spillway (proposed to be move).

Automatic sampling is triggered at the first flow and then every 6 hours. The gauging stations include instream monitoring of pH, EC, Turbidity and flow depth.

5.2 SAMPLING

Sampling is to be conducted in accordance with the Standard Work Procedures for each specific area.

Sampling and Sample Integrity

- Field equipment is prepared and calibrated in accordance with manufacturer's guidelines and site procedures. Site procedures are developed in accordance with the Queensland Government's *Monitoring and Sampling Manual*.
- Field measurements are recorded in the field datasheet. These records are held and maintained. Data is transferred into the Environmental Database.
- Sampling is undertaken in accordance with the most recent version of the QLD Government *Monitoring and Sampling Manual.*
- Samples are placed into labelled laboratory supplied containers, prior to storage on ice in an insulated container. Samples are maintained below 4°C and freighted to the laboratory for analysis within the specified holding times.
- Each sample is to be labelled with a sample point number unique to that sample.
- All equipment contacting the sample is thoroughly cleaned to reduce cross sample contamination.
- Field data sheets and Chain of Custody (CoC) documentation are used to ensure that relevant information for each sample is accurately recorded.
- All laboratory analysis is conducted by a NATA accredited laboratory with an internal quality control and auditing process.

Specific sample preservation techniques must be used in accordance with:

- *AS5667.1: Guidance on the Design and Sampling Techniques and the Preservation and Handling of Samples.*
- *AS5667.1: Guidance on Sampling of Ground Waters.*

Failure to use approved preservation techniques would ultimately lead to analytical results that are not representative of site conditions.

Once filled, all sample containers should be tightly capped immediately, stored and transported between 4°C to 10°C.

Preservation details are recorded on the ***Sample Collection Form***. A functional identification sample ID number is used for all preserved samples from the same original sample.

5.3 SURFACE WATER MONITORING

Mine Affected Water

The follow is routine monitoring of MAW occurs at BA:

- Water level (survey) monthly;
- Field samples (EC and pH) monthly;
- Lab samples for the characteristics listed in Table C2 and Table C3 of the EA quarterly.

5.4 GROUNDWATER MONITORING

Groundwater monitoring shall be undertaken in accordance with the Groundwater Monitoring Program (Condition K2 of the EA). Groundwater is monitored at the locations and for the parameters lists in Table K1 and Table K2 of the EA.

5.5 REGIONAL ENVIRONMENT MONITORING PROGRAM (REMP)

Background water quality monitoring of the receiving environment shall be undertaken in accordance with the REMP.

No approval for MAW releases exists for BA. Downstream and background monitoring still occurs.

5.6 INFRASTRUCTURE

System configuration and sizing have been historically designed with consideration of mine development plans, site topography, regulatory/compliance requirements and operational considerations including site demands (e.g. CHPP, haul road dust suppression). The WBM was used to assess the performance of the WMS.

Key functional infrastructure associated with the BA Mine water management system is described below.

Diverted water / MAW separation

The following infrastructure maintains the separation of diverted water and MAW at BA:

- Natural/undisturbed upstream catchments are diverted around mining operations via the Eastern and Western Diversions.
- The mining area currently has a number of voids within spoil piles (shown in Figure 3.1) that can be used to store and transfer MAW around the operation without having to pump water to and out of pit storage, including:
    - Ramp 4 Rehab Pond
    - Ramp 4 East Sump
    - Transfer Dam
    - Ramp 1 West; and
    - Void Storage
- MAW storage – mine water containment on lease is offered by the following five pits and one storage with a combined storage capacity of around 10,160 ML:
    - Ramp 1 Transfer 2,705 ML
    - Ramp 1 Transfer East 2,542 ML
    - Spoil storage 5,705 ML
    - Ramp 3 Void (North) 2,018 ML
    - Ramp 3 Void (South) 1,658 ML
    - Ramp 4 East Sump 1,198 ML
- The Environment Dam can be used as a MAW storage to enhance evaporation.
- Coal Handling and Preparation Plant – dewatering cell and decant dam.
- Raw water supplies raw water from West Dam (capacity 1,500 ML), through an agreement with CCJV under a permit to take potable water. The water is then treated on ML1881 before being pumped across to BA for site use.
- A network of mobile pumps and pipelines provides cross-continuity between the various mine water storages and active pits.

Tailings Storage Facility

The Tailings storage facility was capped and rehabilitated in 2019. Tailings are now stored in Ramp 3 void. Ramp 3 Void shall be monitored.

Environmental Dam

The Environment Dam is currently operated as a Sediment Dam and managed in accordance with the BA ESC Plan.

In the event that MAW is pumped to the Environment Dam, the dam shall be monitored as a MAW Dam.

Diversions

BA has two main diversions within the mining lease (and CCJV mining lease) that are designed to separate the operational areas from inundation during periods of high flow in local waterways. Monitoring of creek diversions must comply with the applicable Water Licences.

The Breaker Creek Diversion is located north of the rail loop and is a diversion for Breaker Creek North. The Northern diversion transfers overflow from West Dam around the Rail Loop area and the mining area to the Eastern Diversion. Diverted water is prevented from entering the site from the north, diverted around the mining area by the Northern Boundary Drain, along the Eastern Diversion and subsequently into South Eastern Diversion where it meets Bath Creek.

Breaker Creek runs around the western side of the mining operation and accounts for approximately one third of the total catchment area.

All creek diversions are licensed under the *Water Act 2000.*

Blair Athol is to maintain and implement a monitoring and evaluation program that quantifies that the interference authorised under the water licence is meeting or progressing towards achieving the following outcomes:

- Developing features (including geomorphic and vegetation) present in the landscape and in local watercourses;
- The watercourse diversion maintains a sediment transport regime that allows the diversion to be self-sustaining and not directly impact on upstream and downstream reaches; and
- The watercourse diversion and associated structures maintain equilibrium and functionality and do not require ongoing maintenance.

The monitoring and evaluation program must include recommendations as per ACARP Project C9068 “Monitoring and Evaluation Program for Bowen Basin River Diversions”.

Surveillance

Surveillance inspections of structures occurs in accordance with EA requirements and Water Licence conditions. The surveillance inspection report includes the current condition of the structures and the review of the effectiveness of the associated operational plans and standards with any recommendations for remedial works. The recommendations are assessed to determine the appropriate actions required.

6. REPORTING

6.1 DATA MANAGEMENT & RECORDS

Monitoring data shall be uploaded and stored in appropriate business systems that are regularly backed up.

All records will be managed in accordance with the Environmental Authority such that evidence for compliance is readily accessible and validated.

As per EA requirements, all monitoring results are recorded, compiled and kept for a minimum of 5 years.

6.2 INTERNAL

Blair Athol

Regular updates on the Site Water Status will be relayed to personnel via regular meetings, printouts on notice boards, via Toolbox Sessions, and at a scheduled monthly Water Session with the Senior Management Team.

TerraCom

Internal reporting on compliance with site obligations is undertaken in a scheduled weekly discussion and formally noted in a monthly report.

6.3 EXTERNAL

Clermont Coal

Regular reporting to CCJV is required to enable planning and management of water supplies and storages between leases. This includes all transfers to and from BA including the volume, EC and pH.

Annual Returns

The EA requires a report on the water quality across the lease area and any potentially impacted downstream areas. This report is submitted in conjunction with the Annual Return.

As per the EA, the following information must be recorded and submitted to the administering authority with each annual return:

- The date and time the sample was taken;
- The monitoring point at which the sample was taken;
- The measured or estimated daily quantity of the contaminants released from all release points;
- The release flow rate at the time of sampling for each release point; and
- The results of all monitoring and details of any exceedances against the EA water conditions.

Community

As a rural community, reliance on water supplies is a focus of stakeholders and any interference to supplies or perceived impact (i.e. site discharges) can cause concerns.

Understanding of the water system status and quality will be regularly discussed with site personnel so that a level of awareness is maintained.

7. EMERGENCY AND CONTINGENCY PLANNING

7.1 INCIDENT REPORTING AND MANAGEMENT

BA has implemented contingency planning and procedures for the management of unplanned events, including:

- Management of emergencies (LMS-BAC-PRO-12)
- Management of Emergencies Duty Cards (LMS-BAC-SWP-101)
- Emergency Response flowcharts (LMS-BAC-SWP-100)
- Evacuation Register (LMS-BAC-PR-012-FRM-003)
- Emergency Event Log (LMS-BAC-PR-012-FRM-001)
- Emergency Action Checklist (LMS-BAC-PR-012-FRM-002)
- Emergency Procedures Poster (LMS-BAC-PR-012-FRM-004)

Potential event scenarios are evaluated to determine the likelihood and severity. Water management related emergencies will be treated in accordance with procedures developed for all other potential emergency situations.

8. AUDITING AND REVIEW

A review of this Water Management Plan will be undertaken on an annual basis. Reviews may also be initiated following a non-compliance or issue identified through monitoring, inspections or incident.

Changes in legislative requirements or expected reporting will trigger a review and update of this Plan.

The water monitoring programs will be subject to the following reviews and audits:

- Internal Review – annually;
- External Third-Party Audit – variable frequencies depending on the program; and
- Administering Authority Audits – at a frequency determined by DES.

A review of this document must be conducted annually to ensure monitoring parameters and frequencies align with EA requirements.

9. REFERENCES

ANZECC & ARMCANZ (2000)	*Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand Environment Control Council and Agricultural and Resource Management Council of Australia and New Zealand, October 2000
Coffey & Partners Pty Ltd (1983)	*Groundwater Appraisal Blair Athol Coal Field*
Dames and Moore (1983)	*BAC Waste Management and Rehabilitation Program*
DEHP (2010)	*Monitoring and Sampling Manual 2009,* Queensland Government Department of Environment and Heritage Protection, September 2010.
DEHP (2013)	*Queensland Water Quality Guidelines 2009,* Queensland Government Department of Environment and Heritage Protection, July 2013
DES (2019)	*Environmental Authority EPML00876713 – Blair Athol Coal Mine Permit Number: EPML00876713,* Queensland Government Department of Environment and Science,
DES (2019)	*SILO Climate Database.* Point data requested at -22.7, 147.55. Queensland Government
DSITI (2017)	Newham M, Moss A, Moulton D & Thames D (2017). Draft environmental values and water quality guidelines: Fitzroy Basin fresh, estuarine and marine waters, including Keppel Bay - *March 2017*. Department of Science, Information Technology and Innovation, Queensland
EGi (2004)	*Geochemical Assessment of Coal Washery Wastes,* Environmental Geochemistry International (EGi)
EGi (2006)	*Geochemical Assessment of Overburden from Blair Athol Mine,* Environmental Geochemistry International (EGi)
EGi (2008)	*Geochemical Assessment of Rejects and Tailings from the Blair Athol Washery Plant,* Environmental Geochemistry International (EGi)
EGi (2010)	*ARD Assessment of Overburden and Coal from the Clermont Mine,* Environmental Geochemistry International (EGi)
JBT Consulting (2012)	*Blair Athol Mine Closure Groundwater Investigation*
MatrixPlus Consulting (2004 and 2005)	*Annual Report to DNRM On the Taking of Groundwater (Water Licences 84527F & 84530F)*
Rio Tinto (2016)	*Blair Athol Water Management HSEQ MS – Guideline BAM-10-GUI-EV-0003_8*
TerraCom (2018)	*Residual Void Management Plan, Blair Athol Coal Mine*
Terrenus Earth Sciences (2009)	*Groundwater Review Blair Athol Coal Mine. Report Number 09-011-24, 16 June 2009*
URS (2008)	*Post Phase 2 Environmental Site Assessment - June 2008*
WRM (2020)	*Water Balance model report, Blair Athol, WRM report 1549-01-F1, April 2020*



Appendix L

Erosion and sediment control management plan

This page is intentionally blank.

Erosion and Sediment Control Management Plan

Client:	Rio Tinto
Project/Business Unit Name:	Blair Athol Eastern & Western Waterway diversions
Project Number:	3500
Issue Date:	21/03/12
Version:	001
Compiled by:	Kevin O'Mahony

	Project Manager	Project Engineer	Site Supervisor
Name:	**Dylan Price**	**Kevin O'Mahony**	**Gary Oates**
Signature:			
Date:			

UNCONTROLLED DOCUMENT WHEN PRINTED

Erosion & Sediment Control Plan

Table of Contents

1.0 Purpose 2
2.0 Scope 2
3.0 Objective 2
4.0 Backround 5
4.1 Sources and Impact 5
4.2 Bath Creek East 6
4.3 Bath Creek West 6
4.4 Venus Road 7
5.0 Implementation 8
5.1 Excavation & Cleared Areas 9
6.0 Monitoring 11
6.1 Inspections 11
7.0 Responsibilities 11

UNCONTROLLED DOCUMENT WHEN PRINTED

1.0 Purpose

The Georgiou Erosion and Sediment Control Plan (the Plan) outlines current procedures and accountabilities concerning runoff water, erosion and sediment management at Rio Tinto Coal Australia's (RTCA) Blair Athol Mine Road, Venus Road and Bath Creek East to ensure that:

- Runoff water management practices relevant regulatory and RTCA requirements;
- Appropriate erosion and sedimentation control is utilised to minimise the excessive occurrence of these processes; and
- All personnel are adequately trained and aware of their responsibilities regarding storm water management systems on site.

2.0 Scope

The Georgiou Erosion and Sediment Control Plan provides instruction regarding the management of stormwater, erosion and sediment generated from all the Blair Athol Eastern & Western waterway diversions. The objective of this plan is to manage runoff waters, minimise erosion and manage sedimentation in receiving environments

3.0 Objective

Management of stormwater, erosion and sedimentation is managed specific; therefore to best deal with this variability, Georgiou's works has been grouped into areas of specific activity and/or material type as below:

- Excavations & Cleared Areas
- Unsealed Roads
- Spoil Piles

This Plan discusses best practice stormwater, erosion and sediment management for the different site areas to limit associated environmental impacts. These areas include:

Bath Creek East

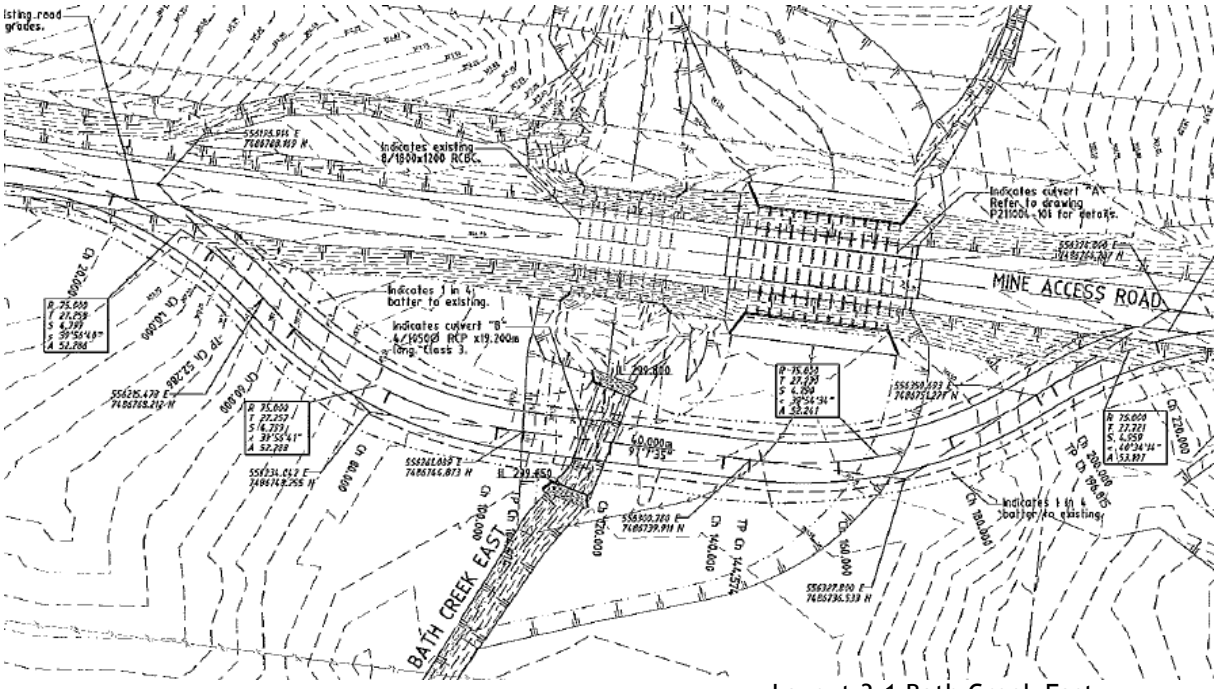
Located along Blair Athol mine access road Bath Creek East is the largest of the three sites. The work consists of:

- Clearing and Grubbing and stripping of topsoil
- Construction of a temporary road south of the mine access road to allow for a traffic diversion.
- Excavation of the existing road to allow for the installation of Culverts for the river diversion

UNCONTROLLED DOCUMENT WHEN PRINTED

- Reinstatement of the existing road.
- Excavation, Realignment, & reconstruction of the new & existing creek bed and batters.

Due to its size, gradient & area this will require the greatest amount of controls. Refer to layout 3.1 for reference to the works at Bath Creek East.



Layout 3.1 Bath Creek East

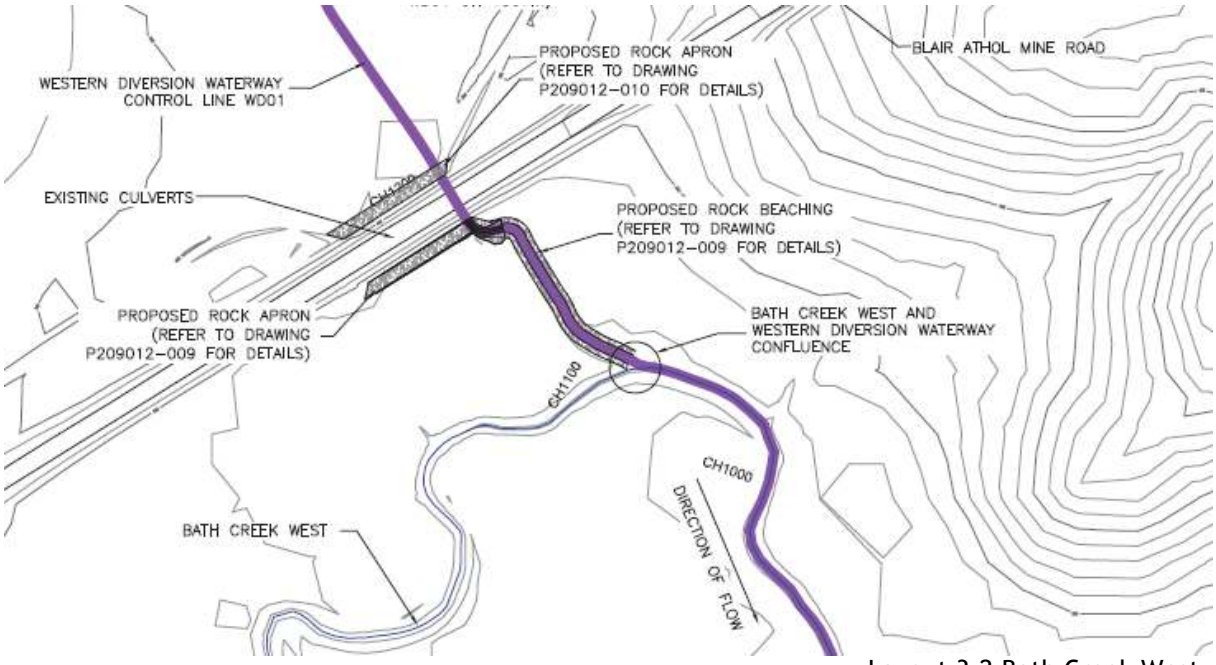
Bath Creek West

Located along Blair Athol mine access road the works is predominately along the creek. Works will include the following:

- Clearing & reconstruction of the existing creek bed and batters.
- Excavation & reconstruction of existing aprons.

Despite to the small amount of the work here the management of Erosion and Sediment control is essential here. Layout 3.2 shows the general layout of works.

UNCONTROLLED DOCUMENT WHEN PRINTED



Layout 3.2 Bath Creek West

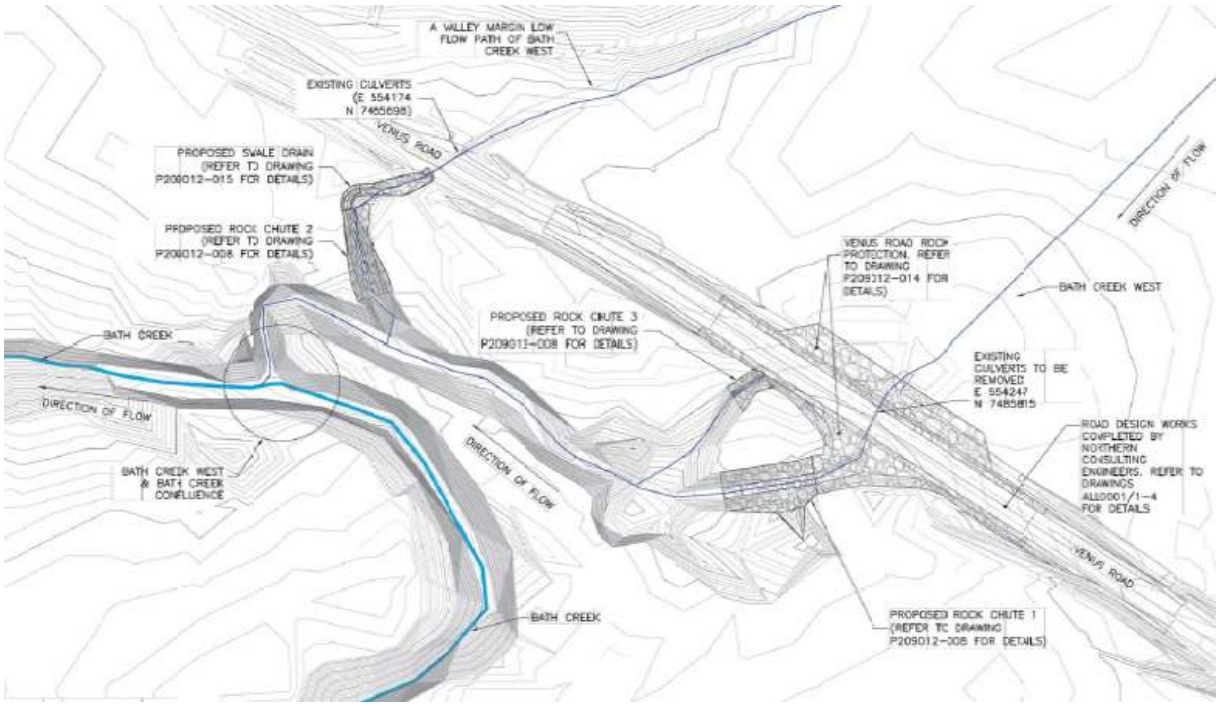
Venus Road

Located adjacent to Blair Athol Mine access road, the site is medium in size relative to the others. Works will include:

- Clearing & reinstatement of existing creek bed and batters
- Creek Realignment (small section)
- Excavation of existing culvert & 105m of unsealed road
- Installation of concrete floodway slab
- Reinstatement of topsoils etc.

Erosion and sediment controls are required to manage the water/sediment runoff and are discussed in section 5.2. Refer to Layout 3.3 for detailed plan.

UNCONTROLLED DOCUMENT WHEN PRINTED



Layout 3.3 Venus Road

4.0 Backround

4.1 Sources and Impact

The primary source of stormwater, erosion and sedimentation in the Region of works is rainfall.

Erosion and entrained sediment in stormwater runoff originates from a variety of sources including roads, excavated areas, spoil piles, and drainage system batters. Erosion and sedimentation are natural processes, which depend on environmental variables including rainfall intensity, soil types, land used, vegetative ground cover and topography. However, extensive occurrence of either process (particularly as a function of human intervention with the environment), can degrade Georgiou's ability to manage stormwater flows. Sedimentation reduces the volume of storage facilities and drainage efficiency of built and downstream natural environments. Erosion can jeopardise the structural integrity of roads, embankments and channel batters, thus affecting the functionality and safety of these structures. Erosion can also lead to the loss of topsoil from rehabilitation zones and form excessive scouring and channel formation in these areas, requiring repair.

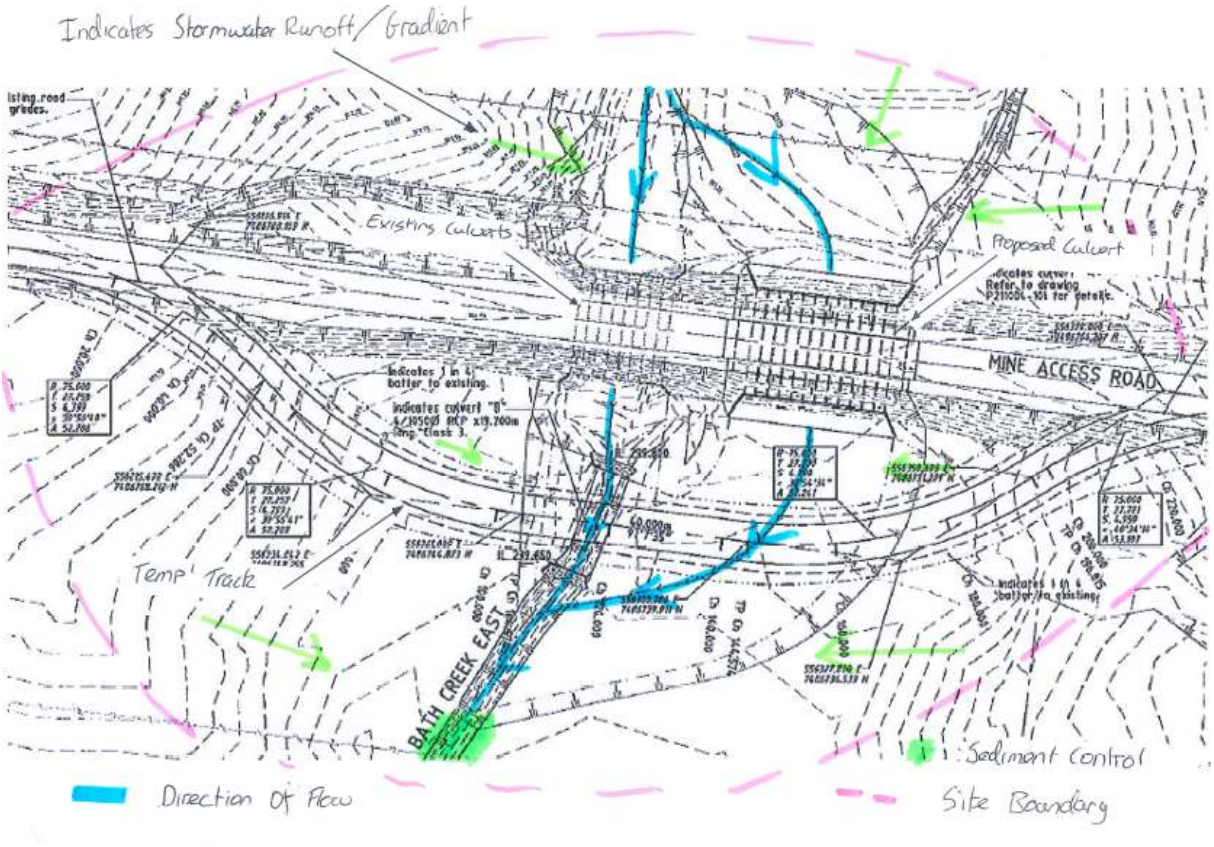
It is therefore important that Georgiou manages stormwater runoff via the most reasonable means to prevent excessive erosion and sedimentation.

UNCONTROLLED DOCUMENT WHEN PRINTED

4.2 Bath Creek East

Stormwater runoff collected from catchments upstream (north) of the access road and onsite discharges to the south via the original creek Layout. Refer to layout 4.2 for a layout of the site

The behaviour of these flows depends on rainfall event intensity and runoff volumes already present in the catchment system. Runoff values will increase as the site is cleared due to the loss of vegetation.



Layout 4.1 Bath Creek East

4.3 Bath Creek West

Stormwater runoff collected from catchments upstream (north) of the access road and onsite discharges to the south via the original creek Layout.

The behaviour of these flows depends on rainfall event intensity and runoff volumes already present in the catchment system. Runoff volumes will not increase by a significant amount due to works. The area within the site boundary is minimal for the works involved so the works will not increase stormwater runoff significantly. However Erosion and Sediment controls will be in place as a precaution. Refer to section 5.0 for controls.

UNCONTROLLED DOCUMENT WHEN PRINTED



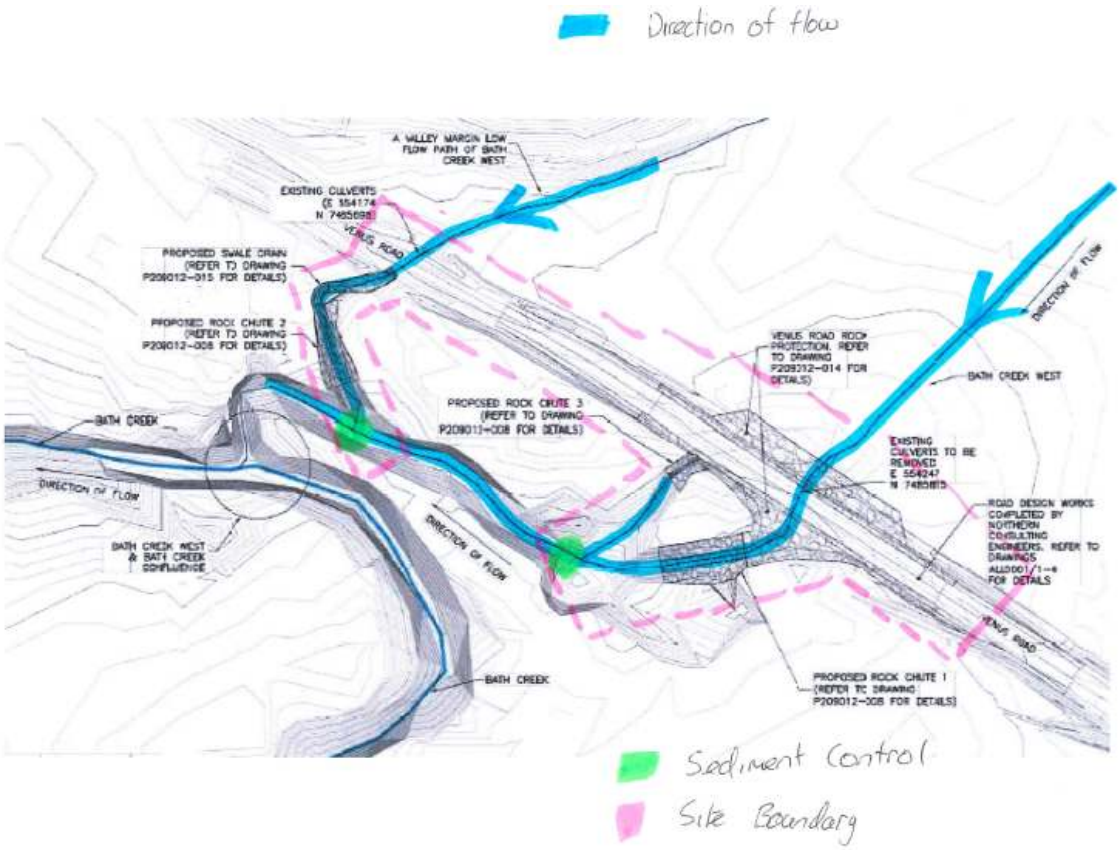
Layout 4.2 Bath Creek West

4.4 Venus Road

Stormwater runoff collected from catchments upstream (West) of the access road and onsite discharges to the south East via the original creek Layout. Refer to layout 4.4 for reference.

The behaviour of these flows depends on rainfall event intensity and runoff volumes already present in the catchment system. Runoff volumes will not increase by a significant amount due to works. However the necessary controls will be implemented as mentioned in Section 5.

UNCONTROLLED DOCUMENT WHEN PRINTED



Layout 4.3 Venus Road

5.0 Implementation

Management of stormwater runoff, erosion and sedimentation will vary between different areas of activity. To address this variability, Georgiou have been divided into the following areas:

- Excavations & Cleared Areas
- Unsealed roads
- Spoil piles

Physical descriptions of these areas, their influence on stormwater activity, exposure to erosion and sedimentation and reasonable means of controlling these processes are discussed in the following sections.

UNCONTROLLED DOCUMENT WHEN PRINTED

5.1 Excavation & Cleared Areas

Stormwater runoff, erosion and sedimentation control will vary from site to site depending on the amount of clearing involved in each. Bath Creek East will have the largest cleared area and therefore will require the largest amount of controls and monitoring. Georgiou will implement the controls listed below to mitigate these issues.

- Stormwater runoff
  - The creek will be excavated of all existing sediment within creek bed this will improve stormwater runoff on site. Refer to photo 5.1
  - In areas of water retention trenches will be dug to allow runoff and prevent further retention.
  - Perimeter banks /trenches will be placed along the temporary road to take surface runoff.
  - Clearing will only occur within the GDP approved areas.



Picture 5.1 Silt removal

- Erosion
  - To prevent erosion/ degradation, plant will operate on designated tracks & within the site boundary where possible. This minimise unnecessary plant movement and reduces the erosion of the surroundings as a result.
  - Silt fences or sediment fences will be used on all three sites. Silt fencing is designed to intercept and retain sediment as it travels across exposed soils while allowing drainage. Generally silt fences are constructed using a filter fabric (also called a geotextile) which can be made of a woven or non-woven material which is entrenched or inserted into the ground to stop the contaminated water getting underneath it. The filter fabric is attached to either timber pegs or steel posts for support.

UNCONTROLLED DOCUMENT WHEN PRINTED

- Where stockpiles contain excessive amount of fines and will remain stockpiled for long periods of time silt fencing is to be placed around the perimeter to prevent the erosion and sediment runoff. Refer to Picture 5.2
- Silt fencing will be monitored throughout the duration of the project and will be replaced if necessary.



Picture 5.2 Silt fencing

- Sediment Control
  - Silt Fencing will be placed downstream of the works to prevent sedimentation runoff. Refer to picture 5.2
  - Straw bales sediment trap is a commonly used sediment trap and is used here onsite in conjunction with Silt fencing to ensure that the sediment controls are met Refer to picture 5.3
  - Excess Silt will be removed from existing creek areas to allow natural creek flow.
  - Any excess build up of sedimentation will be excavated.
  - The location of the sediment controls are shown in layouts 4.1-4.3.



Picture 5.3 Straw Bales Sediment Control

UNCONTROLLED DOCUMENT WHEN PRINTED

5.3 Spoil Piles

Spoil piles vary considerably in dimension and composition. The often dispersive and highly exposed material is susceptible to high rates of erosion. Therefore Georgiou proposes the following:

- Erosion
  - To manage the erosions of stockpiles Georgiou intends to limit the dimensions of the Stockpiles to 3m height and no less than 12m in width.
  - Location of stockpiles will be in flood free zones.
  - Bunding will be put in place if the erosion of the spoil becomes a problem.
  - As mentioned above where stockpiles contain excessive amount of fines and will remain stockpiled for long periods of time silt fencing is to be placed around the perimeter to prevent the erosion and sediment runoff. Refer to Picture 5.2

6.0 Monitoring

6.1 Inspections

In order to implement an efficient and effective Erosion & Sediment control Plan, monitoring of it has to be of paramount importance. Therefore Georgiou intends to perform routine inspections to ensure that the controls listed above are being implemented maintained and improved where necessary.

Note: The attached checklist will be used to monitor the Erosion & Sedimentation Controls.

7.0 Responsibilities

Role	Accountability
Operational Management	• Approve the Erosion and Sediment Control Plan.
Project Manager	• Provide adequate resources for the development and implementation of the Erosion and Sediment Control Plan
Project Engineer	• Raise awareness in the workforce regarding the importance and best practise for managing stormwater runoff, erosion and sedimentation • Ensure appropriate measures of controlling stormwater runoff, erosion and sedimentation are adopted and that monitoring is performed to assess areas of concern or adverse impact.

UNCONTROLLED DOCUMENT WHEN PRINTED

Site Supervisor/ Project Engineer	• Raise awareness in the workforce regarding the importance and best practise for managing stormwater runoff, erosion and sedimentation • Provide technical input into the development and revisions of the Erosion and Sediment Control Plan. • Provide advice regarding implementation stormwater runoff, erosion and sedimentation management. • Manage trials and implementation strategic stormwater runoff, erosion and sedimentation controls in new rehabilitation areas. • Identify, record and mange monitoring of areas displaying effects of adverse levels of stormwater runoff, erosion and sedimentation • Manage implementation of controls to improve stormwater runoff, erosion and sedimentation in areas of concern
All Employees	• Identify and report areas displaying effects of adverse levels of stormwater runoff, erosion and sedimentation • Implement stormwater runoff, erosion and sedimentation management measures where required

UNCONTROLLED DOCUMENT WHEN PRINTED



Appendix M
Water balance model report

This page is intentionally blank.

Water balance model report

Blair Athol

TerraCom Mining Pty Ltd

1549-01-F1, 24 April 2020

For and on behalf of WRM Water & Environment Pty Ltd
Level 9, 135 Wickham Tce, Spring Hill
PO Box 10703 Brisbane Adelaide St Qld 4000
Tel 07 3225 0200



Laurence Ziukelis

Project Engineer

NOTE: This report has been prepared on the assumption that all information, data and reports provided to us by our client, on behalf of our client, or by third parties (e.g. government agencies) is complete and accurate and on the basis that such other assumptions we have identified (whether or not those assumptions have been identified in this advice) are correct. You must inform us if any of the assumptions are not complete or accurate. We retain ownership of all copyright in this report. Except where you obtain our prior written consent, this report may only be used by our client for the purpose for which it has been provided by us.

Contents

1 **Introduction** 4

1.1 Operational description 4

1.2 Mine configuration 4

2 **Climate inputs** 6

2.1 Overview 6

2.2 Rainfall 6

2.2.1 Annual rainfall (SILO) 6

2.2.2 Rainfall statistics 6

2.3 Evaporation 7

2.4 Catchment yield 7

2.4.1 Overview 7

2.4.2 Parameters 8

3 **Water management system** 10

3.1 Simulation methodology and model staging 10

3.2 WMS components and layout 10

3.2.1 Active pits 10

3.2.2 Mining area 14

3.2.3 Water storage areas 14

3.2.4 Rejects 14

3.2.5 Mine water dams 14

3.2.6 Surface water dams 14

3.2.7 Excess storage 14

3.2.8 Storage details 15

3.3 Catchment areas and land use 18

3.4 Water quality 19

3.5 Spoil storage 19

4 **Site water usage** 22

4.1 Overview 22

4.1.1 Haul road dust suppression usage 22

4.1.2 CHPP usage 22

4.1.3 External water import/export 22

5 **Groundwater** 25

6 **Model performance** 26

6.1 Overview 26

6.2 Interpretation of results 26

6.3 Ramp 1 Transfer dewatering 27

6.3.1 'Excess Storage' requirement 27

6.3.2 Ramp 1 dewatering pump rate 28
6.4 Total site inventory 28
6.5 Active pit inundation 29
6.6 Dam spill risk 30
7 Conclusions and recommendations 31
8 References 32

List of Figures

Figure 1.1 – Blair Athol location map 5
Figure 2.1 – Historical annual rainfall percentiles 6
Figure 3.1 – Site catchment boundaries 11
Figure 3.2 – Operational site landuses 12
Figure 3.3 – Water management system schematic 13
Figure 3.4 – Site inventory based on spoil storage 20
Figure 3.5 – Estimated extent of spoil storage 21
Figure 6.1 – Total site inventory (base case) 29

List of Tables

Table 2.1 – Long term SILO database rainfall statistics (mm) (DES, 2019) 7
Table 2.2 – Long term M_{lake} evaporation statistics (mm) (DES, 2019) 7
Table 2.3 – Adopted AWBM parameters 8
Table 3.1 – Project staging 10
Table 3.2 – Storage details 16
Table 3.3 – WMS operating rules 17
Table 3.4 – Landuse/catchment areas 18
Table 3.5 - Adopted salinity concentrations 19
Table 4.1 – Design wash plant parameters 22
Table 4.2 – Predicted CHPP rates 22
Table 4.3 – Predicted Clermont import/export 2020 – 2021 (HEC, 2020) 24
Table 6.1 – Model scenarios 26
Table 6.2 - 'Excess Storage' required in the next 2.5 years 27
Table 6.3 - 'Excess Storage' required in the next 7.5 years 27
Table 6.4 – Pump rate required to dewater Ramp 1 Transfer in 2.5 years 28
Table 6.5 – Maximum site inventory over the LOM 29
Table 6.6 – Annual average number of days of pit inundation (base case) 30

1 Introduction

Blair Athol (BA) is an open cut coal mine located in Central Queensland, approximately 15 km northwest of the town of Clermont (Figure 1.1). WRM Water & Environment Pty Ltd (WRM) was engaged by the owner of BA, TerraCom Mining, to undertake an update of the site water balance model (WBM).

WRM has developed a WBM for BA, using the OPSIM modelling software for the proposed water management infrastructure under the latest Plan of Operations. The model was developed using the *RTCA – Blair Athol Coal/Clermont Coal Mine OPSIM Water Management Update & Review 2012* (Water Solutions, 2012). This report outlines the results of the WBM and undertakes a performance assessment of the proposed water management infrastructure.

The model development process is outlined in this report, including:

- Overview of the climatic data and model assumptions.
- Development of catchment and land use mapping.
- Development of the OPSIM model, operating rules and model schematic.
- Performance of the water management system (WMS), including:
  - required sizing and pumping rates to meet WMS requirements;
  - spill risk of storages; and
  - forecast site inventory.

1.1 OPERATIONAL DESCRIPTION

TerraCom acquired BA and recommenced mining at the site in 2017. Since the acquisition, TerraCom has exported up to 3 Mtpa of thermal coal. As mining progresses, TerraCom are undertaking the progressive rehabilitation of the site. BA is situated within mining lease (ML) 1804 (Figure 1.1) and operates under Environmental Authority EPML00876713.

Run-of-mine (ROM) coal is treated at an onsite Coal Handling and Preparation Plant (CHPP) and loaded onto trains at a purpose-built train load out.

1.2 MINE CONFIGURATION

BA plans to continue mining through previously mined areas. A drag line will remove the mined spoil down to the existing coal floor. The interburden between the existing coal floor and the coal seam will be blasted and excavated to the roof of the coal seam. Excavated spoil will be dumped on the lowwall as the pit progresses.

Due to the geography of the site, BA slopes inwards and water drains to the centre of the site. There are no new areas of disturbance (other than mining through rehabilitated spoil) and the total catchment area for the site will remain unchanged over the life of the mine (LOM). It is therefore assumed that the landuse types and sub catchments will remain relatively constant throughout the mine life. As rehabilitated spoil is mined through as the pit advances, the lowwall spoil behind the pit will be rehabilitated.

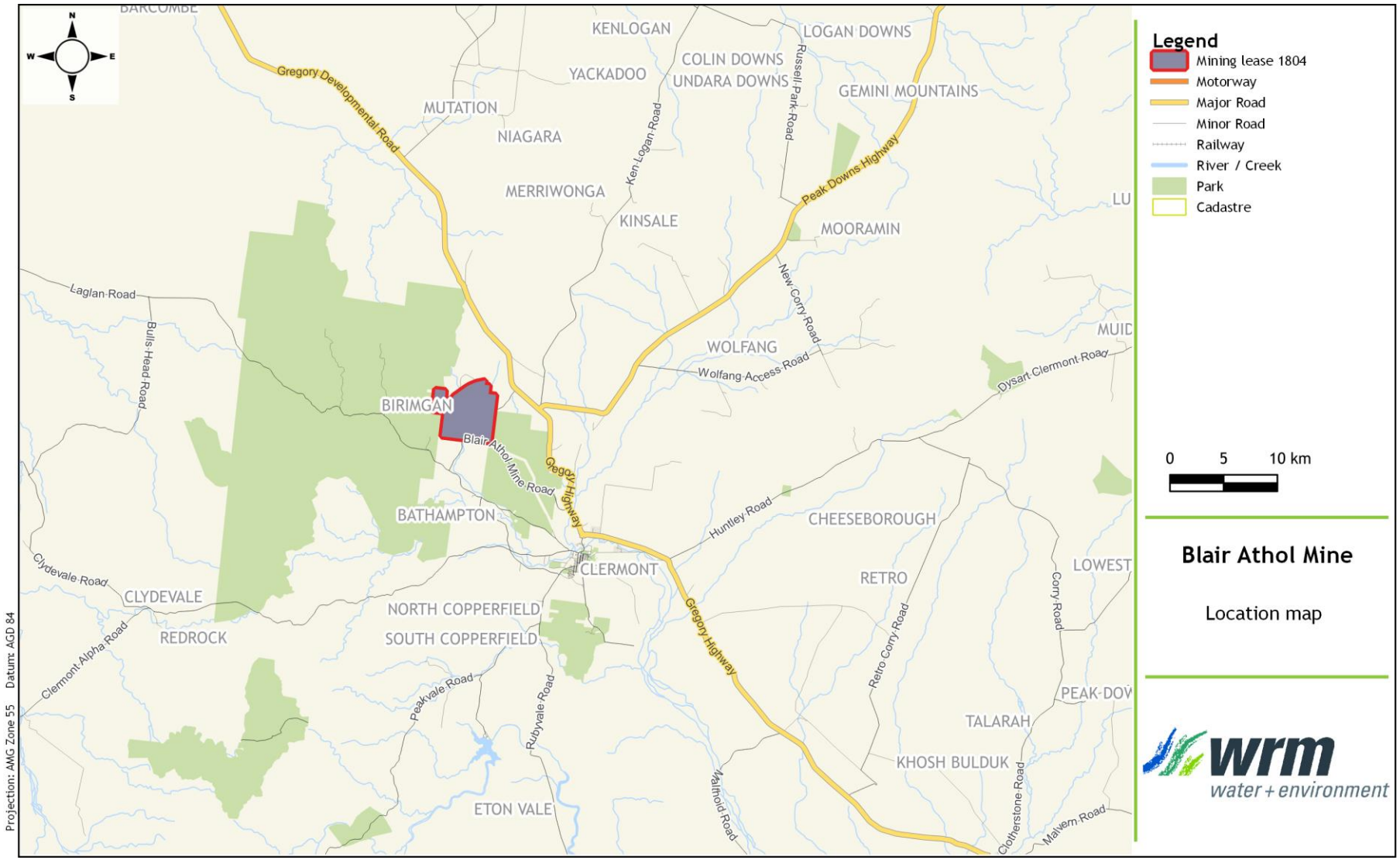


Figure 1.1 – Blair Athol location map

2 Climate inputs

2.1 OVERVIEW

Long term daily rainfall and evaporation data for the area from 1 January 1889 to 1 January 2019 (130 years) obtained from the Department of Environment and Science (DES) SILO database has formed the basis of the simulation (DES, 2019). This data set is corrected for accumulated daily rainfall totals and missing data and is well suited to use in water balance modelling.

2.2 RAINFALL

2.2.1 Annual rainfall (SILO)

Annual rainfall totals have been presented in Figure 2.1 on a percentile basis. Yearly totals have been measured using a "water year", from 1 October to 31 September of each year (i.e. year 2000 measures the annual rainfall from 1 October 1999 to 31 September 2000). Review of this information shows that annual rainfall varies between approximately 150 mm and 1,450 mm (~1,300 mm spread), with a median of 577.5 mm.

Shown for reference are "water year" rainfall totals for the 8 most recent years, as these represent a period of time approximately equal to the BA modelled LOM. The recent 2018 rainfall was equivalent to a historical 36th percentile (dry), whilst the 2017 rainfall was equivalent to a historical 20th percentile (dry).

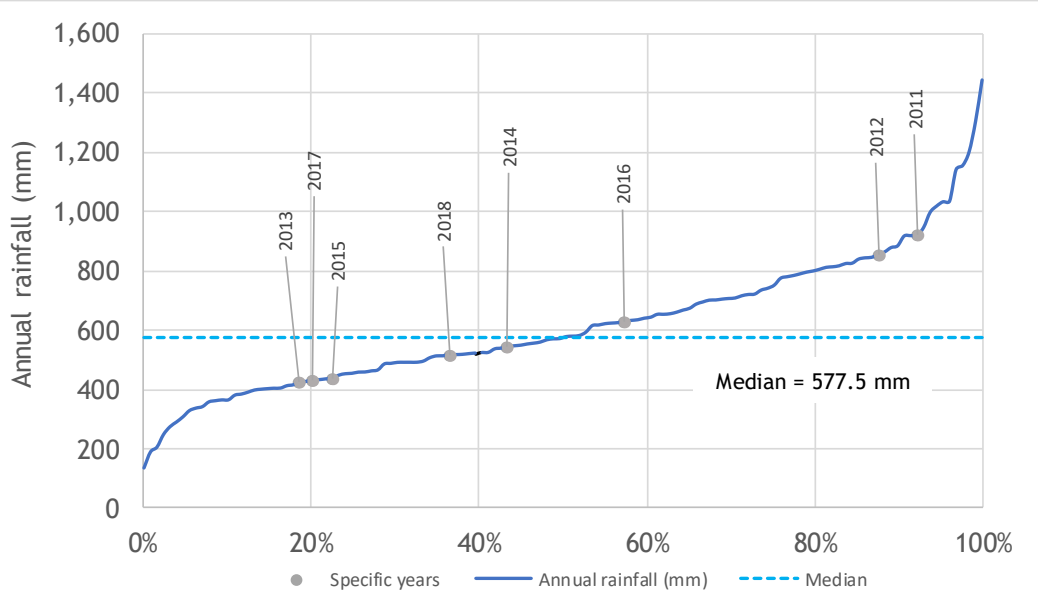


Figure 2.1 - Historical annual rainfall percentiles

2.2.2 Rainfall statistics

The statistics for the long-term SILO (DES, 2019) rainfall data are summarised in Table 2.1. Annual totals are for a calendar year (i.e. January to December). Note the annual values are not a sum of monthly statistics.

Table 2.1 – Long term SILO database rainfall statistics (mm) (DES, 2019)

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Max	483	426	286	273	218	331	228	173	167	177	243	477	**1,292**
90th %ile	234	255	171	85	76	73	59	51	56	76	127	185	**959**
Median	98	76	43	19	18	17	9	7	5	25	40	69	**575**
10th %ile	24	17	1	0	0	0	0	0	0	0	2	15	**334**
Min	0	0	0	0	0	0	0	0	0	0	0	1	**187**

2.3 EVAPORATION

Long term daily evaporation data for BA has been sourced from the SILO Data service, as summarised in Table 2.2. Morton lake (M_{lake}) evaporation has been used to estimate evaporation from the wet surface areas of surface storages. A factor of 0.96 was applied to catchments to represent evapotranspiration which is used in the AWBM runoff values. Note the annual values are not a sum of monthly statistics.

Table 2.2 – Long term M_{lake} evaporation statistics (mm) (DES, 2019)

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Max	240	208	204	152	115	94	101	142	171	218	228	244	**1,989**
90th %ile	225	193	189	144	108	87	96	125	161	200	217	231	**1,896**
Median	206	170	169	133	101	79	90	117	151	189	204	216	**1,814**
10th %ile	175	147	151	122	92	73	82	109	141	174	184	189	**1,732**
Min	128	123	120	96	78	60	76	21	118	163	124	146	**918**

2.4 CATCHMENT YIELD

2.4.1 Overview

Accurate estimation of catchment yield hydrology is an important component of water management investigations. Catchment yield within the BA OPSIM model is simulated using the Australian Water Balance Model (AWBM). The AWBM is a saturation overland flow model which uses daily rainfalls and estimates of catchment evapotranspiration to calculate daily values of runoff using a water balance approach (Boughton, 1993). The AWBM is widely accepted and commonly used throughout Australia.

2.4.2 Parameters

Catchments across the site have been characterised into the following land use types:

- natural/undisturbed, representing areas in their natural state;
- industrial, representing stockpile and haul roads;
- mining pit floor areas;
- spoil dump, representing uncompacted dumped overburden material; and
- rehabilitated spoil, representing established rehabilitated spoil areas.

The adopted rainfall runoff parameters are based on an investigation by Water Solutions (2012). The AWBM parameters from the model are summarised in Table 2.3. These parameters should be reviewed regularly through model calibration.

Table 2.3 – Adopted AWBM parameters

Parameter	Natural/ Undisturbed	Industrial/Pits	Spoil/Dump	Rehabilitated spoil
A1	0.2	0.1	0.1	0.1
A2	0.4	0.9	0.9	0.9
A3	0.4	0	0	0
C1 (mm)	70	12	12	12
C2 (mm)	105	38	38	125
C3 (mm)	210	0	0	0
C_{avg} (mm)	140.0	35.4	35.4	113.7
BFI	0	0	1	0.3
K_{base}	0	0	0.997	0.997
K_{surf}	0	0	0	0
Cv	9%	25%	25%	14%

The AWBM is a catchment water balance model that simulates runoff from rainfall in a catchment. The catchment is represented by three 'bucket' storages to simulate partial areas of runoff. The water balance of each surface store is calculated independently of the others and accumulates daily rainfall and evaporation. When the bucket storage is exceeded, runoff is generated.

The AWBM parameters are variables applied to the 'bucket' storages as follows:

- The AWBM assumes a unit area (1). The partial areas (A1, A2 and A3) represent the proportion of the total catchment occupied by each bucket;
- The three soil moisture stores (C1, C2 and C3) represent the capacity of the soil in each bucket to store moisture prior to generating runoff. The average soil moisture capacity (Cavg) is the average of these three values, calculated from their respective partial areas (A1, A2, A3). Land types with hard and flat surfaces will have a lower Cavg than land types with looser/deeper soil, topographical depressions and vegetation, which typically generate less runoff.
- The *base flow index* (BFI) is the proportion of total runoff which is reported as baseflow. Baseflow represents the runoff which flows through the ground and reports to catchment storages. This runoff generally occurs over a longer period than surface flow and can be used to represent the attenuation of runoff in a catchment. A BFI of 0.35 means 35% of total runoff is directed to the base flow storage.

- The *baseflow recession constant* (K_b) represents the rate at which the baseflow runoff is generated from the *baseflow storage*. A K_b of 0.95 means that each day, 5% (1-K_b) of the volumed stored in the *base flow storage* is reported as baseflow runoff.
- When at least one of the three *soil moisture stores (C1/C2/C3)* is exceeded, runoff is generated and reports to the *surface runoff attenuation store*. The rate at which this store generates surface runoff each day is based on the *surface flow recession constant* (K_s). A K_s of 0.95 means that each day, 5% (1-K_s) of the volume stored in the *surface runoff attenuation store* is reported as surface runoff.
- The coefficient of runoff (C_v) is a measure of the average annual runoff generated over a specified period, represented as a percentage of the rainfall total over the same period. That is, a C_v of 10% means that, on an average annual basis, 10% of rainfall is converted into runoff for that particular land type.

3 Water management system

3.1 SIMULATION METHODOLOGY AND MODEL STAGING

The OPSIM operational WBM has been run on a daily time step for a seven-and-a-half-year period, corresponding to the period of operation between July 2019 and December 2026. The model has been broken down into two discrete stages over the seven-and-a-half-year period, as shown in Table 3.1. The two model periods are to simulate the following two distinct operational requirements:

- Stage 1: Determine the pump rate required to dewater the mine area storages (i.e. Ramp 1 Transfer/Ramp 1 Transfer East, Ramp 4 East Sump, Ramp 4 Rehab Pond and Transfer Dam) to Ramp 3 North and Ramp 5, so that the storages can be mined through; and
- Stage 2: Determine BA storage requirements through to the end of mining, to account for the removal of Ramp 1 Transfer due to mining.

The required pump rate has been varied in the model to dewater the Mine Area storages within 2.5 years.

Table 3.1 – Project staging

Stage	Model Period	No. of model years
1	July 2019 – December 2021	2.5
2	Year 2022 to Year 2026	5

A total of 123 climate sequences (or realisations) have been simulated using the 130 years of historical data for an operational duration of seven-and-a-half-years.

3.2 WMS COMPONENTS AND LAYOUT

Figure 3.1 shows the catchment boundaries across the site, as well as the planned extent of mining, indicated by the 'Final pit floor'. Any storages located within the 'Final pit floor' will be dewatered in the first 2.5 years, so that mine progression is not impacted.

Figure 3.2 shows the landuse mapping used in the operational WBM. As described in Section 1.2, the total area of land uses has been assumed to stay relatively similar throughout the mine life and therefore the land uses shown in Figure 3.2 have been used for the entire operational WBM.

In the development of the catchment mapping it was assumed that a diversion bund exists along the western side of the Industrial Dam. This bund diverts a significant undisturbed catchment to the west of the dam and therefore significantly lowers the spill risk profile of the dam. It is strongly recommended that the diversion bund is maintained to lower the spill risk of the dam.

A summary of the water storages within the WMS is outlined in Table 3.2 and shown schematically in Figure 3.3. The storages and the general assumptions adopted in the WBM associated with each storage are listed in the sub-sections below.

3.2.1 Active pits

The active pits have been treated as a single catchment area. The WBM has been used to predict how frequently (i.e. how many days per year) the active pits are inundated by more than 50 ML.

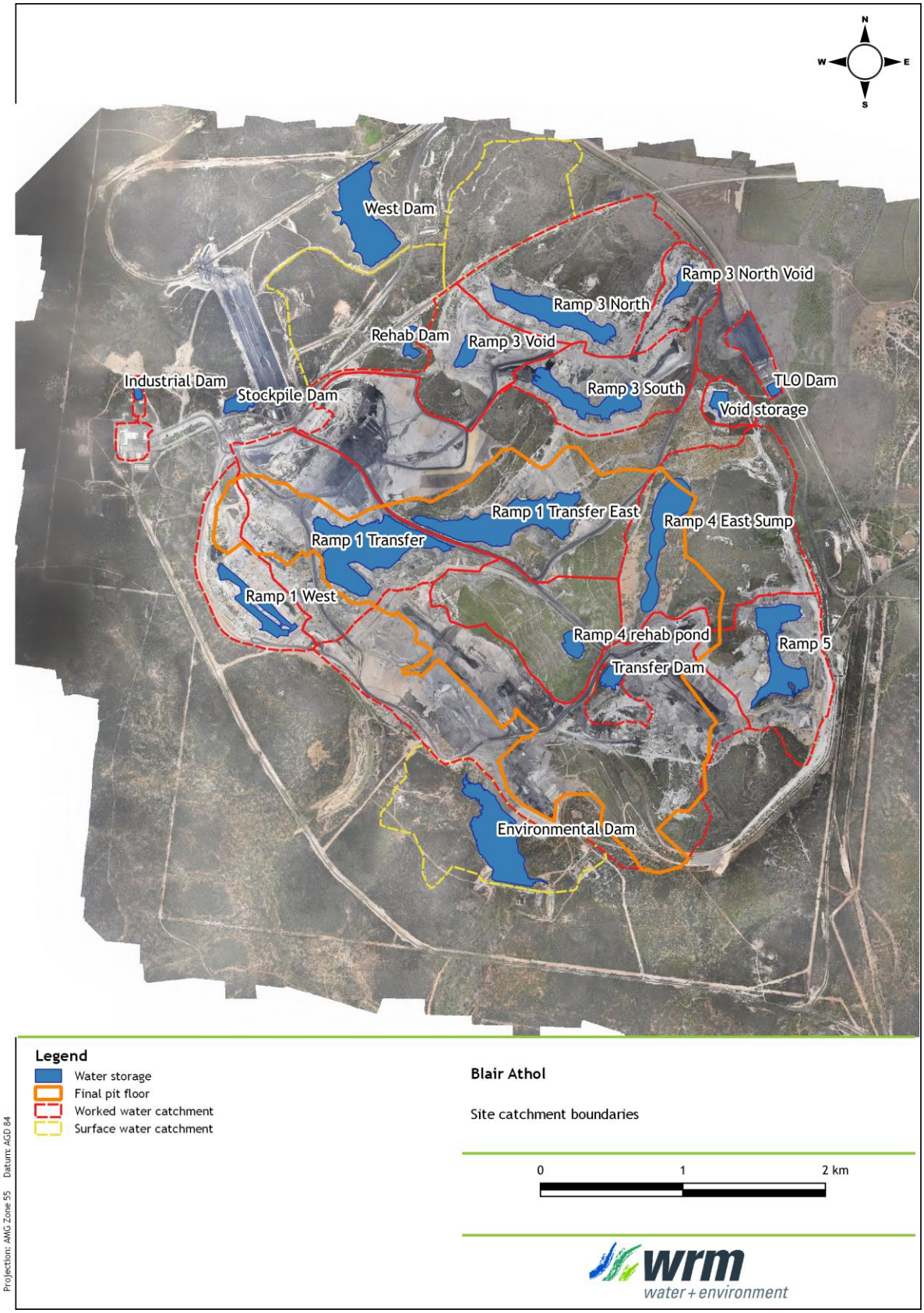


Figure 3.1 - Site catchment boundaries

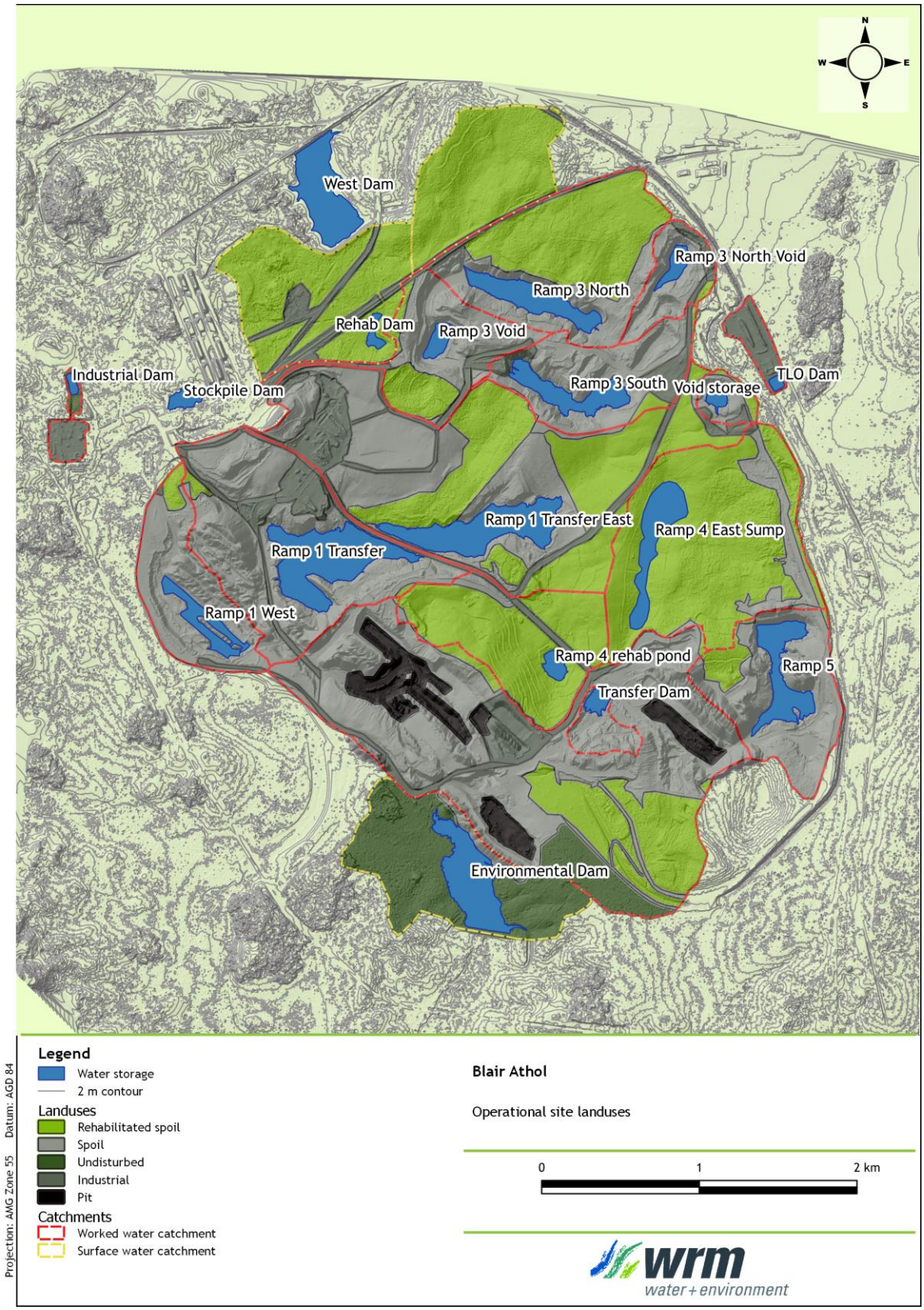


Figure 3.2 – Operational site landuses

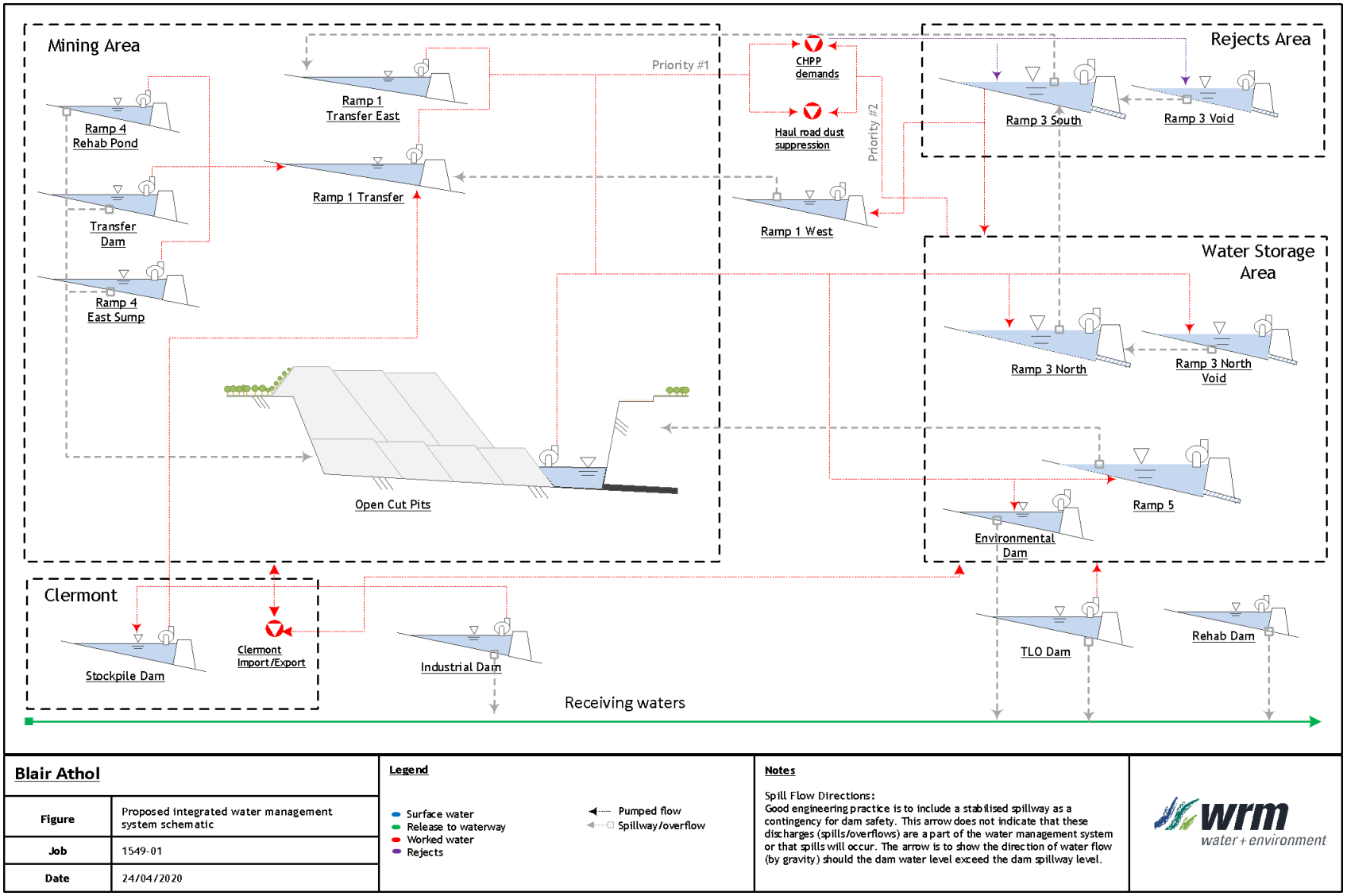


Figure 3.3 - Water management system schematic

3.2.2 Mining area

Ramp 1 Transfer, Ramp 1 Transfer East, Ramp 4 Rehab Pond, Transfer Dam and Ramp 4 East Sump are located within the final pit floor area (Figure 3.1). These storages have therefore been assumed to be actively dewatered to the water storage areas over the mine life to reduce any impact on mining. Note Ramp 1 Transfer and Ramp 1 Transfer East have been combined in the WBM due to spoil storage and are collectively referred to as 'Ramp 1 Transfer'.

3.2.3 Water storage areas

Ramp 3 North, Ramp 3 North void, Ramp 5 and Environmental Dam will be used for water storage. Water from the mining area will be pumped to these storages. Ramp 5 would spill to the active pits, however, the WMS has been optimised to minimise the possibility of this spill occurring. Note that Ramp 3 North and Ramp 3 North void have been combined in the WBM and are collectively referred to as 'Ramp 3 North'.

The Environmental Dam spills to the environment. The WBM has been used to minimise the spill risk for the Environmental Dam.

3.2.4 Rejects

Ramp 3 South and Ramp 3 Void will be used to store rejects from the CHPP. Note that Ramp 3 South and Ramp 3 Void have been combined in the WBM and are collectively referred to as 'Ramp 3 South'. The predicted volume of rejects over the LOM (about 4 million tonnes) will use the entire storage capacity of these storages, therefore, they are not proposed to be used as active storages.

3.2.5 Mine water dams

Two mine water dams have been included in the WBM - the Industrial Dam and TLO dam. Both of these dams have the potential to spill to the environment. The Industrial Dam and the TLO dam will be dewatered to the water storage area dams.

The Industrial Dam will collect drainage off the workshop hardstand and washdown water after passing through an oil water separator. The TLO dam will collect coal fines off the TLO area and transfer this water to the adjacent Void storage (note that this transfer has not been modelled).

Ramp 1 West will be retained as a mine water storage but will not be treated as an active storage and will not be dewatered. The storage will be backfilled with boxcut material from the mining operation.

3.2.6 Surface water dams

The Rehab Dam has been included as a surface water dam in the WBM, which currently spills to the Ramp 3 Void. Future site plans for the Rehab Dam involve filling in the existing spillway which means the storage will spill northward towards the receiving environment.

3.2.7 Excess storage

To assess the need for additional storage required onsite to account for mining through Ramp 1 Transfer, an additional 'Excess storage' was introduced in the WBM. This 'Excess storage' has been modelled to act as an additional water storage if the 'Water storage area' reaches capacity. Thereby, all excess water from dewatering Ramp 1 Transfer and the Active Pits is pumped to the 'Excess storage' once Ramp 3 North and Ramp 5 are full. The 'Excess storage' was modelled as a turkey's nest dam (i.e. no external catchment).

3.2.8 Storage details

Table 3.2 outlines the catchment areas based on the maximum catchment area reporting to each dam for the LOM. Storage capacities have been sourced from site LiDAR and bathymetric surveys. A summary of the modelled WMS operating rules is outlined in Table 3.3.

Table 3.2 – Storage details

Storage Name	Storage Type	Maximum Catchment Area (ha)	Storage capacity (ML)	Overflows to
Ramp 1 Transfer	Worked water	131.6	9,355[a]	NA
Ramp 1 Transfer East	Worked water	231.9		NA
Ramp 1 West	Worked water	54.1	1,245	Ramp 1 Transfer
Environmental Dam	Worked water	85.1	745	Receiving waters
Transfer Dam	Worked water	12.2	265	Active Pits
Ramp 4 rehab pond	Worked water	74.6	575	Active Pits
Ramp 5	Worked water	71.6	1,030	Active Pits
Ramp 4 East Sump	Worked water	137.7	2,140	Active Pits
TLO Dam	Worked water	10.0	5	Receiving waters
Ramp 3 South	Worked water	61.2	3,480	Ramp 1 Transfer East
Ramp 3 Void	Worked water	56.7		Ramp 3 South
Ramp 3 North	Worked water	166.7	2,220	Ramp 3 South
Ramp 3 North Void	Worked water	24.2		Ramp 3 North
Rehab Dam	Surface water	84.3	325	Receiving waters
Industrial Dam	Worked water	8.1	5	Receiving waters
Active Pits	Worked water	304.9	9,100	Internally

[a] The Ramp 1 Transfer stage-storage curve has been varied based upon the assumed spoil-storage in the surrounding spoil. The storage capacity listed above is the value based upon an assumed spoil-storage of 5% (i.e. from the base case simulation).

Table 3.3 – WMS operating rules

Item	Node Name	Operating Rules
1	***Water Storage Area***	
1.1	Ramp 5	• Used as water storage, receives water from the 'Mining Area', Ramp 3 South and TLO Dam • Seeps water to the Active Pits at a rate of 5 L/s after it exceeds a 50% capacity water level • Spills to the Active Pits
1.2	Ramp 3 North (Ramp 3 North and Ramp 3 North Void)	• Used as a water storage, receives water from the "Mining Area", Ramp 3 South and TLO Dam • Ramp 3 North Void spills to Ramp 3 North, which spills to Ramp 3 South • Supplies water to the CHPP as Priority #2 if Ramp 1 Transfer is empty • Seeps water to the Active Pits at a rate of 5 L/s after it exceeds a 50% capacity water level
1.3	Environmental Dam	• Used as a water storage, receives water from the 'Mining Area', Ramp 3 South and TLO Dam • Spills to the receiving environment
2	***Mining Area***	
2.1	Active Pits	• Dewaters to Ramp 5, Ramp 3 North and Ramp 3 North Void (75 L/s) • Receives a groundwater inflow • Receives seepage from Ramp 5, Ramp 3 North/Ramp 3 North Void and Ramp 3 Void
2.2	Ramp 4 Rehab Pond/Transfer Dam/Ramp 4 East Sump	• Dewaters to Ramp 1 Transfer (75 L/s) • Spill to the Active Pits
2.3	Ramp 1 Transfer/Ramp 1 Transfer East	• Supplies CHPP demands and haul road dust suppression • Dewaters to Ramp 5, Ramp 3 North and Ramp 3 North Void • Receives pumped inflows from Industrial Dam, Ramp 4 Rehab Pond, Transfer Dam and Ramp 4 East Sump
3	***Rejects Area***	
3.1	Ramp 3 South (Ramp 3 South and Ramp 3 Void)	• Receives rejects inflow from the CHPP and tailings • Dewaters to Ramp 1 West, and the 'Water Storage Area' if its volume exceeds 1 GL • Seeps water to the Active Pits at a rate of 5 L/s after it exceeds a 50% capacity water level • Ramp 3 Void spills to Ramp 3 South which spills to Ramp 1 Transfer East
4	***Water demands***	
4.1	CHPP Demands	• Demands from Ramp 1 Transfer (Priority #1) Ramp 3 North (Priority #2). Receives return water from Ramp 3 Void (via Ramp 3 North). • Rate determined based upon the design and coal wash plant parameters outlined in Section 4.1.2 • Pumps rejects to Ramp 3 Void
4.2	Haul road dust suppression	• Demands from Ramp 1 Transfer East and Ramp 1 Transfer (Priority #1) and the 'Water Storage Area' (Priority #2) • Assumed demand at 57 kL/d (Section 4.1.1)

Table 3.3 – WMS operating rules (continued)

Item	Node Name	Operating Rules
5	***Additional storages***	
5.1	Excess storage	• Used as water storage when all other storages are at maximum operating level • Receives water from the 'Mining Area', Ramp 3 South, Industrial Dam and TLO Dam when Ramp 5, Ramp 3 North and Environmental Dam are full. • Modelled as a turkeys nest dam
5.2	Rehab Dam	• Captures undisturbed catchment runoff • Spills to the receiving environment
5.3	Industrial Dam	• Spill to the receiving environment • Industrial Dam dewaters to Ramp 1 Transfer at 75 L/s
5.4	TLO Dam	• Dewaters to the 'Water Storage Area' at 50 L/s • Spills to the receiving environment
6	***Import/export***	
6.1	Clermont	• Import water transferred to 'Water Storage Area' and then 'Excess storage' if capacity full. Export water sourced from all available water storages. • Median import/export rates adopted in the model for the first 2 years of transfer, as outlined in Section 4.1.3

3.3 CATCHMENT AREAS AND LAND USE

Figure 3.1 and Figure 3.2 show the catchment and land use plans for BA. Catchment and landuse areas which have been incorporated into the WBM are outlined in Table 3.4.

Table 3.4 – Landuse/catchment areas

	Landuse areas (ha)					
Storage catchment	Undisturbed	Rehabilitated spoil	Spoil	Pit	Industrial	Total catchment area (ha)
Ramp 1 Transfer	-	2.2	110.7	-	18.7	131.6
Ramp 1 Transfer East	-	97.0	105.7	-	29.2	231.9
Ramp 1 West	-	3.1	49.9	-	1.2	54.1
Environmental Dam	80.0	-	5.0	-	0.1	85.1
Transfer Dam	-	-	12.2	-	-	12.2
Ramp 4 Rehab pond	-	67.338	3.574	-	3.709	74.621
Ramp 5	-	6.953	64.679	-	-	71.632
Ramp 4 East Sump	-	122.1	15.2	-	0.4	137.7
TLO Dam	-	-	-	-	10.0	10.0
Ramp 3 South	-	2.6	48.1	-	10.4	61.2
Ramp 3 North	-	120.6	42.3	-	3.8	166.7
Ramp 3 North Void	-	1.1	19.8	-	3.4	24.2
Ramp 3 Void	-	14.8	34.1	-	7.9	56.7
Rehab Dam	-	70.7	0.1	-	13.5	84.3

Industrial Dam	2.2	-	-	-	5.9	8.1
Pit	17.9	55.2	179.0	32.0	20.8	304.9

3.4 WATER QUALITY

The WBM was configured to use salinity as an indicator of water quality. This was achieved by assigning representative electrical conductivity (EC) concentrations to runoff from catchments and other sources of water.

The adopted salinity values for different landuses are based on Water Solutions (2012) and shown in Table 3.5. The adopted salinity for groundwater has been sourced from TerraCom (2018), which measured average baseline total dissolved solid levels of 405 mg/L (i.e. approximately 735 µS/cm) in the basalt aquifer at BA.

Salinity from baseflow (seepage) through the spoil and the rehabilitated spoil is the same as surface flow.

Table 3.5 - Adopted salinity concentrations

Landuse	Salinity (µS/cm)	Source
Natural/Undisturbed	200	Water Solutions (2012)
Industrial/Pits	5,000	
Spoil	2,500	
Rehabilitated spoil	500	
Groundwater	735	TerraCom (2018)

3.5 SPOIL STORAGE

The management of water stored within existing spoil in the historical pit shells at BA represents a significant risk to the site operation and WMS.

The mined extent of BA has created a depressed landform. This depressed landform includes the existing mine floor and in-pit backfill spoil. Backfilled spoil has the potential to store water within the spoil pore space. BA is re-mining the existing mined extent, which means mining through backfilled spoil.

The volume of water potentially stored within the backfilled spoil at BA will have a large impact on the WBM and therefore operations at BA. It has been assumed that the water level within the spoil is similar to the water level in Ramp 1 Transfer (i.e. 264.5 mAHD).

Figure 3.4 shows the estimated site inventory (based on aerial photography and LiDAR). Assuming there is no water stored in the spoil, there is approximately 4.2 GL of water currently stored onsite. This volume would fill Ramp 3 North and Ramp 5 voids. However, if we assume there is water stored in the spoil (up to 264.5 mAHD), the Ramp 1 Transfer inventory is significantly higher. If 5% of the spoil volume to 264.5 mAHD contains water, the site inventory increases to approximately 8.2 GL.

Figure 3.5 shows the estimated extent of spoil water storage at BA, based on a water level of about 264.5 mAHD in Ramp 1 Transfer. The current mining pits are interacting with the spoil water storage and there are signs of water ingress in these locations. The estimated extent of spoil water storage covers approximately two thirds of the planned mining extent. It has been assumed that all water stored in the spoil is part of Ramp 1 Transfer as it is the storage with the lowest elevation.

BA is mining towards the lowest elevation in the existing mine floor, which means that all the water stored in the spoil will drain towards the mining areas. Therefore, a large proportion of the water within the backfilled spoil will likely need to be managed by the BA WMS

The inclusion of water stored in spoil has been modelled as three different percentages of the total spoil volume above the existing coal floor. This has an impact on the initial site inventories. The initial total site inventories for each spoil storage percentage are:

- approximately 4,200 ML for Scenario 1 (0% spoil storage);
- approximately 8,200 ML for Scenario 2 and Scenario 3 (5% spoil storage); and
- approximately 12,200 ML for Scenario 4 (10% spoil storage).

The current estimate for spoil storage is approximately 800 ML per 1%.

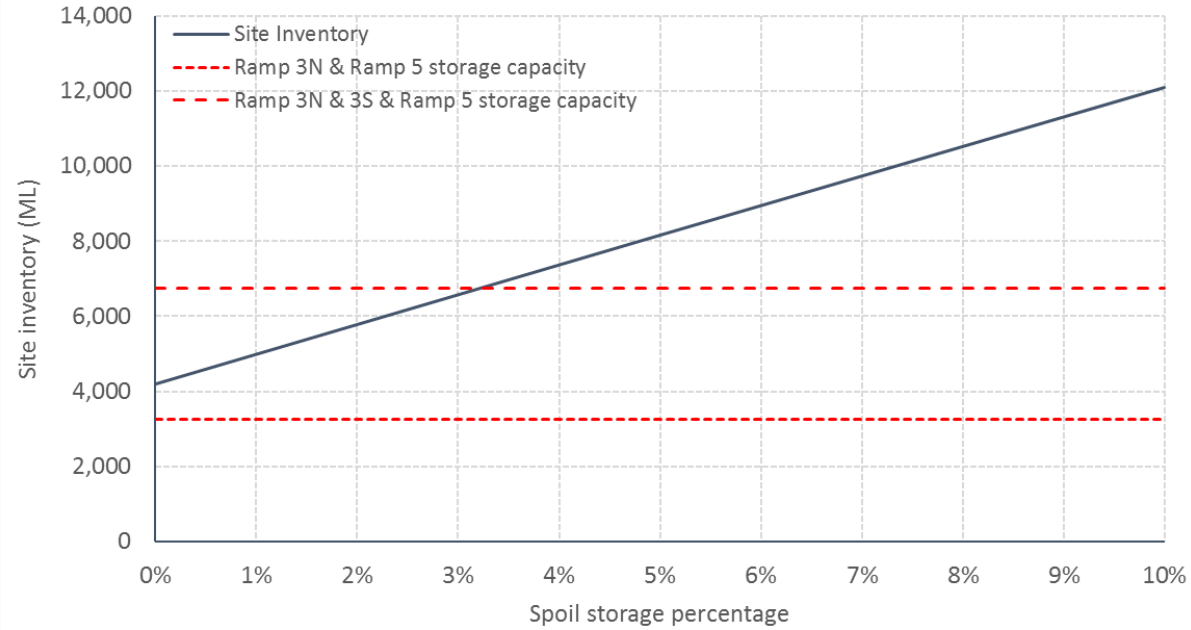


Figure 3.4 – Site inventory based on spoil storage

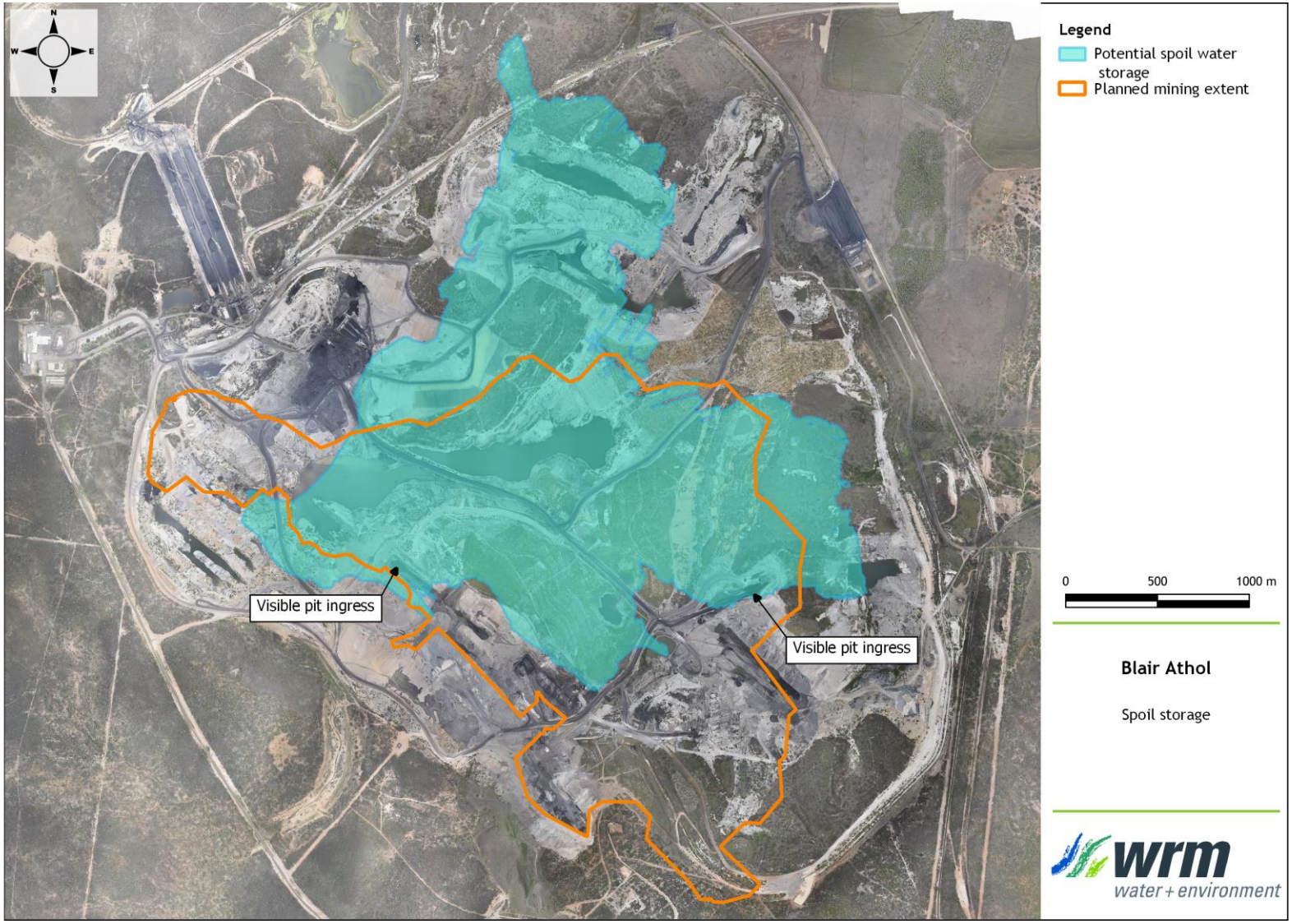


Figure 3.5 – Estimated extent of spoil storage

4 Site water usage

4.1 OVERVIEW

Water demands for BA include haul road dust suppression, Clermont import/export and CHPP demands. Site water demands are supplied by Ramp 1 Transfer and the 'Water Storage Area'.

4.1.1 Haul road dust suppression usage

The adopted haul road dust suppression has been assumed at 57 kL/day, as estimated from supplied data from site personnel. Site personnel provided monthly data for dust suppression from January 2018 – July 2019. Haul road dust suppression is supplied by Ramp 1 Transfer (Priority #1) and when Ramp 1 Transfer is dry, by the 'Water Storage Area' (Priority #2).

4.1.2 CHPP usage

Table 4.1 shows CHPP moisture contents based on the coal tonnes and moisture content provided by site and the tailings moisture content based on the Water Solutions (2012) WBM. The predicted ROM coal, product coal, rejects and CHPP makeup rates calculated in the WBM for the CHPP are outlined in Table 4.2. Makeup water is supplied via the Ramp 1 Transfer (Priority #1) and the 'Water Storage Area' (Priority #2).

Table 4.1 - Design wash plant parameters

Item	Wash Plant Parameter
Raw coal feed (% moisture)	13%
Product coal (% moisture)	16.5%
Fine tailings (% moisture)	70%
Coarse tailings (% moisture)	12.1%
Coarse tailings (dry)	60%
Fine tailing (dry)	40%

Table 4.2 - Predicted CHPP rates

Item	Rate (ML/day)
ROM coal	+1.17
Product coal	-1.27
Rejects	-0.61
CHPP makeup	**-0.71**

4.1.3 External water import/export

External transfers from BA occur to/from the adjacent Clermont Mine operated by Glencore. These transfers are controlled by Clermont and relate to storage inventories at Clermont driven by climate (i.e. when Clermont storages reach a high trigger, water is transferred to Blair Athol and when storages reach a low trigger, Clermont demands water from Blair Athol).

Hydro Engineering and Consulting (HEC) is currently undertaking a review of the Clermont water balance model. HEC provided probability envelopes for the predicted import and exports over the next 2 years of operation (i.e. January 2020 – December 2021) as predicted by their water balance model. The predicted import/export values are shown in Table 4.3.

The median monthly import and export Clermont transfers have been included in the model over the coming 2 year period.

Table 4.3 - Predicted Clermont import/export 2020 - 2021 (HEC, 2020)

%ile	Jan 20	Feb 20	Mar 20	Apr 20	May 20	June 20	July 20	Aug 20	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb 21	Mar 21	Apr 21	May 21	June 21	July 21	Aug 21	Sep 21	Oct 21	Nov 21	Dec 21
Transfer from Clermont to Blair Athol (ML/month)																								
5th	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10th	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Median	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90th	0.0	0.0	0.0	0.0	46.0	187.2	267.8	254.9	205.7	180.0	163.8	158.6	195.0	198.2	216.9	235.4	267.8	259.2	267.8	258.0	212.9	195.2	179.2	186.2
95th	0.0	37.4	214.1	229.0	267.1	259.2	267.8	256.8	212.0	189.9	174.3	180.2	215.1	216.8	240.9	239.7	267.8	259.2	267.8	259.1	216.7	199.0	188.1	196.4
Transfer from Blair Athol to Clermont (ML/month)																								
5th	107.6	10.3	9.1	2.4	4.6	3.5	8.1	11.2	12.5	62.4	77.9	33.3	18.1	9.1	7.4	2.4	7.6	4.0	8.8	12.0	13.7	97.5	66.3	53.8
10th	127.7	13.7	12.3	4.8	8.9	6.2	9.9	15.2	15.0	129.7	119.2	70.6	24.1	10.5	10.5	7.5	10.5	7.3	11.2	14.9	72.5	143.3	126.7	68.8
Median	285.7	98.4	89.3	104.8	79.4	57.1	82.4	117.2	207.0	236.7	242.3	226.6	177.1	92.8	90.2	108.7	83.3	75.3	84.7	123.6	211.3	249.3	248.6	239.2
90th	308.6	273.3	233.9	193.3	132.9	102.2	124.1	195.6	318.7	354.0	359.0	346.4	316.0	243.0	228.8	254.2	289.5	275.2	292.7	368.5	362.4	373.7	364.2	368.1
95th	312.1	282.4	240.3	201.4	147.1	122.7	153.9	314.8	356.6	372.7	362.9	363.3	357.4	274.1	305.4	338.2	339.6	304.3	320.2	374.9	364.9	376.0	367.0	376.7

5 Groundwater

Groundwater inflow rates from the basalt aquifer have been reported at the following rates:

- Rio Tinto (2016) indicated that groundwater inflows would be approximately 1,300 kL/d; and
- JBT Consulting (2012) concluded that inflow rates are in the order of 3 - 5 L/s (i.e. approximately 350 kL/d).

Therefore, groundwater inflow rates based upon the above recordings has been applied to the WBM in two different scenarios. The groundwater inflow is added the active pits and does not affect any other storage in the WBM.

6 Model performance

6.1 OVERVIEW

The performance of the WMS was assessed using the OPSIM water balance software. The model results have focussed on the following WMS areas:

- the minimum pump rates to de-water the storages within the path of mining within 2.5 years;
- the additional site storage requirements to account for mining through Ramp 1 Transfer; and
- the total site inventory over the LOM.

To assess the varying climate/site conditions present, a number of scenarios were setup in the WBM which varied:

- assumed spoil storage; and
- groundwater inflows.

The model scenarios are outlined in Table 6.1.

Table 6.1 – Model scenarios

Scenario	Spoil storage	GW Inflow (kL/d)
1	0%	350
2 (Base case)	5%	350
3	5%	1,300
4	10%	350

Scenario 2 has been adopted as the base case and analysed in detail, as it has the characteristics deemed most typical for the site.

6.2 INTERPRETATION OF RESULTS

In interpreting the results of the WBM assessment, it should be noted that the results provide a statistical analysis of the WMS performance over the seven-and-a-half years of mine life, based on 123 realisations with different climatic sequences.

The model results are presented as a probability of exceedance. For example, the 10th percentile (10P) 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.

The forecast results have been presented as percentiles to represent different climate conditions as follows:

- The 1%ile (P1) results represents very wet climate conditions;
- The 10%ile (P10) results represent wet climate conditions;
- The 50%ile (P50) results represent median climate conditions;
- The 90%ile (P90) results represent dry climate conditions; and
- The 99%ile (P99) results represent very dry climate 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.

6.3 RAMP 1 TRANSFER DEWATERING

Ramp 1 Transfer is the main water storage at BA. The initial inventory has been varied between scenarios based upon assumptions of spoil storage.

Due to the potential volume of water stored in the spoil surrounding Ramp 1 Transfer, additional storage is required to de-water Ramp 1 Transfer. An 'Excess storage' has therefore been modelled to store water once the 'Water Storage Area' reaches capacity. The required capacity of the 'Excess storage', as well as the required pumping rate to dewater Ramp 1 Transfer in 2.5 years, is outlined in the following sub-sections.

6.3.1 'Excess Storage' requirement

Table 6.2 and **Table 6.3** show the maximum 'Excess Storage' over the next 2.5 years and the LOM respectively for the 1%ile, 10%ile, 50%ile, 90%ile and 99%ile climate conditions and the 4 model scenarios. The following is of note:

- changing the groundwater inflow from the base case increases storage requirements by approximately 300 - 600 ML in the first 2.5 years and 300 - 2100 ML over the LOM. Therefore, the WBM is sensitive to groundwater inflow assumptions;
- under 1%ile conditions, 9.9 to 16.4 GL of additional storage is required;
- under 10%ile conditions, 6.5 to 11.8 GL of additional storage is required;
- under 50%ile conditions, 0.7 to 4.8 GL of additional storage is required;
- under 90%ile conditions, 0 to 4.0 GL of additional storage is required; and
- under 99%ile conditions, 0 to 3.6 GL of additional storage is required.

The results show when spoil storage is 0%, BA still requires additional storage under median climate conditions for the LOM. However, if spoil storage is 5%, "Excess Storage" will be required under 90%ile, 50%ile, 10%ile and 1%ile climate conditions in order to dewater Ramp 1 Transfer within 2.5 years.

Table 6.2 - 'Excess Storage' required in the next 2.5 years

Scenario	Maximum storage inventory in 'Excess Storage' (ML)				
	1%	10%	50%	90%	99%
1	2,965	376	0	0	0
2 (base case)	6,336	3,715	862	165	0
3	6,906	4,376	1,324	598	324
4	10,241	7,331	4,724	4,005	3,696

Table 6.3 - 'Excess Storage' required in the next 7.5 years

Scenario	Maximum storage inventory in 'Excess Storage' (ML)				
	1%	10%	50%	90%	99%
1	9,903	6,556	710	0	0
2 (base case)	12,709	8,597	2,612	165	0
3	14,891	10,632	4,282	770	324
4	16,410	11,864	4,791	4,005	3,696

6.3.2 Ramp 1 dewatering pump rate

Table 6.4 shows the minimum pump rate required at Ramp 1 Transfer to dewater the storage in 2.5 years to allow the area to be mined through. This is based on 100% pump use, so additional pump capacity should be accounted for to cover down time. It has also been assumed that all the water in the spoil will freely drain to Ramp 1 Transfer, however this may need to be confirmed by a hydrogeologist. The results show the percentage of water stored in the spoil is critical to the pump capacity calculations.

Table 6.4 – Pump rate required to dewater Ramp 1 Transfer in 2.5 years

Scenario	Pumping rates (L/s)		
	1%	10%	50%
1	69	53	37
2	91	77	66
3	91	77	66
4	149	133	120

6.4 TOTAL SITE INVENTORY

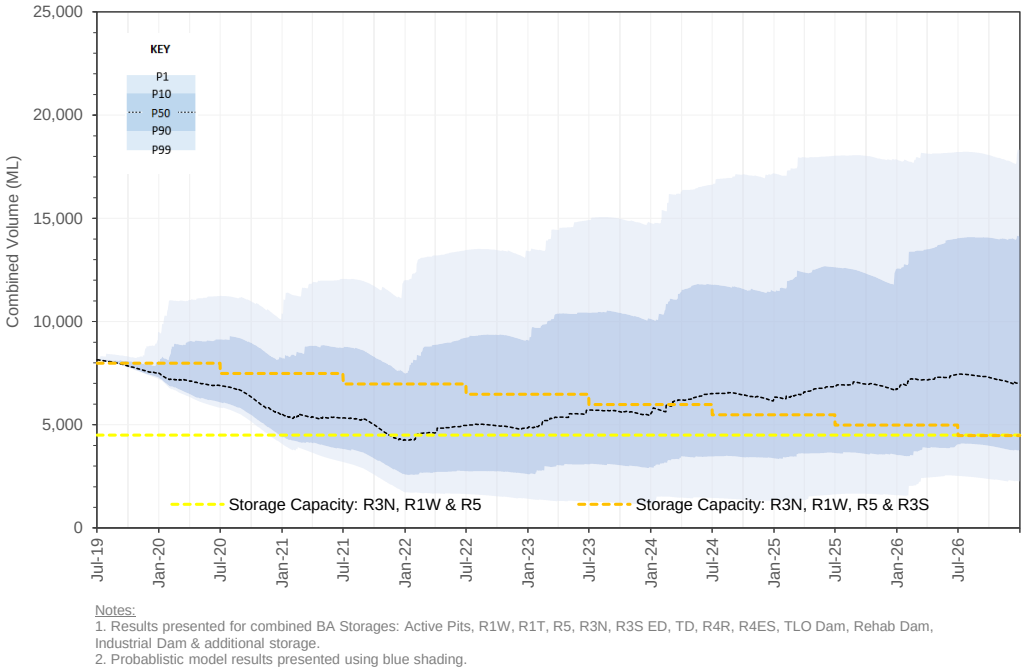
Figure 6.1 shows the predicted total site inventory (incorporating all major storages) over the LOM for the base case. The site inventory over the LOM is predicted to change by the following:

- under 1%ile conditions, increase by up to about up to 10 GL;
- under 10%ile conditions, increase by up to about 6.0 GL;
- under 50%ile conditions, decrease by up to about 3.9 GL;
- under 90%ile conditions, decrease by up to about 5.6 GL; and
- under 99%ile conditions, decrease by up to about 7.0 GL.

Figure 6.1 shows that initially the total site storage lowers for the first 2 years under the median and dry conditions. This is due to the high median water take predicted by Clermont. After the 2 years of modelled transfers (i.e. at end 2022) the total volume stabilises and steadily increases over the LOM.

Figure 6.1 also shows the available existing site storages as dashed lines when Ramp 1 Transfer is excluded. In Figure 6.1, the yellow line shows the storage capacity without Ramp 3 South and the dashed orange line shows the storage capacity with Ramp 3 South. Although Ramp 3 South is not proposed to be used as a storage (and has not been modelled as such), the orange line shows the possibility of using the void to store water as well as rejects. When used as a storage, the storage capacity of Ramp 3 South is assumed to reduce by 500 ML each year based on the forecast rejects tonnes.

The results show that if Ramp 3 South is used as a storage, BA holds enough storage capacity for the median, dry and very dry climates for the first 2.5 years only. However, with Ramp 3 south being used for rejects the accumulated storage will decrease each year and site will need additional storage for at least the 90%ile climate conditions over the LOM.



Notes:
1. Results presented for combined BA Storages: Active Pits, R1W, R1T, R5, R3N, R3S ED, TD, R4R, R4ES, TLO Dam, Rehab Dam, Industrial Dam & additional storage.
2. Probablistic model results presented using blue shading.

Figure 6.1 – Total site inventory (base case)

The total site inventory over the four scenarios for the LOM under different climate conditions is outlined in Table 6.5. The results show that the maximum site inventory is dominated by spoil storage.

Table 6.5 – Maximum site inventory over the LOM

Scenario	Initial site inventory (ML)	Maximum site inventory (ML)				
		1%	10%	50%	90%	99%
1	4200	15,727	11,780	5,388	4,198	4,197
2	8200	18,334	14,165	8,148	8,148	8,148
3	8200	20,673	16,041	9,141	8,149	8,149
4	12200	21,778	17,084	12,100	12,100	12,100

6.5 ACTIVE PIT INUNDATION

Pit inundation risk was modelled for the active pits over the LOM. If the pit is inundated by more than 50 ML, it is assumed this may impact mining operations at the coal floor. The pit dewatering rate is assumed to be 75 L/s to the 'Water Storage Area' and, when additional storage capacity is required, to the Excess storage.

Table 6.6 shows the annual average number of days of pit inundation for the base case, with the assumed pit dewatering rate of 75 L/s, as well as with an alternative dewatering rate of 100 L/s.

The following is of note:

- under the base case simulation there are no days of pit inundation predicted for 50%ile climatic conditions;
- increasing the pit dewatering rate from 75 L/s to 100 L/s lowers the average annual number of days of pit inundation by:

- 56 days per year for 10%ile conditions; and
- 88 days per year for 1%ile conditions.

This shows that the number of days of pit inundation is sensitive to the pit dewatering rate.

Table 6.6 – Annual average number of days of pit inundation (base case)

Adopted dewatering pump rate (L/s)	Annual average days of pit inundation		
	1%	10%	50%
75	233	71	0
100	145	15	0

6.6 DAM SPILL RISK

Dam spill risk was estimated from the WBM at the three mine water dams (TLO dam, Industrial Dam and Environmental Dam). As shown in Figure 3.3, these three dams spill externally from the mine site rather than internally.

Based upon the operating rules in Table 3.3, the spill risks predicted from the WBM are as follows:

- Environmental Dam has less than a 1% AEP chance of spill under all four scenarios;
- the Industrial Dam does not spill at any point under any of the four scenarios; and
- under all scenarios, the TLO Dam has a spill risk of at least 1% AEP with an average annual spill volume of about 8.1 ML.

Note that the modelling assumes that there is fixed pump infrastructure and always available storage to dewater the dams.

7 Conclusions and recommendations

An OPSIM water balance model has been developed to predict the behaviour of the BA WMS under a variety of climate conditions. Four scenarios were simulated with differing groundwater inflows and assumed spoil storage.

Key conclusions for the BA WMS include:

- Site does not have sufficient water storage capacity to dewater Ramp 1 Transfer and commence mining in this area within 2.5 years. Therefore, additional storage will be required at site. The predicted 'Excess Storage' requirements over the seven-and-a-half-year LOM are:
    - between 0.7 to 4.8 GL under the 50%ile climate conditions, under the different model scenarios; and
    - between 6.5 to 11.8 GL under the 10%ile climate conditions, under the different modelled scenarios.
- Minimum pumping rates to dewater Ramp 1 Transfer within 2.5 years and allow mining following this period were predicted as follows:
    - between 37 to 120 L/s under the 50%ile climate conditions, under the different model scenarios; and
    - between 53 to 133 L/s under the 10%ile climate conditions, under the different model scenarios.
- over the seven-and-a-half-year LOM, the maximum site inventory is predicted to behave as follows:
    - increase by up to 0 to 2.4 GL under 50%ile climate conditions, under the modelled scenarios; and
    - increase by up to 4.8 to 7.8 GL under 10%ile climate conditions, under the modelled scenarios.
- Increasing the pit dewatering rate from 75 L/s to 100 L/s significantly reduces the predicted days of pit inundation under 10%ile and 1%ile climate conditions.
- Environmental and Industrial Dam have a predicted annual spill risk of less than 1% under any of the modelled scenarios. Under all scenarios, the TLO Dam has a spill risk of at least 1%.

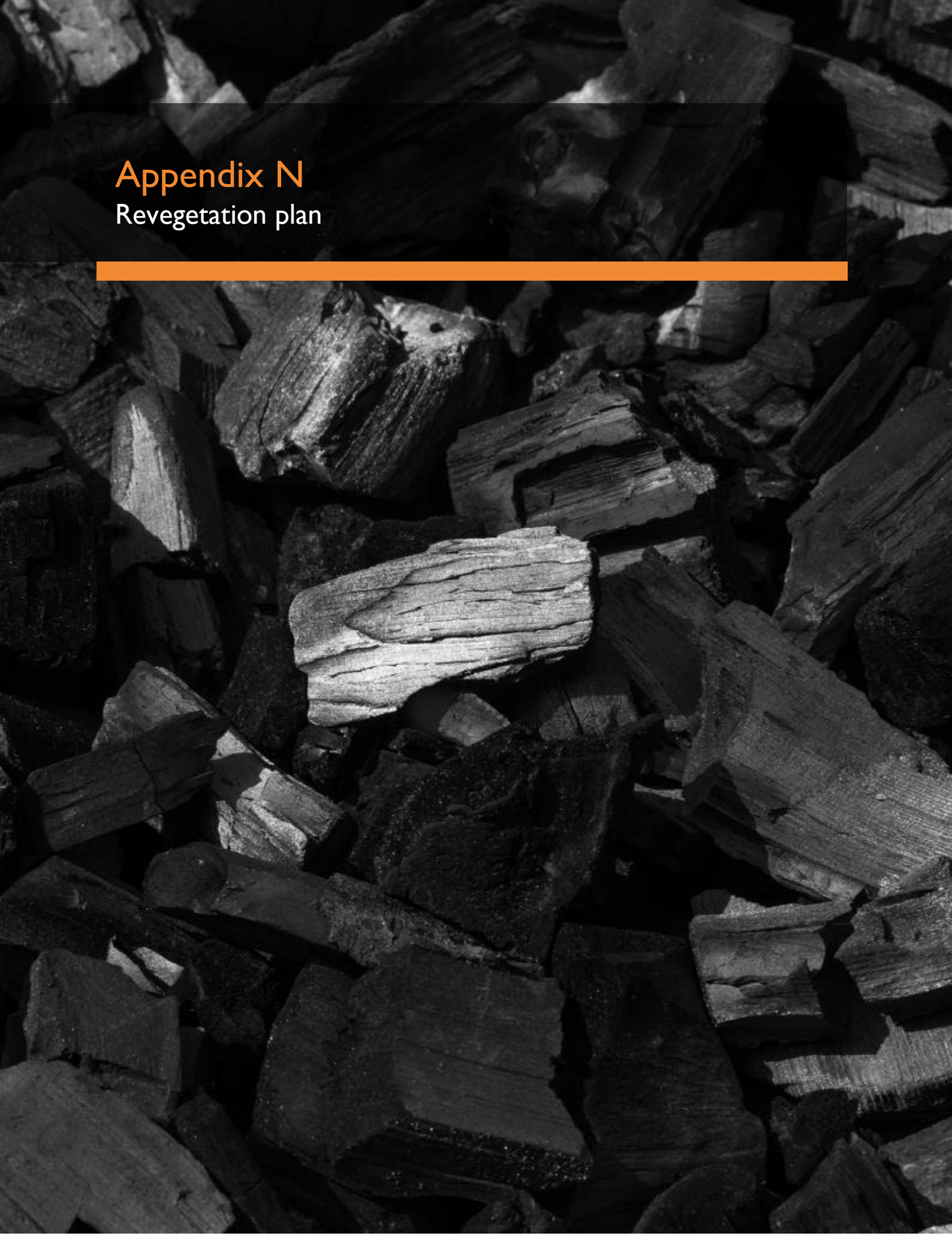
To provide a more accurate representation of the site WMS for future WBM updates we recommend the following:

- Conduct studies to determine an accurate understanding of water stored within the spoil.
- Engage a suitably qualified groundwater expert to develop a contemporary BA groundwater model, in order to predict inflows to the pits.
- Determine the additional water storage which could be developed onsite to facilitate the dewatering of Ramp 1 Transfer and incorporate it into the WBM to assess the potential impact from storage restrictions.
- Conduct monthly (or preferentially weekly) water level monitoring of storages in order for the AWBM parameters to be calibrated.
- Obtain predicted Clermont import/export values over the entire LOM for the Project.

It should be noted that the content of this report may be subject to revision with any future improved understanding of the operational and response characteristics of the BA WMS.

8 References

Boughton, 1993	*'A Hydrograph-based Model for Estimating the Water Yield of Ungauged Catchments'*.
Department of Environment and Science, 2019	*SILO Climate Database*. Point data requested at -22.7, 147.55. Queensland Government
JBT Consulting, 2012	*Blair Athol Mine Closure Groundwater Investigation*
Rio Tinto, 2016	*Blair Athol Water Management HSEQ MS – Guideline BAM-10-GUI-EV-0003_8*
TerraCom, 2018	*Residual Void Management Plan, Blair Athol Coal Mine*
Water Solutions, 2012	*RTCA – Blair Athol Coal/Clermont Coal Mine OPSIM Water Management Update & Review 2012*



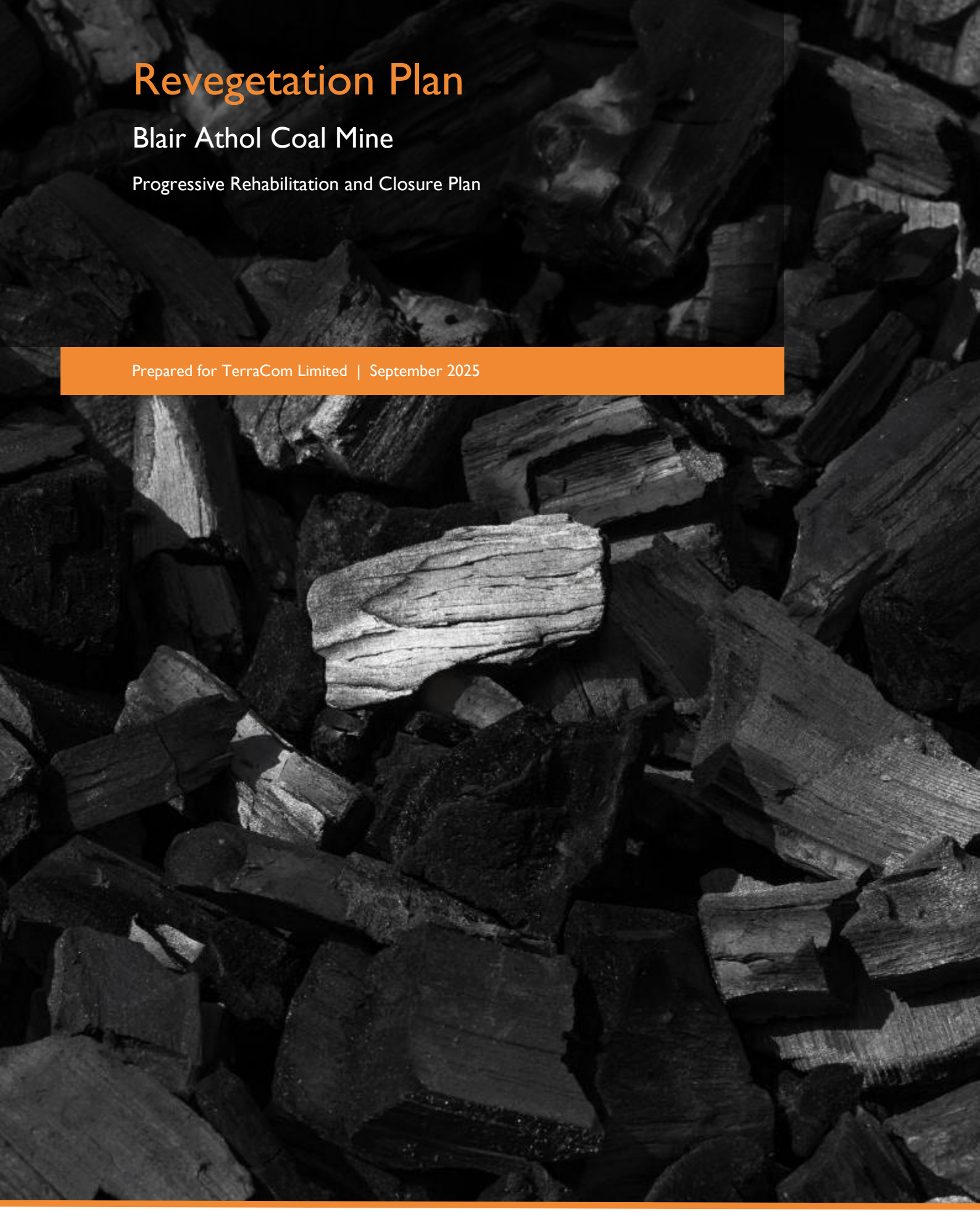
Appendix N
Revegetation plan

This page is intentionally blank.

Revegetation Plan

Blair Athol Coal Mine

Progressive Rehabilitation and Closure Plan



Prepared for TerraCom Limited | September 2025

TerraCom

SGMenvironmental

This page is intentionally blank

Revegetation Plan

Blair Athol Coal Mine

Progressive Rehabilitation and Closure Plan

Prepared for TerraCom Limited | 16 September 2025

Project number:	21B031
Document title:	Revegetation Plan | Blair Athol Coal Mine
Revision:	V1-5
Date:	16 September 2025
Client:	TerraCom Limited

Project manager:	D Borombovits, M Forbes
Author:	D Borombovits, G Greening, C Brownbill, T Kelly

Legal Name:	SGM Environmental Pty Limited		
Address:	PO Box 5622, Stafford Heights, Qld 4053		
ACN:	621 989 866	ABN:	65 621 989 866
Representative:	T Rohde	Phone:	+61 7 3148 6288
Email:	trohde@sgmenvironmental.com		



Honest | Trust | Innovation | Safety

This Report is provided to you the abovenamed Client (Client, you or your) in respect of the above Project and in accordance with our Standard Terms. Capitalised terms that are not specifically defined in this Report have the meanings given to them in our Standard Terms.

© Copyright 2022 SGM Environmental Pty Limited. The concepts and information contained in this document are the property of SGM Environmental Pty Limited. Use or copying of this document in whole or in part without the written permission of SGM Environmental Pty Limited constitutes an infringement of copyright.

Data / confidentiality: This report contains information and data that is confidential and / or subject to restrictions in respect of Intellectual Property Rights (IP). Readers agree to be bound by confidentiality and IP provisions contained in our Standard Terms and the obligation not to cause any damage or hardship to SGM Environmental Pty Limited or the Client.

Document history and status

Revision	Date	Description	By	Review	Approved
V0-1	17/03/23	Draft	G Greening	T Rohde	T Rohde
V0-2	22/03/23	Draft	D Borombovits	T Rohde	T Rohde
V1-3	18/08/23	Final draft	D Borombovits	TCL	T Rohde
V1-4	17/05/24	Final	D Borombovits	T Rohde	T Rohde

Revision	Date	Description	By	Review	Approved
V1-5	16/09/25	Resubmission	C Brownbill, T Kelly	M Forbes	T Rohde

Table of contents

1.0 Introduction 1
1.1 Blair Athol Coal Mine 1
1.1.1 Location 1
1.1.2 Tenure 1
1.2 Purpose and scope 3
1.3 Rehabilitation objectives 3
2.0 Existing environment 5
2.1 Climate 5
2.2 Topography 5
2.3 Land use 5
2.4 Local geology and soil 5
2.5 Local catchment hydrology 6
2.6 Vegetation communities and ecological data 6
2.6.1 Matters of environmental significance 6
2.6.2 Environmentally sensitive areas 7
2.6.3 Regional ecosystems 7
2.6.4 Fauna habitat considerations 7
2.7 Existing rehabilitation 8
3.0 Reference sites 10
3.1 Location and number of reference sites 10
3.2 Assessment of reference sites 12
3.2.1 Pasture reference sites 12
3.2.2 Native reference sites 12
3.2.3 Assessment framework for Queensland 12
3.2.4 When to assess reference sites 12
3.2.5 Data collection 12
4.0 Revegetation method 14
4.1 Soil 14
4.1.1 Inventory 14
4.1.2 Stripping 15
4.1.3 Surface preparation 15
4.1.4 Spreading 15
4.2 Rehabilitation techniques 16
4.2.1 Strategy 16
4.2.2 Species selection and seed mix rate 17
4.2.3 Tube stock 21
4.2.4 Seed treatment 21
4.2.5 Timing 21

4.3 Sustaining the PMLU 21
4.3.1 Soil availability 22
4.3.2 Depth of cover 22
4.3.3 Amelioration and fertiliser 22
5.0 Revegetation management 24
5.1 Rehabilitation criteria 24
5.2 Soil management plan 24
5.3 Weeds and pests 25
5.4 Fire regimes 26
5.5 Infrastructure 26
5.5.1 Fencing and signage 26
5.5.2 Erosion and sediment control 26
6.0 Revegetation objectives 28
7.0 Revegetation monitoring and maintenance 33
7.1 Rehabilitation performance 33
7.1.1 Key revegetation issues 33
7.1.2 Historic rehabilitation monitoring 33
7.2 Monitoring objectives 34
7.2.1 Vegetation monitoring 34
7.3 Monitoring methods 34
7.3.1 Data collection and data analysis 34
7.3.2 Schedule 35
7.3.3 Maintenance 35
7.3.4 Reporting 35
7.3.5 Adaptive management 36
7.3.6 Adverse and unplanned events 36
7.3.7 Quality assurance and quality control 36
7.4 Rehabilitation trials 36
7.4.1 Historic rehabilitation trials 36
7.4.2 Future rehabilitation trials 36
7.5 Review 37
References 38

Figure

Figure 1 Tenure 2
Figure 2 Existing rehabilitation 9
Figure 3 Reference monitoring sites 11

Table

Table 1	Relationship to information requirements	3
Table 2	TECs	6
Table 3	Fauna presence	7
Table 4	Available materials for revegetation success	14
Table 5	RE 11.3.4 species list	17
Table 6	RE 11.11.1 species list	18
Table 7	Grazing seed mix	19
Table 8	Estimated stem densities for soil comparison trials	20
Table 9	Suitable grazing land systems	22
Table 10	Recommended soil ameliorants	23
Table 11	Rehabilitation milestone criteria	28
Table 12	Previous rehabilitation monitoring	33
Table 13	Revegetation issues and mitigation measures	35

Important note about your report

This Report is provided for the exclusive use of the Client pursuant to the Scope of Works 12 October 2022, which requires us to provide Services relating to preparing a revegetation plan.

This Report is provided to the Client on the terms and conditions set out in the Standard Terms of SGM Environmental Pty Limited (SGME, we, us or our).

We derive data in this Report from information (or confirmation of the absence thereof) sourced from the Client and their subconsultants, designated laboratories and / or information that has been made available in the public domain at the time or times outlined in this Report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the revegetation plan and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this Report.

SGME has prepared this Report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to any applicable standards, guidelines, procedures and practices outlined in the Scope of Works as at the date of issue of this Report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this Report, to the extent permitted by law.

This Report would be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by SGME for use of any part of this Report in any other context.

Reporting of the revegetation plan are based on a desktop assessment of data that has been measured by the Client and their subconsultants and other third parties.

SGME does not accept any Liability whatsoever for, or in respect of, any use of, or reliance upon this Report by any person contrary to the above or our Standard Terms.

1.0 Introduction

1.1 Blair Athol Coal Mine

Blair Athol Coal Mine (the Mine) is an open-cut coal mining operation owned and operated by TerraCom Limited (TCL). It was previously operated by Blair Athol Coal Pty Limited a subsidiary of Rio Tinto, in the 1980s until it was put into care and maintenance in 2012. Small scale mining operations date back to the 1890s.

TCL via its subsidiary bought the Mine grant of title transfer from the Queensland Government in 2017. The acquisition means that TCL can efficiently reshape and restore one of Queensland's oldest coal mines while cost effectively retrieving remnant resources.

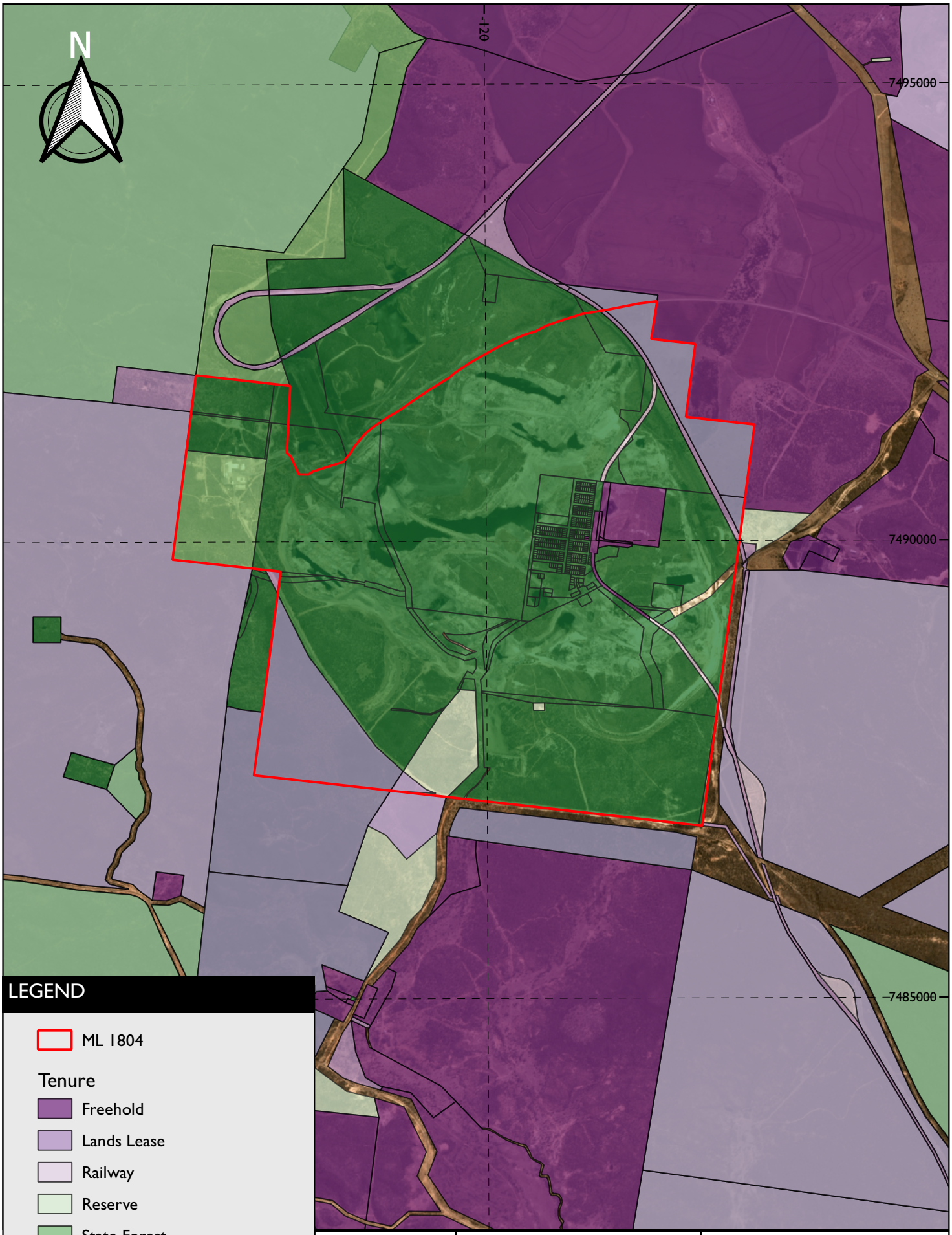
1.1.1 Location

The Mine is approximately (~) 240 kilometres (km) south-west of Mackay and ~17 km north-west of Clermont in Central Queensland. The Blair Athol State Forest adjoins the west of the Mine; the Apsley State Forest is located to the south-east.

1.1.2 Tenure

The Mine is authorised by the Department of Environment and Science (the department) under environmental authority (EA) EPML00876713 and mining lease (ML) 1804 (Figure 1).

It is predominately located on unallocated State Land but also includes State Forest, freehold, lands lease, railway and reserve land (Figure 1). It includes land that has a Permit to Occupy; allowing the permittee to graze the land.



LEGEND

ML 1804

Tenure

- Freehold
- Lands Lease
- Railway
- Reserve
- State Forest
- State Land

Scale 1 : 40 000

0 1 2 km

SGM environmental	Client: TerraCom Limited	Project: Progressive Rehabilitation and Closure Plan	
	Design: SGM Environmental Pty Ltd 19/10/2022 Scale: 1 : 40,000 CRS: GDA2020	Title: Tenure	Figure: 1

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

1.2 Purpose and scope

This *Revegetation Plan* (this plan) has been prepared to support the *Progressive Rehabilitation and Closure Plan* (PRCP) and includes proposed activities that would establish self-sustaining vegetation communities that are appropriate for the intended post mining land uses (PMLUs), and non-use management areas (NUMAs).

Revegetation would therefore not only establish groundcover but also associated fauna habitat and other ecological services.

Table 1 describes the information requirements described in *Guideline: Progressive rehabilitation and closure plans (PRC plans)* (the PRC plan guideline), and where it has been addressed.

Table 1 Relationship to information requirements

Information requirements	Reference
Clearly articulate revegetation objectives that are consistent with the PMLUs, NUMAs and rehabilitation milestones identified in the PRC plan schedule	Section 6.0
Identify key flora species including pasture plants, tree and shrub species representative of the PMLU	Section 4.2.2
Identify any species of conservation significance relevant to the Mine's approval	Section 2.6
Identify any fauna habitat and use requirements — where fauna habitat is proposed, a management and monitoring plan to describe how rehabilitated land would be utilised by fauna and what other management measures would need to be implemented	Section 2.6.4
Include evidence and justification for analogue sites of the monitoring plan	Section 3.0
Describe the works for establishing and managing revegetation, including a description of preparation and the timeframe for work	Section 4.0
Identify what plant / seed mixes are appropriate for the PMLU and where the mixes would be sourced — locally sourced seed should be used where appropriate	Section 4.2.2
Identify seed density, spreading rate, and timing for application	Section 4.2.2 and Section 4.2.5
Identify the location of any infrastructure needed to protect revegetation	Section 5.5
Identify the growth media that would be suitable to sustain the PMLU and whether this is available	Section 4.1
Identify soil depth requirements for revegetation success and sustainable PMLU	Section 4.1.4

1.3 Rehabilitation objectives

The rehabilitation objectives, in accordance with condition F4 of the EA, is to return all land disturbed by mining activities, except for the residual voids, in a manner that ensure it is:

- safe for humans and wildlife;
- stable;
- able to sustain vegetation; and
- non-polluting.

The *Environmental Protection Act 1994* (EP Act) requires that all land disturbed within the relevant mining tenure must be rehabilitated to a PMLU or managed as a NUMA. Any undisturbed land within the relevant mining tenure must also be identified as having a PMLU.

Land must be rehabilitated to a stable condition for a PMLU in accordance with the definition in section 111A of the EP Act:

- the land is safe and structurally stable;
- there is no environmental harm being caused by anything on or in the land; and
- the land can sustain a PMLU.

2.0 Existing environment

The following sections describe the existing environment relating to revegetation including climate, topography, land use, local geology and soil, local catchment hydrology, and vegetation communities and ecological data.

2.1 Climate

The climate of the Mine is classified as subtropical using the Bureau of Meteorology (BoM) modified Köppen classification system (BoM 2016). These climates tend to experience hot humid summers and a cool to mild winter.

There is a distinct wet and dry season. The wet season generally falls between December and March with ~60% of the region's rainfall occurring then (BoM 2022). The dry season is generally between July and September (rainfall is less than 25 millimetres (mm)) (BoM 2022).

2.2 Topography

The Mine is located on relatively flat lying terrain at ~317 m above sea level. Topography is typical of an open-cut coal mine with spoil stockpile relief associated with the open-cut pits.

2.3 Land use

The Mine is located in the former Blair Athol township. The Blair Athol township was a coal mining town with operations dating back to the 1860s. In the mid-1970s, the Blair Athol township was closed to construct the Mine and residences were transferred to Clermont. The historic cemetery reserve remains.

The Apsley State Forest is to the south-east and the Blair Athol State Forest is located directly to the west. The region is made up of coal and gold mining and agriculture.

2.4 Local geology and soil

The Mine is located in the Blair Athol Basin, which is an isolated Permian basin near the western edge of the northern Bowen Basin on the northern extension of the Dennison Trough (JBT 2012).

A soil survey was done by Dames & Moore in 1983 to investigate the nature, disturbance and handling requirements of soil. Six soil types were identified including Soloth (soil type A), Alluvial (soil type B, C_1 and C_2), Solofic (soil type D) and Yellow Pozolic (soil type E) Great Soil Group (GSG) classifications (Dames & Moore 1983).

Dames & Moore (1983) found that:

- there were no significant elemental imbalances in the surface soils (A_1 and A_2 horizons); however, subsoils (B horizon) of soil types A, D and E were sodic;
- there were no soil acidity problems with pH concentrations above 5;
- levels of exchangeable calcium in all A horizons were greater than two times the levels of exchangeable magnesium;
- nitrogen was within normal range however phosphorus was relatively low; and
- percentages of organic material were relatively low.

2.5 Local catchment hydrology

The Mine is located at the top of Bath Creek, a tributary of Sandy Creek, in the foothills of the Drummond Range. Sandy Creek is a sub-catchment within the Theresa Creek part of the Nogoa River catchment in the north-western corner of the Fitzroy Basin.

Diversions of Bath, Washpool and Breaker Creeks have been constructed around the Mine. The historical mine workings have created a depressed landform, where the majority of land drains internally.

2.6 Vegetation communities and ecological data

2.6.1 Matters of environmental significance

2.6.1.1 Matters of national environmental significance

Matters of national environmental significance (MNES) are listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). There is limited baseline information on MNES given the long history of the Mine

WSP (2019; 2020) was engaged by TCL to prepare an *Ecological Values Report* of areas south of mined land but within the Mine boundary (the study area).

A search of the EPBC Act *Protected Matters Search Tool* (PMST) identified three listed threatened ecological communities (TECs), 22 listed threatened species and nine listed migratory species within a 10 km buffer of the study area (WSP 2019).

The three TECs listed under the EPBC Act that are known or are likely to occur are in Table 2. The PMST identified five flora species listed as threatened under the EPBC Act as having been previously recorded or predicted to occur.

Table 2 TECs

TEC	EPBC Act status	Likelihood of occurrence
Brigalow	Endangered	Moderate — Brigalow ecosystems are mapped within the locality and were identified and field verified
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Endangered	Low — Grassland not observed in aerial photography
Weeping Myall Woodlands	Endangered	Low — Broad alluvial not observed in aerial photography

Table 3.1 (WSP 2020)

2.6.1.2 Matters of state environmental significance

Matters of state environmental significance (MSES) are a component of biodiversity state interest and are listed under the *Environmental Offsets Regulation 2014* (Offset Regulation). There is no baseline information on MSES despite its long history of mining operations.

WSP (2019) found no high ecological significance wetlands, high ecological value waters or strategic environmental areas (SEAs).

The *Wildlife Online* database search identified five threatened flora species listed under the *Nature Conservation Act 1992* (NC Act) as having been previously recorded within 10 km of the study area; one threatened flora species (*Corymbia clandestine*) listed as Vulnerable under the NC was found to have a moderate likelihood of occurring in the study are (WSP 2019).

MSES recorded or likely to occur (WSP 2019) include:

- field verified regulated vegetation:
  - remnant regional ecosystems including:
    - 14.7 hectares (ha) of regional ecosystems (REs) 11.3.4 listed as Of Concern under the *Vegetation Management Act 1999* (VM Act);
    - 6.2 ha of RE 11.11.16 listed as Of Concern under the VM Act;
    - 2.5 ha of RE 11.11.4 listed as Endangered under the VM Act;
  - Endangered or Of Concern High Value Regrowth regional ecosystems including:
    - ~4.3 ha of RE 11.11.6 listed as Of Concern under the VM Act;
    - ~1.1 ha of RE 11.3.4 listed as Of Concern under the VM Act;
  - ~33.7 ha Essential Habitat 860 (Koala) listed as Vulnerable under the NC Act;
- protected Wildlife Habitat including:
  - ~11.6 ha of potential Koala habitat listed as Vulnerable under the NC Act;
  - ~4.3 ha of potential Greater Glider habitat listed as Vulnerable under the NC Act;
- 2 ha of remnant vegetation within a defined distance from a Stream Order 1 watercourse and 3.5 ha of remnant vegetation within a defined distance from a Stream Order 3 watercourse.

Native ecosystem PMLU will be revegetated in line with RE 11.1.11 and 11.3.4. Species lists for native ecosystem PMLU are outlined in Section 4.2.2.

2.6.1.3 Matters of local environmental significance

A matter of local environmental significance (MLES) is a locally significant matter that is prescribed under a local planning instrument. There are no MLES identified in *Isaac Regional Planning Scheme* (IRC 2021).

2.6.2 Environmentally sensitive areas

Environmentally sensitive areas (ESAs) are described in the *Environmental Protection Regulation 2019* (EP Regulation). The majority of the Mine is not located in mapped ESAs. There is a small section to the west of the Mine boundary that is mapped as a Category C ESA (State Forest).

2.6.3 Regional ecosystems

Baseline field-verified REs are not available.

2.6.4 Fauna habitat considerations

Areas with a PMLU of native ecosystem can provide future habitat for native fauna species. An ecological survey by WSP (2019) recorded a total of 16 native fauna species. These species, along with their conservation status according to the *Nature Conservation Act 1992* (NC Act), are in Table 3.

Table 3 Fauna presence

Scientific name	Common name	NC Act status
Anas superciliosa	Pacific Black Duck	Least concern
Aquila audax	Wedge-tailed Eagle	Least concern

Scientific name	Common name	NC Act status
Ardea ibis	Cattle Egret	Least concern
Ardea intermedia	Intermediate Egret	Least concern
Corvus orru	Torresian Crow	Least concern
Cracticus tibicen	Australian Magpie	Least concern
Dacelo novaeguineae	Laughing Kookaburra	Least concern
Eolophus roseicapilla	Galah	Least concern
Granilla cyanoleuca	Magpie-lark	Least concern
Manorina melancephala	Noisy Miner	Least concern
Pardalotus striatus	Striated Pardalote	Least concern
Philemon corniculatus	Noisy Friarbird	Least concern
Rhipidura leucophrys	Willie Wagtail	Least concern
Todiramphus macleayii	Forest Kingfisher	Least concern
Macropus giganteus	Eastern Grey Kangaroo	Least concern

WSP (2019) states that there have been numerous anecdotal sightings of *Phascolarctos cinereus* (Koala) in the area and that there is a moderate likelihood of *Petauroides* spp. (Greater Glider) occurring. The NC Act lists Koalas as endangered and Greater Glider species as either vulnerable or endangered.

It is anticipated that native ecosystem rehabilitation areas will attract native fauna. An indicator of fauna presence is to be monitored as part of rehabilitation monitoring and included as a milestone criterion.

2.7 Existing rehabilitation

The Mine was previously operated by Rio Tinto who did stages of progressive rehabilitation. Rio Tinto last completed rehabilitation in 2010.

Several rehabilitation methods (seeding, ground preparation and fertiliser) and rehabilitation monitoring techniques have been used. The rehabilitation methods together with other influential factors including terrain, soil characteristics and climate, have resulted in rehabilitation that is in varying condition and stages of development.

Rio Tinto placed the Mine into care and maintenance in 2012; the focus at this time was keeping the operation in compliance with all respective legislation and generally in a safe, stable and secure state. In September 2016, Rio Tinto did a review of rehabilitated land to evaluate its status against the rehabilitation criteria. The rehabilitation strategy used by Rio Tinto was consistent with a PMLU of native ecosystems. Since acquiring the Mine, TCL has progressively rehabilitated land disturbed by mining. As of 2025, 309.9 ha have been progressively rehabilitated, with areas shown in Figure 2.



LEGEND

- ML 1804
- Existing rehabilitation

Scale 1 : 17 500

0 0.5 1 km

	Client: TerraCom Limited	Project: Revegetation plan	
	Design: SGME Pty Limited 2.09.2025 Scale: 1 : 17,500 CRS: GDA2020	Title: Existing rehabilitation	Figure: 2

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

3.0 Reference sites

Reference sites (also known as analogue sites) are an important source of information on the type of vegetation, species composition and structure that is proposed to be revegetated.

Reference sites are used to monitor rehabilitation success and:

- provide a guide on the level and type of vegetation cover and its influence on infiltration and runoff;
- allow evaluation of climatic and seasonal influences that may affect rehabilitation progress; and
- provide an understanding of the water availability and movement across reconstructed landforms and how it may affect nutrient availability in the rehabilitated system.

Where possible, a reference site should:

- be homogenous with regard to the relevant RE and condition status;
- represent an undisturbed site with no extensive chemical or mechanical disturbance (eg fire, erosion or weed infestation);
- be located within a reasonably large (greater than (>) 5 ha) intact patch of remnant vegetation;
- be located at least 50 m from a road or track; and
- exclude areas subject to recent significant management change.

3.1 Location and number of reference sites

Three native ecosystem reference sites were established in the 2019 rehabilitation monitoring program (WSP 2020).

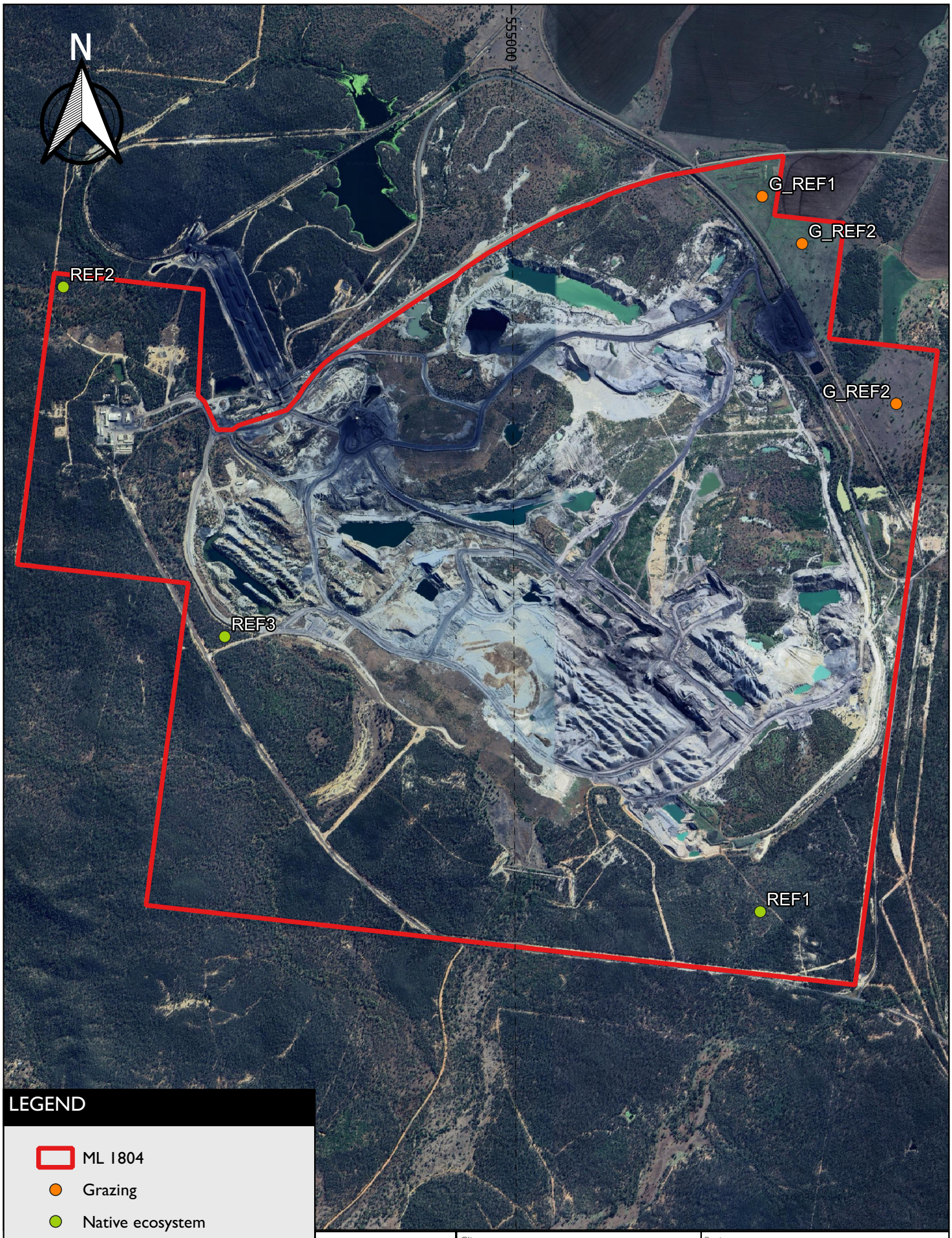
Reference transects are monitored to collect data within vegetation communities' representative areas of naturally occurring RE 11.11.1 (*Eucalyptus crebra +/- Acacia rhodoxylon* woodland on old sedimentary rocks with varying degrees of metamorphism and folding) surrounding the Mine. The characteristics of the RE 11.11.1 community (structure, species abundance, diversity, etc) is representative of a self-sustaining native woodland ecosystem and has therefore been used to assess the current trajectory of rehabilitation. The community is also common, and as such, has been used as a reference site in order to assess the performance of rehabilitation.

Reference site locations are:

- REF1S – in the south-eastern extent of the ML, adjacent to Bath Creek East;
- REF1E – in the south-eastern extent of the ML, adjacent to Bath Creek East;
- REF2E – in the north-western extent of the ML, adjacent to Waterloo Creek West;
- REF2S – in the north-western extent of the ML, adjacent to Waterloo Creek West;
- REF3E – in the western extent of the ML, adjacent to Bath Creek West; and
- REF3S – in the western extent of the ML, adjacent to Bath Creek West.

Three proposed reference sites for grazing have been selected to be within areas of pre-existing grazing / cropping land within the ML. These grazing reference sites have yet to be monitored to establish baseline condition and confirm suitability.

Locations of all reference sites are provided in Figure 3.



LEGEND

- ML 1804
- Grazing
- Native ecosystem

Scale 1 : 15 000

0 0.5 1 km

SGME	Client: TerraCom Limited	Project: Revegetation plan	
	Design: SGME Pty Limited 9.09.2025 Scale: 1 : 15,000 CRS: GDA2020	Title: Reference sites	Figure: 3

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

3.2 Assessment of reference sites

3.2.1 Pasture reference sites

The reference plots should be located adjacent to existing mining operations outside of planned future disturbance. The sites should be established based on a pasture grass land use and consider vegetation and soil attributes. Past and current grazing pressures would also be considered as part of selecting suitable sites. Multiple plots should be developed to enable appropriate statistical analysis to be applied.

3.2.2 Native reference sites

The native reference plots should be located adjacent to existing mining operations outside of planned future disturbance. The sites should represent vegetation communities used in revegetation and consider location and soil attributes. Multiple plots should be developed to enable appropriate statistical analysis to be applied.

3.2.3 Assessment framework for Queensland

BioCondition is an assessment framework for Queensland that provides a measure of how well a terrestrial ecosystem is functioning for biodiversity values. It is a site-based, quantitative and repeatable assessment procedure that can be used in any vegetative state. It provides a numeric score that can be summarised as a condition rating (1, 2, 3 or 4) or functional to dysfunctional condition for biodiversity.

Assessment of reference site vegetation structure and composition would be done using the BioCondition manual and framework (the site assessment) (Eyre et al 2015). The site assessment would be used to gauge vegetation condition and impact disturbance, and relevance for use as a comparison site for rehabilitated land.

3.2.4 When to assess reference sites

The site assessment would generally be done after the wet season (between March and May) to allow for adequate sampling of groundcover species. Floristic surveys would also be done close to the peak flowering period for the majority of species occurring in reference sites.

3.2.5 Data collection

Site-based attributes that would be measured at each reference site in accordance with the *Ecological Values Report* (WSP 2019; 2020) and the *Rehabilitation Monitoring Report* (Earthtrade 2021) include:

- plot characteristics;
- weed presence / absence;
- extent of disturbance (eg erosion);
- visual record;
- climate variables;
- lower-storey density and richness;
- lower-storey cover (vegetative cover);
- pasture yield;
- soil properties;
- basal cover;
- upper-storey and mid-storey density and richness; and
- species inventory.

3.2.5.1 Weeds and disease

Recording weed species, extent and density, or diseases present in plant species would help identify appropriate management techniques and support revegetation outcomes.

4.0 Revegetation method

4.1 Soil

Conservation and management of soil is critical for revegetation success. Current estimates indicate that there is a deficit of growth media required for rehabilitation. *Growth Media – Mitigation and Management Strategy (*GM-MMS*)*, TCL (2017) have developed mitigation and management strategies either currently used or proposed to address the soil shortfall (Table 4). These include:

- reducing the depth of soil placement;
- strip placement (alternating strip of soil and no soil with predominantly tree species seeded);
- amelioration of subsoil / spoil to use as a soil substitute;
- direct seeding to spoil; and
- utilising specific treatment s in specific areas, that is, hydromulching in diversions.

The GM-MMS indicates that trials have been undertaken to determine the germination and survival rates of vegetation resulting from direct seeding into spoil. Additionally, trials have been done to determine the effectiveness of soil stripping on areas with different disturbance types. For the latter, trials include the old helipad laydown, a scrap laydown area, a disused light vehicle road and an area with exposed spoil.

It is likely that the final strategy will be a combination of these approaches. Currently, the rehabilitation monitoring program includes the assessment of soil physical and chemical characteristics. It identifies potential challenges and remediation opportunities to support the intended PMLU. Additionally, the GM-MMS has been developed to manage soil integrity during stripping, stockpiling and spreading and to manage soil so that enough is available for rehabilitation.

4.1.1 Inventory

Following stockpile assessments by SKM (2012) and SEAM Surveys Pty Ltd (2016) the soil inventory and rehabilitation schedule was changed. Soil inventory available for rehabilitation was updated internally by TCL in 2024. The relocation of stockpiles from the north of the Mine to the south has reduced haulage for future rehabilitation.

There is currently 787,768.78 metres cubed (m^3) of stockpiled soil available for rehabilitation (Table 4) (SGME 2023a).

Table 4 Available materials for revegetation success

Soil mitigation and management strategy		Placement[1]	Strip placement	Hydromulch	Direct seed spoil	Not required
Hectares	1,688	784	165.8	17.5	48.6	672.1
Needed (m^3)	1,300,350	1,176,000	124,350	-	-	-
Available (m^3)	787,768.78	-	-	-	-	-
Excess / deficiency	-512,581.22	-	-	-	-	-

1. Assumes a depth of 0.15 m

4.1.2 Stripping

After vegetation clearing, soil is stripped to the base of the A horizon (approximately 0.15 m depth). The B horizon is avoided to reduce the risk of sodicity and dispersion. It is either directly placed, or in circumstances where this is not possible, is stockpiled for later use (Section 5.2).

Soil stripping is timed to avoid the risk of soil compaction, loss of structure, seed viability and biological health. It should account for general condition of the soil (ie not saturated or hard set) and is done, where possible, after seed has set to maximise soil seed bank.

4.1.3 Surface preparation

Before spreading soil two factors are considered:

- characteristics of the underlying spoil; and
- physical preparation of soil.

For example, if spoil is dispersive (ie white sodic spoil) it is treated with gypsum to increase stability before spreading.

A fine tilth soil surface with deep spoil decompaction is considered the best landform preparation for establishing vegetation. Decompaction is done by deep ripping, which blends soil and spoil eliminating a sharp profile (GSS 2007). Ripped surface levelling is done to stop seed loss in deep crevices.

The following general site preparation is recommended:

- deep rip to approximately 0.4-0.5 m;
- rip lines would be no greater than 1 m apart;
- ripping should always be along (parallel) to the contour (even slight grades can result in gully erosion);
- ripping should always be done before seeding;
- seeding should always be done into a fresh surface tilth before rain; and
- excessive surface rock does not necessarily need to be removed since it would act as armouring, reducing the potential for erosion.

Soil spreading should be done at an appropriate time of year to minimise the potential for erosion before vegetation establishes. Where available, mulched vegetation or vegetative debris should also be spread. This supports the development of ecosystem services including nutrient cycling, habitat (for small invertebrate species) and reduces the uncovered surface area.

4.1.4 Spreading

Once the landform has been reshaped and spoil treated (if needed) the next step is soil spreading. Placement would largely be governed by its location; however, soil would first be used to cover landform that has steep slopes and / or erosive spoil.

Soil is spread onto prepared land to a depth of 0.15 m in accordance with the *Soil Management Program* (SMP; 2016) and GM-MMS.

The following measures are used to reduce soil loss during spreading and promote vegetation growth:

- a soil inventory is prepared before soil is spread, the inventory shows the depths and volume of soils to be reapplied to each rehabilitation area;
- soil and spoil characteristics (ie erosion potential) are taken into account during spreading, moderately and highly dispersive materials are placed below the final surface and on flatter land to minimise the potential for surface exposure and erosion;

- soils are spread immediately after disturbed land has been reshaped and deep-ripped;
- soil spreading is done in even layers to the thickness needed for the PMLU;
- the final surface is lightly scarified on the contour to encourage rainfall infiltration, minimise runoff and improve seed retention;
- direct seeding is done at the same time as soil spreading;
- erosion and sediment controls are implemented where needed before vegetation growth; and
- surface water management measures are installed eg rock lined drains to direct and manage runoff.

Hydromulching is a highly efficient and cost-effective method of establishing vegetation in areas which may be large, difficult to access or heavily sloped (TerraCom 2020c). It involves spraying a mix of water, seed, fertiliser, organic mulch fibres and a binder or tackifier onto the ground where vegetation establishment is desired. Hydromulching is scheduled for a portion of the Eastern Diversion and has previously been used on the Ramp 2 CDA.

4.2 Rehabilitation techniques

Progressive rehabilitation commenced in 1984 (WSP 2016). Since that time rehabilitation has been ongoing as land has become available as per condition G3 of the EA:

> *Progressive rehabilitation must commence within two years of areas becoming available within the operational land.*

Rehabilitation has been done within the spoil disturbance domains. Other areas including the sediment dam walls, some infrastructure features and exploration domains have also been rehabilitated (Section 2.7)

4.2.1 Strategy

The rehabilitation strategy aims to reinstate disturbed land (excluding the residual void which is classified as a NUMA) to a PMLU of predominantly light grazing, and some areas as native ecosystem.

The strategy sets out to achieve rehabilitation goals outlined in the superseded *Queensland guideline — Guideline: Rehabilitation requirements for mining resource activities* (DES 2014).

Rehabilitation objectives, indicators and completion criteria have been developed for each domain. The rehabilitation strategy aims to ensure final landforms are stable and non-polluting and that the intended PMLU can be achieved.

Rehabilitation methods have been developed which reflect the rehabilitation goals and objectives (Section 1.3). Methods focus on creating safe, stable and non-polluting landforms that achieve the intended PMLU. These methods are periodically reviewed and adapted based on the outcomes of rehabilitation monitoring.

Current methods used for progressive rehabilitation are consistent with leading practice, which can be summarised as:

- decommissioning and removal of services;
- reshaping / recontouring;
- drainage management structure installation;
- soil management;
- land preparation;
- soil spreading, ripping and seeding; and
- inspection and monitoring.

4.2.2 Species selection and seed mix rate

Seeding would be guided by the allocation of final land, and would be specific according to the final land use. Seed viability testing and treatment for dormancy would be done as needed. Seed spreading techniques could include direct seeding, tube stock planting, and aerial seeding.

Species suitability, species ratio and seeding rates have been considered and would be specific to each land use (further detail is in AECOM 2013a and 2013b). Species would be selected based on their relative abundance in existing rehabilitation analogue sites.

Seed mixes would be developed through consultation with Traditional Owners and through site specific trials (ie Earthtrade 2021). Native seed would be collected from a suitable supplier within 100 km of the Mine because they:

- are acclimatised to the region;
- have developed resistance to local pests and diseases;
- provide suitable habitat that resembles pre-existing conditions;
- generally, require minimal inputs (ie fertiliser and water);
- support the occurrence of native species;
- have minimal risk of becoming a future weed;
- help to conserve biodiversity; and
- would blend in with the local plant communities.

The spreading rate of seeding mixes will be refined based on the desired density, seed viability, germinability and potential growth rates.

4.2.2.1 Native ecosystem

Areas to be returned to a PMLU of native ecosystem will be rehabilitated to meet remnant vegetation status for RE 11.3.4 and RE 11.11.1. The proposed species seeding lists for the two RE's are provided in Table 5 for RE 11.3.4 and Table 6 for RE 11.11.1.

Table 5 RE 11.3.4 species list

11.3.4	Species	Common name	Seeding rate (kg/ha)
Trees	*Eucalyptus tereticornis*	Forest Red Gum	0.3
	Corymbia tessellaris	Moreton Bay Ash	0.3
	Angophora subvelutina	Broad-leaved Apple	0.3
	Corymbia clarksoniana	Clarkson's Bloodwood	0.3
	Lophostemon suaveolens	Swamp Mahogany	0.3
	Angophora floribunda	Rough-barked Apple	0.3
	Eucalyptus melanphloia	Silver-leaved Ironbark	0.3
	Eucalyptus populnea	Poplar Box	0.3
Shrub	*Acacia glaucocarpa*	Hickory Wattle	0.25
	Acacia disparrima subsp disparrima	Southern Salwood	0.25
	Alphitonia excelsa	Red Ash	0.25

11.3.4	Species	Common name	Seeding rate (kg/ha)
	Acacia crassa subsp. longicoma	-	0.25
	Acacia falcata	Sickle Wattle	0.25
	Acacia leiocalyx subsp. leiocalyx	Black Wattle	0.25
Grasses	*Arundinella nepalensis*	Reed Grass	3
	Heteropogon contortus	Black Speargrass	2
	Bothriochloa bladhii subsp. bladhii	Forest Bluegrass	1
	Dinebra decipiens	Slender Canegrass	1
	Cyperus gracilis	Slender flat Sedge	1
	Themeda triandra	Kangaroo Grass	1
	Capillipedium spicigerum	Scented-top Grass	1
Forbs	*Cyanthillium cinerum*	Ironweed	0.2
	Sida hackettiana	Spiked Sida	0.2
	Eustrephus latifolius	Wombat Berry	0.2
	Glycine tomentalla	Rusty Glycine	0.2
	Desmodium varians	Slender Tick-trefoil	0.2
	Euphorbia dallachyana	Caustic Weed	0.2
Total	-	-	**15.1**

Table 6 RE 11.11.1 species list

11.11.1	Scientific name	Common name	Seeding rate (kg/ha)
Trees	*Eucalyptus crebra*	Narrow-leaved Ironbark	0.3
	Acacia rhodoxylon	Rosewood	0.3
	Corymbia clarksoniana	Clarkson's Bloodwood	0.3
	Acacia shirleyi	Lancewood	0.3
	Acacia falciformis	Broad-leaved Hickory	0.3
	Alstonia constricta	Bitterbark	0.3
	Corymbia dallachiana	Dallachy's Gum	0.3
	Alphitonia excelsa	Red Ash	0.3
Shrubs	*Erythroxylum australe*	Dogwood	0.2

11.11.1	Scientific name	Common name	Seeding rate (kg/ha)
	Acacia leiocalyx subsp. leiocalyx	Curracabah	0.2
	Capparis canescens	Wild Orange	0.2
	Carissa ovata	Bush Plum	0.2
	Alectryon subdenatus	Hard Alectryon	0.2
	Cassia brewsteri	Brewster's Cassia	0.2
	Grewia latifolia	Dog's Balls	0.2
Grasses	*Aristida queenslandica var. dissimilaris*	Queensland Wiregrass	3
	Themeda triandra	Kangaroo Grass	2
	Digitaria ramularis	Finger Panic Grass	1
	Aristida queenslandica var. queenslandica	Three-Awn	1
	Enteropogon unispicues	-	1
	Enneapogon lindleyanus	Purple-Head-Nine-Awn	1
	Eragrostis lacunaria	Lovegrass	1
Forbs	*Cyanthillium cinereum*	Little Ironweed	0.2
	Phyllanthus virgatus	Creeping Phyllanthus	0.2
	Sida hackettiana	Spiked Sida	0.2
	Breynia oblongifolia	Coffee Bush	0.2
	Cheilanthes distans	Bristly Cloak Fern	0.2
Total	-	-	**14.8 kg/ha**

4.2.2.2 Grazing

The remaining area to be rehabilitated will meet a PMLU of grazing, for which the species list can be located in Table 7. These key species include native Australian grasses that are suitable for cattle grazing in addition to a number of trees local to the area. This is the most suitable seed mix for achieving the required PMLU.

Table 7 Grazing seed mix

Grazing	Scientific name	Common name	Seeding rate (kg/ha)
Grasses	*Dichanthium sericeum*	Queensland Bluegrass	3
	Heteropogon contortus	Black Speargrass	3
	Cynodon dactylon	Couch Grass	1.5
	Astrebla lappacea	Curly Mitchell Grass	1.5

Grazing	Scientific name	Common name	Seeding rate (kg/ha)
	Bothriochloa insculpta	Creeping Bluegrass	1
Forbs	*Cyanthillium cinereum*	Little Ironweed	0.6
	Phyllanthus virgatus	Creeping Phyllanthus	0.6
	Sida hackettiana	Spiked Sida	0.8
Shrubs	*Acacia falcata*	Sickle Wattle	0.25
	Alphitonia excelsa	Red Ash	0.25
	Erythroxylum australe	Dogwood	0.25
	Acacia leiocalyx subsp. leiocalyx	Curracabah	0.25
Trees	*Eucalyptus tereticornis*	Forest Red Gum	0.3
	Corymbia tessellaris	Moreton Bay Ash	0.3
	Angophora subvelutina	Broad-leaved Apple	0.3
Total	**-**	**-**	**14.9 kg/ha**

Direct seeding rates were assessed by GSS (2008) and TCL (2017) and examined a range of alternative soil spreading techniques, vegetation growth and seed specification options (Table 8). The assessment included rehabilitated land that was deep ripped and tree seeded with the same species mix used on Ramp 3 North and Ramp 4 East. The assessment found that black and grey soil was dominated by *Acacia* and / or *Dodonaea* species, while eucalypt species dominated red and grey soils and spoil.

Table 8 Estimated stem densities for soil comparison trials

Soil	Stems/100 m^2	Estimated stems/ha	Criteria	
			Species/ha	**Stems/ha (min)**
Ramp 3 North				
Red	25	2,500	two trees / four shrubs	150 trees / 500 shrubs 50-70% groundcover
Black	36	3,600	two trees / four shrubs	150 trees / 500 shrubs 50-70% groundcover
Grey	71	7,100	one tree / four shrubs	40 trees / 500 shrubs 50-70% groundcover
Spoil	47	4,700	-	-
Broadacre Rehabilitation	19	1,900	-	-
Ramp 4 East				
Red	101	10,100	two trees / four shrubs	150 trees / 500 shrubs 50-70% groundcover

Soil	Stems/100 m^2	Estimated stems/ha	Criteria	
			Species/ha	Stems/ha (min)
Black	64	6,400	two trees / four shrubs	150 trees / 500 shrubs 50-70% groundcover
Grey	100	10,000	one tree / four shrubs	40 trees / 500 shrubs 50-70% groundcover
Spoil	123	12,300	-	-
Scalped Rehabilitation	12	1,200	-	-

4.2.3 Tube stock

A combination of regeneration from the seed bank, direct seeding and tube stock of trees and shrubs can improve landscape function and help to address current rehabilitation issues (ie poor soil nutrients, low species diversity and low vegetation density). Supplementary tube stock of native trees and shrubs would be used if needed.

4.2.4 Seed treatment

Seed germination rates for some native tree and shrubs is dramatically improved if the seeds are treated before planting. Treatment methods include:

- heat treatment;
- scarification;
- exposure to smoke; or
- smoked water.

Appropriate treatments would be investigated with seed suppliers as needed to maximise revegetation success and cost effectiveness.

4.2.5 Timing

Timing of direct seeding is important for success. For example, growth of grass at the right time is important for seed survival which requires specific moisture and temperature conditions to germinate. Generally, seed would be sown immediately before rain and before November each year.

There are no irrigation requirements.

4.3 Sustaining the PMLU

Soil quality should be checked to make sure that it can support the PMLU. Testing would be done following soil spreading to see if soil is dispersive. Depending on the PMLU, suboptimal soils may be applied with ameliorants (Section 4.3.3).

Other checks could include to see if soil has enough:

- infiltration capacity;
- available water capacity;
- aeration;

- rooting depth (ie mechanical and chemical inhibition);
- plant nutrients; and
- microbial associations needed for plant growth.

There is not enough soil to cover all land that would be rehabilitated (Table 4). Therefore, some land may be seeded directly into spoil. Land lacking in soil coverage may be particularly suited to final land uses requiring low biodiversity, as per AECOM (2013b).

Any testing of soils would be included in a soil database and used to keep the soil inventory up to date.

The recommended land systems, suited to a PMLU of light grazing pasture, are in Table 9 (SSA 2013).

Table 9 Suitable grazing land systems

No.	Land systems	Undisturbed soil	Equivalent soil after rehabilitation
1	Black soil grasslands	Black cracking clays (black soil)	Black
2	Alluvial woodlands	Grey silt clays and black soils	Black or spoil
3	Woodlands on sands and earths	Sandy red brown earths	Red / brown

4.3.1 Soil availability

A soil inventory detailing stockpile volumes is in Section 4.1.1, including quantities of soil, hydromulching and direct seeding resources needed for rehabilitation

4.3.2 Depth of cover

The spreading rate of soil to land would be 0.15 m and is consistent with profiles from the pre-mining soil survey (GSS 2008). Some areas may be directly seeded into spoil with the addition of ameliorant to improve spoil. Soil placement will be prioritised in native ecosystem PMLU rehabilitation areas.

As mentioned in Section 4.1, another management strategy of the soil deficit is to place soil in an alternating pattern of ~ 10 m wide soil strips and bare spoil strips of the same width (TerraCom 2017). Potential areas of this strategy include haul roads, minor roads, the MIA and spoil.

Alternating soil and bare spoil strips will have numerous benefits including:

- reducing the needed volume of soil and, therefore, doubling the potential coverage area;
- enabling the oil strip to be seeded with cover crops and native grasses to reduce erosion and runoff;
- sowing woody species on the bare strips, decreasing the competition between grass and woody species;
- cross-propagating the native grasses, trees and shrubs into the adjacent media; and
- allowing the biological components of soil to migrate into the spoil strips.

Typically, soil is transported to re-profiled land in dump trucks before the wet season in November and spread by dozer. Contour banks are constructed at predefined intervals down the slope and the land is deep ripped along the contour to a depth of approximately 0.5 m.

4.3.3 Amelioration and fertiliser

Amelioration refers to the improvement of soil and / or spoil to:

- improve soil structure;
- reduce the exchangeable sodium percentage (gypsum);
- increase mineral content;
- correct pH; and
- enhance moisture holding capacity.

Soil organic carbon (SOC) has typically not been addressed during amelioration. SOC improvement may be needed, particularly for direct seeding in spoil and would be subject to future investigation. A summary of soil ameliorants for increasing SOC (SSA 2013) is in Table 10.

Table 10 Recommended soil ameliorants

Items	Rate	Estimated amount
Cow manure for composting	40 t / ha	58,400 tonnes
Inoculant for composting	50 g / tonne cow manure	2,920 kg
Gypsum	10 t /ha	14,600 tonnes
Basaltic rock dust	10 t/ ha	14,600 tonnes
Evergreen	2 L / ha	2,920 L
Green manure plus	1 L / ha	1,460 L

A *Soil and Capping Material Assessment* by SGME (2023a) found that:

- soil stockpiles will be suitable for rehabilitation, but may need amelioration to satisfy rehabilitation outcomes;
- the majority of soil would benefit from gypsum due to high salinity which increases the erosion potential;
- P-based fertiliser may be required for soil that is phosphorus deficient;
- the majority of spoil is considered low-risk indicating that it is suitable for use in rehabilitation;
- only spoil with an ESP<15% can be used as cover material for the co-disposal waste (high-risk).

5.0 Revegetation management

5.1 Rehabilitation criteria

Applicable rehabilitation success criteria are specified in the EA. As rehabilitation knowledge and techniques improve, revised criteria may be developed and applied. Proposed rehabilitation criteria are:

- the maximum slope for rehabilitated spoil is >15%, except for sections of Ramp 3 which is cut through competent rock which will be ripped parallel to the slope;
- spoil stockpiles would be reshaped so they are internally draining, undulating landforms with slopes up to 15%;
- minimum distances between contour banks on rehabilitated spoil slopes are maintained;
- maximum slope of final void highwalls and end walls are needed to be geotechnically stable and certified by an Appropriately Qualified Professional (AQP);
- ramps and low walls would be breached and graded with a maximum slope >15%;
- tailings and sodic spoil with exchangeable sodium percentage (ESP) >30% must be covered with not less than one metre of benign material (ie with ESP <15%);
- landforms of tailings would be externally draining and capped;
- successfully rehabilitated land would have gully erosion consistent with surrounding landscapes;
- regulated dams, other than those for tailings disposal, would have the walls breached and the dam drained. Salt impacted residue would be taken to the tailings storage facility (TSF), or capped;
- water storages would be drained and breached;
- revegetation would meet species and abundance criteria;
- all other land would be rehabilitated to a stable landform with self-sustaining vegetation and able to sustain a PMLU.

The rehabilitation schedule is built around five benchmarks:

- re-contouring (reshaped to final grade);
- soil spreading;
- seeding (ripped and seeded, irrespective of germination success);
- PMLU established (vegetation has established, minor reseeding / erosion repairs may be needed); and
- successfully rehabilitated (compliance with rehabilitation success criteria).

5.2 Soil management plan

The objective of the *Soil Management Plan* (SMP) (SSA 2013) is to improve soil management protocols and maximise the probability of a successful rehabilitation outcome. It has drawn from historical experiences, including rehabilitation programs, trials, studies and monitoring.

After clearing of vegetation, soil is stripped to the bottom of the A horizon and where appropriate, directly placed on re-profiled land. In circumstances where this is not possible, it is stockpiled for later use. Soil stockpiles are kept below three metres to limit potential for biological degradation. Where storage space is limited, soil is stockpiled to four metres, but only if alternative options are not viable. Revegetation using grass cover is promoted to further mitigate biological, physical and chemical impacts.

The amount of time soil is stockpiled is kept to a minimum. Stockpile management procedures are designed to minimise soil degradation which could impact vegetation growth. The following measures are consistent with leading practice (DISER 2016), and aim to reduce soil degradation:

- stockpiles are placed a suitable distance from drainage lines or trafficked areas;
- runoff is diverted around stockpiles;

- the amount of time soil is stockpiled is kept to a minimum;
- stockpiles are kept as low as possible and to a maximum height of 3-4 m with a large surface area;
- stockpiles are seeded (revegetated) to prevent erosion, discourage weed growth and improve biological activity with suitable grasses;
- stockpiles are surveyed and included on mine plans;
- machinery and vehicles are excluded for general access (except for maintenance works);
- stockpiles are protected from future disturbance to prevent compaction and minimise degradation;
- growth of weeds is monitored and control programs implemented (as needed) to avoid a weed seed bank from developing; and
- soil and spoil are stockpiled separately (where possible).

5.3 Weeds and pests

Rehabilitated land is routinely inspected for weeds and pest species, with management controls developed and implemented where needed. Management and monitoring focuses on pest species identified in previous rehabilitation monitoring; particularly *Cryptostegia grandiflora* (Rubber Vine), *Opuntia spp.* (Tree Pear), *Parthenium hysterophorus* (Parthenium), *Vachellia farnesiana* (Vachellia), and *Leucaena leucocephala* (Leucaena) (Earthtrade 2021).

The exotic pasture species Buffel (*Cenchrus ciliaris*) and Red Natal (*Rhynchelytrum repens*) are well established and have become naturalised. These species compete with emerging native plants which are slow to emerge. A high content of weed is known to be present in the soil stockpiles and following soil spreading this is likely to lead to dense weed coverage in short timeframes. Incorporating a cover crop is a proven option to alleviate this impact.

Dingoes, feral dogs, foxes, rabbits, feral pigs and cats are common. These would be managed in accordance with the requirements of the *Land Protection (Pest and Stock Route Management) Act 2002* (Land Protection Act 2002) and the *Queensland Invasive Plants and Animals Strategy 2019-2024 (QDAF 2019).*

Surveys would be conducted annually to identify weed proliferation. Weed species to be targeted are declared weeds within the Land Protection Act. Remedial action would be taken on land identified through monitoring.

Weeds and pest animal management includes:

- rehabilitated land would be routinely inspected for weeds, with management controls developed and implemented where needed;
- vehicle wash-downs for all new vehicles (including earthmoving and other construction machinery);
- disposal and storage of putrescible wastes is done appropriately to limit feral animals being attracted;
- laydown areas are maintained to limit pest fauna; and
- domestic animals, including pets, are not permitted onsite.

Methods to prevent weeds include spreading of annual cover crops and mulches. The cover crop would help to prevent weeds by establishing rapidly, it would provide an in-situ mulch and would allow for natives to grow through as the cover crop dies off. Directly applied mulch creates a weed free zone, reduces the erosive impact of raindrops and increases humidity at the soil / seed interface.

Weed management would be done in combination with the following soil management practices:

- soil stockpiles scalped before spreading, scalped soil is used for drainage contours in zones with low biodiversity requirements;
- after spreading soil is sown with a cover crop; and
- further seeding is only done if natural vegetation does not volunteer.

5.4 Fire regimes

Protection from fire is important during vegetation growth. Juvenile plants may be killed by fire preventing successful rehabilitation and achieving rehabilitation criteria.

Fire management includes the following measures:

- monitoring of weather conditions during high-risk conditions;
- maintaining communication with local emergency services including the Queensland Fire and Emergency Services (QFES);
- establishing and maintaining fire breaks around revegetation and key infrastructure (assessed as needed);
- serviceable firefighting equipment and appropriate training;
- a fire management plan would be developed to limit fire risk and provide response procedures.

5.5 Infrastructure

5.5.1 Fencing and signage

If needed, fencing may be installed to restrict access to stock, particularly during early stages of germination. It may also be needed to stop compaction, surface stability degradation (caused by grazing animals) and rill and gully erosion.

Vegetated corridors would be retained where practicable and land disturbance would be restricted. Undisturbed land would be fenced and buffers around sensitive habitats would minimise human interaction with wildlife.

5.5.2 Erosion and sediment control

Erosion is a significant factor stopping successful rehabilitation because of soil, seed and nutrient losses and an overall decrease in surface stability. At the time of preparation, the SMP noted that over 50% of monitored rehabilitation exhibit slight to severe soil erosion (SSA 2016).

The majority of rehabilitated slopes range from 0-15%. Rehabilitation on steeper slopes (13-18%) substantially reduces costs associated with landform reshaping; however, it increases the risk of rehabilitation failure because steeper slopes cause greater runoff and increase erosion. Steep slopes have already been rehabilitated, for example Ramp 4 West; however, the area exhibits severe erosion. So far, there has been no evaluation of rehabilitation on steep slopes.

Erosion control on rehabilitated land primarily focuses on surface water management and surface protection. Soil stability can be increased by building organic carbon which would lead to the formation of stable humus. Stable humus binds soil clay particles together, thereby reducing particle movement and capacity for erosion. Soil stability and the building of organic carbon is discussed in Section 4.3.3.

An *Erosion and Sediment Control Plan 2020* (ESCP) has been developed in accordance with the International Erosion Control Association (IECA) guidelines for *Best Practice Erosion and Sediment Control* (2008). The purpose of the ESCP is to define the overall erosion hazard of land disturbance and to provide appropriate management strategies to make sure that adverse effects from sediment are controlled.

Current sediment and erosion control measures on disturbed and rehabilitated land include:

- erosion and sediment control during clearing such as minimising time soil is left exposed, limiting clearing to essential works, and directing runoff from cleared areas to sediment dams;
- erosion and sediment control for exposed soil and spoil, including the use of gravelling, mulching, revegetation, sediment fences, check dams, grass and rock filter traps, and gypsum application on dispersive soils;

- contour cultivation and contour deep ripping or furrowing to minimise soil compaction and improve water infiltration;
- contour levee and diversion banks to reduce or eliminate the catchment to the heads of gullies;
- grassed waterways to confine runoff from structures into a stable vegetated flow path;
- the use of sediment (settling) dams to confine the movement of soil and/or mineral waste for disturbed areas with >150 cubic metres per year (m^3/yr) estimated soil loss;
- the use of sediment control structures to intercept and convey disturbed area runoff water to sediment dams; and
- sediment fences and / or coir logs for retention/filtration of suspended sediments.

6.0 Revegetation objectives

Revegetation objectives must be consistent with the PMLU (light grazing or native ecosystem) and NUMAs, and rehabilitation and management milestones in the PRC plan.

Specific rehabilitation milestone criteria targets are in Table 11.

Table 11 Rehabilitation milestone criteria

Milestone reference	Rehabilitation milestone	Strategies
RM1	Infrastructure decommissioning and removal	a) decommissioning and removing services; b) removing infrastructure; c) decommissioning dams; d) removing all general and regulated waste; and e) decommissioning or converting water or monitoring bores, exploration drill holes.
RM2	Remediation of contaminated land	a) removing or remediating contaminated land to a PMLU of light grazing pasture or native ecosystem; b) all contaminated sediment is removed; c) all plastic liners are removed and disposed; d) site investigation report is prepared by an AQP; and e) certification from an AQP that all contaminated land has been removed.
RM3	Cover system installation	a) certification by an AQP that waste products generated from the washing of coal are buried under spoil with a minimum of thickness of five metres.
RM4	Landform construction and reshaping or reprofiling	a) reshaping or recontouring the landform; b) install drainage management structures; c) all major earthworks completed; d) stable landform and slope angles ~15 % average; and e) landform is assessed as geotechnically stable by an AQP. **Diversions (RA12)** f) certification from an AQP that diversions are constructed as per the requirements of the certified design, and in accordance with DNRME's Guideline: *Works that interfere with water in a watercourse for a resource activity — watercourse diversions under the Water Act 2000* (OSW/2019/4599).
RM5	Surface preparation	a) placement of a minimum of 0.15 m of soil; b) contour ripping finished; and c) fertiliser applied at rates of 250 kg/ha.
RM6	Revegetation (light grazing pasture)	a) direct seeding at application rate determined by an AQP;

Milestone reference	Rehabilitation milestone	Strategies
		b) seed mix applied contains a suitable range of trees, shrubs and perennial grass species and suitable leguminous species consistent with the surrounding area; and c) stock exclusion fencing installed until achieving surface requirements for grazing pasture.
RM7	Revegetation (native ecosystem)	a) Seed mix applied contains species consistent with RE 11.1.11 or RE 11.3.4; b) Species comprise ≥ 20 % of the average number of species described in RE 11.1.11 or RE 11.3.4 technical descriptions; c) Average height of each layer is ≥ 70 % of average layer height described in RE 11.1.11 or RE 11.3.4 technical descriptions; d) Average fractional cover of each layer is ⩾ 50 % of average fractional cover described in RE 11.1.11 or RE 11.3.4 technical description.
RM8	Achievements of surface requirements (light grazing pasture)	a) species richness and diversity achieved is consistent with the sown seed mix and similar to reference sites; b) revegetation ≥70% comparable to analogue site; c) no active areas of gully erosion and drainage follows appropriate drainage paths; d) certification from an AQP that rehabilitation is resilient to fire; and e) certification by an AQP that weeds and pest species are in densities no greater than at analogue sites. **Diversions (RA12)** f) an AQP prepares an assessment report annually based on the Index of Diversion Condition (IDC) assessment, where: a. the diversions have achieved a target Geomorphic Index score of ≥ 95 % relative to baseline condition. b. the riparian corridor has achieved a target Riparian Index score of ≥ 70 % relative to baseline condition.

Milestone reference	Rehabilitation milestone	Strategies
RM9	Achieving surface requirements (native ecosystem)	a) for RE 11.1.11 species richness ≥ 15 native species: – tree species richness ≥ 2 species, including Yellow Jacket (*Corymbia liechhgardtii)*; – shrub species richness ≥ 3 species; – grass species richness ≥ 5 species; and – forb and other species richness ≥ 5 species. b) For RE 11.3.4, species richness ≥ 18 native species: – tree species richness ≥ 3 species, including Forest Red Gum (*Eucalyptus tereticornis);* – shrub species richness ≥ 4 species; – grass species richness ≥ 6 species; and – forb and other species richness ≥ 5 species. c) revegetation ≥ average fractional cover derived from RE technical descriptions for RE 11.1.11: – trees cover ≥ 57.7 %; – shrubs ≥ 36.9 %; and – grasses and forbs cover ≥ 29.3 %. d) revegetation ≥ average fractional cover derived from RE technical descriptions for the RE 11.3.4: – trees cover ≥ 37.1 %; – shrubs ≥ 4.3 %; and – grasses and forbs cover ≥ 61.6 %. e) no active areas of gully erosion and drainage follow appropriate drainage paths; f) certification from an AQP that rehabilitation is resilient to fire; and g) certification by an AQP that weeds and pest species are in densities no greater than at analogue sites.
RM10	Achieving PMLU to a stable condition (light grazing pasture)	a) certification from an AQP that the area has achieved stable condition; b) certification from an AQP that the landform achieved a factor of safety ≥ 1.5; c) maximum erosion rate of < 10 t/ha/yr; d) total percentage groundcover (vegetation, litter and rock combined) is > 70 %; e) there are no declared Noxious Class 1 or Class 2 weeds; f) native fauna identified at reference sites are present or indicators of these species are recorded; g) water quality complies with *Table C7* of EPML00876713. **Diversions (RA12)** h) prepare assessment report by an AQP certifying that the diversion is operating in accordance with,

Milestone reference	Rehabilitation milestone	Strategies
		DNRME Guideline: *Works that interfere with water in a watercourse for a resource activity — watercourse diversions under the Water Act 2000* (OSW/2019/4599) criteria and is in a stable condition. The report will include data from the IDC assessment, showing that Geomorphic Index has maintained a score of ≥ 95 % and the Riparian Vegetation Index has maintained a score of ≥ 70 % for two consecutive years. i) certification from AQP that the diversions have achieved a stable condition, and are able to sustain a 0.1% AEP flood event.
RM11	Achieving PMLU to stable condition (native ecosystem)	a) certification from an AQP that the area has achieved stable condition; b) certification from an AQP that the landform achieved a factor of safety ≥ 1.5; c) total percentage groundcover (vegetation, litter and rock combined) is ≥50 %; d) maximum erosion rate of < 10 t/ha/yr; e) there are no declared Noxious Class 1 or Class 2 weeds; f) native fauna at reference sites are present or indicators of these species are recorded; and g) water quality complies with *Table C7* of EPML00876713.
MM1	Conversion of the void into a permanent waterbody	a) all major earthworks finished.
MM2	Highwall and low wall treatment	a) maximum slope of 30% in competent rock; b) maximum slope of 15% in incompetent rock; c) factor of safety ≥1.5; and d) void complies with condition F17 of EA EPML00876713.
MM3	Achieving surface requirements	a) fencing of 1.8 m high erected around the perimeter of the void; b) warning signage posted around the perimeter of the void following the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland*: c) safety bund constructed at two metres in height, four metres in base width and 10 m beyond the area which may be affected by void edge instability; and d) direct seeding of low walls with species and application rates determined by an AQP.

Milestone reference	Rehabilitation milestone	Strategies
MM4	Achieving improvement	a) certification from an AQP that the void will not cause environmental harm outside of the tenure boundary: b) certification from an AQP that the void is safe to humans and livestock; and c) certification from an AQP that the water level in the void will not cause environmental harm to the surrounding environment.

7.0 Revegetation monitoring and maintenance

7.1 Rehabilitation performance

7.1.1 Key revegetation issues

Rehabilitation monitoring has found several issues that may impact rehabilitation outcomes including:

- erosion;
- unstable landform;
- poor soil nutrients;
- low species diversity;
- low vegetation density;
- bushfire resilience; and
- poor plant available water.

7.1.2 Historic rehabilitation monitoring

Several rehabilitation monitoring campaigns have been done and are described in *Rehabilitation Status Review* (WSP 2016). Rehabilitation monitoring is classified under the following 'eras' in Table 12:

Table 12 Previous rehabilitation monitoring

Year	Consultant	Comments
Pre 2008		
1995	Centre for Mined Land Rehabilitation	Field measurements taken across four rehabilitation sites completed in 1984.
1999	Unnamed consultancy	Comparison between 1997 and 1998 work.
2000	Unnamed consultancy	Field measurement of nine rehabilitation sites
2000	Centre for Mined Land Rehabilitation	Two monitoring campaigns relating to specific target areas based on the year rehabilitation was completed.
2001-2003	AustralAsian Resource Consultants	Annual monitoring of 11 sites.
2005	Emerton and Elsol	Broad rehabilitation assessment including review of past monitoring activities from 1995 to 2003.
2008-2012		
2007	Rio Tinto (internal)	Rio Tinto Coal Australia (RTCA) internally developed a rehabilitation monitoring program centred around landscape function analysis (LFA). The plan incorporated vegetation assessment, soil and spoil sampling, and rill and gully erosion assessment. 33 sites were monitored in 2008, which was proposed to increase to 85 sites by 2016.
2012 – Present		

Year	Consultant	Comments
2016	WSP	WSP were engaged to prepare the Blair Athol Coal Mine (BACM) *Rehabilitation Monitoring Program* (RMP)
2019	WSP	Rehabilitation monitoring was done across 12 sites, using methods detailed in the RMP (WSP 2016).
2020	WSP	Rehabilitation monitoring was done across 12 sites, using methods detailed in the RMP (WSP 2016).
2021	Earthtrade	Monitoring of 15 existing rehabilitation sites, establishment and monitoring of two new sites located in the TSF. Vegetation monitoring of three existing reference sites, monitoring of five existing gully locations, and soil monitoring at two persistent bare areas (PBAs).

7.2 Monitoring objectives

7.2.1 Vegetation monitoring

Vegetation monitoring objectives for the Mine are to:

- measure total lower-storey cover (foliage and basal), species density and richness in the rehabilitation block compared to reference sites;
- measure pasture yield compared to reference sites;
- measure the cover (foliage and basal), presence / absence of upper-storey (tree) and mid-storey (shrub) species;
- measure the presence of declared weeds to identify weed management issues
- assess the success of sown species by comparing seeding mixes to monitoring data; and
- obtain data to statistically indicate trends and demonstrate success.

7.3 Monitoring methods

The following monitoring methods ensure that revegetation monitoring is cost effective, measurable, accurate and repeatable.

7.3.1 Data collection and data analysis

Rehabilitation data will be collected and assessed against milestone criteria to identify changes and monitor trends. This includes the use of data predictions to ensure rehabilitation performance is on target to meet rehabilitation milestones. Remedial or maintenance actions will be conducted as needed.

Permanent vegetation monitoring transects have been established in previous rehabilitation trials. This approach is scientifically robust, simple to execute and easily established.

Monitoring would be done along a standardised 50 m long transect, with a 10 m wide plot, at ~45 degrees across the slope. The parameters to be recorded within each rehabilitation site transect include:

- canopy height (ecological dominant layer);
- canopy cover;
- groundcover;
- species richness;

- relative abundance;
- weed presence / absence;
- stem count;
- erosion gully monitoring; and
- soil sampling;

7.3.2 Schedule

Successful rehabilitation requires continuous monitoring and evaluation of performance in order to achieve the intended PMLU outcomes.

Vegetation growth is rapid in the early stages and slows as the community matures. Initial monitoring (ie 1-2 years) would enable the Mine to identify trends in vegetation growth and success, with improvements or remedial actions implemented as needed. Therefore, rehabilitation would be assessed at 1, 2, 5, 10 and 15 years after establishment; then every 5 years until progressive certification is achieved (Earthtrade 2021).

To minimise differences in seasonal effects (ie temperature, rainfall, likelihood of severe weather events) monitoring would be done during May and August, following the wet season.

7.3.3 Maintenance

Appropriate maintenance and/or remedial works will be done if issues impacting completion criteria are identified by rehabilitation monitoring. Current maintenance issues and mitigation measures are in Table 13.

Table 13 Revegetation issues and mitigation measures

Revegetation issue	Mitigation measure
Historical rehabilitation	Augment as per current rehabilitation method, as needed.
Gully erosion	Fill and clad gully, modify drainage as needed, revegetate infill areas as soon as possible.
Poor vegetation cover	Adjust fertiliser or ameliorant inputs and reseed during appropriate seasonal conditions.
Erosion control device failure	Assess against design specifications, as needed.

7.3.4 Reporting

The following framework is leading practice for summary information to be included in annual rehabilitation reporting:

- methodology (field sampling and data statistical analysis);
- site establishment and descriptions, including photos (reference and rehabilitation plots);
- results for all assessments;
- comparison of the rehabilitation data (vegetation) with the data obtained from the reference plots, including statistical analysis to compare results between rehabilitation and reference plots;
- assessment and discussion on the soil chemical and physical properties and soil nutrient status of the reconstructed soil profile, identifying potential properties that may contribute to any areas of rehabilitation not meeting the desired objectives;
- statistical analysis to identify trends between soil and vegetation measurements;
- establishment success of seeded species;
- description of management and land use potential;

- graphical presentation (ie heat mapping) and description of key settlement / subsidence and progression of erosion features;
- detail type and global positioning system (GPS) location of erosion identified within, or near each monitoring plot;
- map outlining the blocks and transect locations of rehabilitation and reference plots; and
- discussion including, but not limited to:
  - trends in the vegetation and soil data; and
  - recommendations for managing erosion and weeds.

7.3.5 Adaptive management

Adaptive management controls would be developed and implemented as needed to improve revegetation practices. Appropriate investigations would be done with remediation programs and specific management measures to be prepared as part of adaptive management, where improvement opportunities are identified.

7.3.6 Adverse and unplanned events

Reporting of any adverse or unplanned event would be done in accordance with legislative requirements. A report would be prepared and include at a minimum:

- the nature and extent of the adverse event;
- actions taken to limit the extent of an impact at the time of the event;
- the proposed monitoring and remediation of any adverse event;
- actions currently taken to remediate and potential outcomes of remediation; and
- schedule of reporting for ongoing event management and reporting.

7.3.7 Quality assurance and quality control

Monitoring, data assessment and reporting would be done by an AQP. All monitoring data files would be stored onsite. Project staff would be responsible for reviewing monitoring data, analysis, reports and managing consultants.

Aspects to consider when reviewing the data, analysis and reports include quality assurance and quality control of data, methodologies used, fluctuating trends in data from previous years, accuracy of figures and graphs and general conclusions made about rehabilitation progress.

7.4 Rehabilitation trials

7.4.1 Historic rehabilitation trials

7.4.1.1 Direct seeding trials

Two separate direct tree seeding trials site were established at Ramp 3 (North) and Ramp 4 (East) in late December 2007. The purpose of the direct seeding trials was to assess the effect of direct tree seeding a standard tree seed mix onto four different surface material including the three main soil types (Section 4.2.2).

7.4.2 Future rehabilitation trials

Rehabilitation trials can improve the chances of achieving a nominated rehabilitation outcome, providing valuable ecological insights on the success of revegetation methods. At this stage, no further rehabilitation trials are planned. If trials are planned, the following would need to be included:

- the objective of the trial(s);
- the trial design including, but not limited to, the location, underlying land characteristics and potential issues;
- the details of how the trial(s) would be done;
- when the trial(s) would commence;
- the duration of the trial(s);
- how the trial(s) would be assessed for success; and
- how the results of the trial(s) would be incorporated into rehabilitation strategies and the development of milestones.

Rehabilitation trials must not result in the delay of rehabilitation.

7.5 Review

For continual improvement, revision of this plan would be done when monitoring identifies deficiencies in revegetation or in response to a significant event (ie natural disturbance), or if rehabilitation trials are planned, as needed.

References

AECOM 2013a, *BA Micro-habitat Planning Report*, prepared for RTCA by AECOM Australia Pty Ltd.

AECOM 2013b, *BA Revegetation Planning Report*, prepared for RTCA by AECOM Australia Pty Ltd.

BoM 2022 *Climate statistics for Australian locations*, Bureau of Meteorology, date retrieved 8 April 2022 from http://www.bom.gov.au/climate/averages/tables/cw_035019.shtml

Dames & Moore 1983, *Waste Management and Rehabilitation Programme: Soil and Overburden Characterisation,* prepared for Blair Athol Coal Company by Dames & Moore Pty Ltd.

DISER 2016, *Leading Practice Handbook: Mine Rehabilitation*, Commonwealth of Australia, Department of Industry, Science, Energy and Resources.

Earthtrade 2021, *Blair Athol Coal Mine: Rehabilitation Monitoring Report — April 2021,* prepared for TerraCom Limited by Earthtrade.

Eyre, T J, Kelly, A L, Neldner, V J, Wilson, B A, Ferguson, D J, Laidlaw, M J and & Franks, A J 2015, BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland Assessment Manual: Version 2.2, Queensland Herbarium, Department of Science, Information Technology, Innovation and Arts, Brisbane.

GSS 2007, *Blair Athol Establishment of Direct Tree Seeding and Soil Trials*, prepared for RTCA by Global Soil Systems Pty Ltd.

GSS 2008, *Blair Athol Assessment of Direct Tree Seeding Trials at Blair Athol Mine approximately 7 months after sowing*, prepared for RTCA by Global Soil Systems Pty Ltd.

IRC 2021, *Isaac Regional Planning Scheme: February 2021*, Isaac Regional Council.

JBT 2012, *Blair Athol Mine Closure Groundwater Investigation*, prepared for RTCA by JBT Consulting Pty Ltd.

QDAF 2019, *Queensland Invasive Plants and Animals Strategy 2019-2024,* Queensland Department of Agriculture and Fisheries.

SEAM 2016, *Soil Stockpile Volume Report for Blair Athol Mine*, prepared for BACM by SEAM Surveys Pty Ltd.

SGME 2023a, *Soil and capping material assessment*, prepared for TerraCom Limited by SGM Environmental Pty Limited.

SKM 2012, *Blair Athol Mine - Landform Review, Testing & Design Parameters*, prepared for RTCA by Sinclair Knight Merz

SSA 2013, *Blair Athol Soil Management Programme*, prepared for RTCA by Soil Systems Australia.

TerraCom (TCL) 2017, *Growth Media - Mitigation & Management Strategy*, prepared by TerraCom Limited.

TCL 2020, *Erosion and Sediment Control Plan*, prepared by TerraCom Limited.

WSP 2016, *Blair Athol Coal Mine Rehabilitation Status Review 2016*, prepared for RTCA by WSP Australia Pty Ltd.

WSP 2019, *Draft: Ecological Values Report: Blair Athol Coal Mine,* prepared for TerraCom Limited by WSP Australia Pty Ltd.

WSP 2020, *Draft: Ecological Values Report: Blair Athol Coal Mine,* prepared for TerraCom Limited by WSP Australia Pty Ltd.

SGM Environmental Pty Limited (SGME) is a boutique consulting firm of experienced industry experts working with our clients and their stakeholders to develop and deliver innovative solutions to complicated challenges that create enduring value.

SGME was established to provide services in soil science, geochemistry, mine closure and Environmental management, planning & approvals cost efficiently. When you engage SGME you engage a partner to your business, priding themselves on:

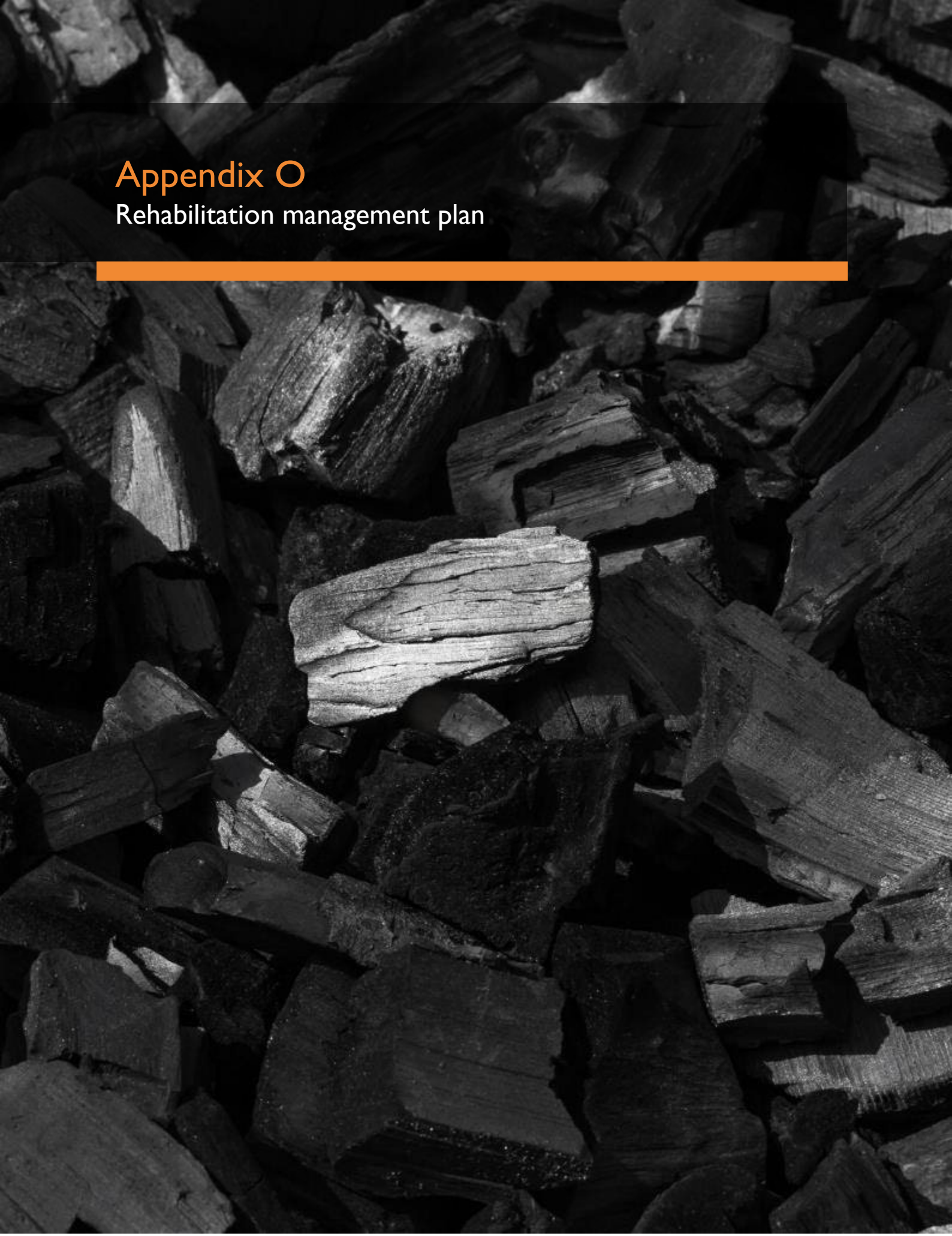
Honest – Straight-up and no nonsense.

Trust – We say what we mean and we will deliver on our promises. We will advocate strongly for you.

Innovation – We will always look for new ways to help and create enduring value because that is what friends do when they work together.

Safety – We do it right so we all go home safely.

Australian Location
PO Box 5622, Stafford Heights, Qld 4053
Tel +61 7 3148 6288
Email admin@sgmenvironmental.com
Web sgmenvironmental.com



Appendix O
Rehabilitation management plan

This page is intentionally blank.

Blair Athol Coal Mine – Environmental Management System

TerraCom

Rehabilitation Management Plan

Document Number:	**EMS-PLN-1.3**
Document Version:	**0**
Effective Date:	**30/09/2025**
Document Owner:	**Technical Services Manager**



TABLE OF CONTENTS

1 PURPOSE AND SCOPE 4
2 PROCEDURE 4
3 MANAGEMENT OF CONTRACTORS ROLES AND RESPONSIBILITIES 4
4 ACCOUNTABILITIES 4
5 DOCUMENT INFORMATION 4
5.1 DEFINITIONS 4
5.2 RELATED DOCUMENTS 5
5.3 REFERENCE MATERIAL 5
5.4 DOCUMENT VERSION AND HISTORY 5
6 INTRODUCTION AND BACKGROUND 7
7 LEGISLATIVE CONTEXT 7
7.1 BLAIR ATHOL COAL MINE ENVIRONMENTAL AUTHORITY 9
8 REHABILITATION STRATEGY 11
8.1 EA REQUIREMENTS 11
8.2 REHABILITATION STRATEGY 11
9 REHABILITATION AREAS AND OBJECTIVES 14
9.1 EA REQUIREMENTS 14
9.2 REHABILITATION GOALS AND ACTION PLANS 14
9.3 TOPSOIL AND GROWTH MEDIA MANAGEMENT 20
9.4 SOIL AMELIORANTS 23
10 REHABILITATION LANDFORM OBJECTIVES 23
10.1 EA REQUIREMENTS 23
10.2 REHABILITATION METHODS 23
10.3 LANDFORM DESIGN OBJECTIVES 24
11 REHABILITATION MONITORING 28
11.1 EA REQUIREMENTS 28
11.2 REHABILITATION MONITORING 28
11.3 MONITORING METHODS 30
11.4 PERFORMANCE CRITERIA 31
11.5 TRANSITIONAL AGE 35
11.6 GULLY EROSION 36
12 REHABILITATION MANAGEMENT ACTIONS 38

12.1 EA REQUIREMENTS 38
12.2 MANAGEMENT ACTIONS 38
12.3 REHABILITATION STATUS 38
12.4 END OF MINE LANDFORM PLANNING 39
13 PLAN REVIEW AND UPDATE 40
14 REFERENCES 41
APPENDIX A — ENVIRONMENTAL AUTHORITY 42

1 PURPOSE AND SCOPE

This Rehabilitation Management Plan (this plan) has been prepared to support the current Environmental Authority (EA) EPML00876713 and the *Progressive Rehabilitation and Closure Plan* (PRC plan). It includes proposed activities for rehabilitation, including rehabilitation areas, objectives and monitoring for the intended post-mining land uses (PMLUs).

2 PROCEDURE

The procedure is to review relevant site information and regulatory guidelines and assign management plan procedures that align with these components.

3 MANAGEMENT OF CONTRACTORS ROLES AND RESPONSIBILITIES

4 ACCOUNTABILITIES

Role	Accountabilities
NOTE	Only use this table if there is a role that is not mentioned in the S55 Mgt Structure e.g. Shotfirer, Document Controller

5 DOCUMENT INFORMATION

5.1 Definitions

Term	Definition
BACM	Blair Athol Coal Mine
RMP	Rehabilitation Management Plan
EA	Environmental Authority
PRCP	Progressive Rehabilitation and Closure Plan
EP Act	Environmental Protection Act (1994)
PMLU	Post-mining land use
NUMA	Non-use management area
DETSI	Department of Environment, Tourism, Science and Innovation (the administering authority)
RPR	Revegetation Planning Report
t/ha	Tonne per hectare

Term	Definition
ESP	Exchangeable sodium percentage
EC	Electrical conductivity

5.2 Related Documents

Reference	Title
SGME 2025	Blair Athol Progressive Rehabilitation and Closure Plan
EPML00876713	Environmental Authority

5.3 Reference Material

Reference	Title
AECOM. (2013).	*Revegetation Planning Report.* Brisbane : AECOM.
AECOM. (2013).	*Blair Athol Micro-habitat Planning Report* . Brisbane : AECOM.
Rio Tinto. (2016).	*Blair Athol Coal Mine - Rehabilitation Monitoring Program* . Brisbane : WSP Parsons Brinckerhoff.
Rio Tinto. (2016).	*Blair Athol Coal Mine Rehabilitation Status Review 2016.* Brisbane: WSP Parsons Brinckerhoff.
SGME. (2023).	*Soil and capping material assessment*, prepared for TerraCom Limited by SGM Environmental Pty Limited.
WSP. (2017).	*Blair Athol Coal Mine Rehabilitation Monitoring Report* . Brisbane: WSP.
WSP Parsons Brinckerhoff . (2016).	*Blair Athol Coal Mine Rehabilitation Monitoring Report.* Brisbane : WSP Parsons Brinckerhoff.

5.4 Document Version and History

Only the history of the current version is recorded below. For prior version histories, please contact the site Document Controller.

Version	Date	Change Details
A	23/10/2020	Draft (WSP Pty Limited)

Version	Date	Change Details
B	28/10/2020	Final (WSP Pty Limited)
C	26/08/2025	Revision (SGME Pty Limited) – converted to TerraCom Document

6 INTRODUCTION AND BACKGROUND

This updated Blair Athol Coal Mine (BAC) Rehabilitation Management Plan (RMP) has been prepared for TerraCom Ltd (TerraCom), in accordance with condition F12 of the existing EA EPML00876713 issued 11 June 2025, as presented in Appendix A. This updated RMP includes specific details for guiding ongoing progressive rehabilitation and rehabilitation monitoring across the mine site.

TerraCom acquired BAC through its wholly owned subsidiary Orion Mining Limited in May 2017, following grant of Title Transfer from the Queensland Government.

The acquisition of the BAC brings with it the following benefits:

1 Progressive rehabilitation of one of Queensland's oldest coal mines.

2 Resumption of coal mining, and local and export sales from BAC, providing local, state, and federal economies with increased economic activity, employment, royalties, and taxation.

3 Forecast positive cash flow through a low overhead structure and operational efficiencies.

Since acquiring BAC, TerraCom have been undertaking ongoing progressive rehabilitation and rehabilitation monitoring at the mine in accordance with the previous Rehabilitation Management Plan (WSP 2018) and the Blair Athol Coal Mine Rehabilitation Monitoring Program (Rio Tinto 2016).

More specifically, since acquiring BAC, TerraCom have progressively rehabilitated the following areas:

- 2017/2018 – 51.5 ha (Area 53)
- 2019 – 37.3ha (Tailings Storage Facility).

In addition to undertaking progressive rehabilitation at the mine, TerraCom have also undertaken a 5.4 ha ProGanics direct seeding trial into mine spoil to determine the potential for achieving progressive rehabilitation directly into mine spoil in the absence of available topsoil or to support the strip spoil / soil rehabilitation method. If successful, using ProGanics Biotic Soil Media may be an efficient alternative method in the absence of sufficient topsoil, or to increase the rehabilitation success where the strip spoil / soil rehabilitation method is also used.

Additional rehabilitation studies have been undertaken by TerraCom, the results thereof are included in this update to the RMP, including:

- Blair Athol Coal Mine Growth Media Mitigation & Management Strategy (GMMM Strategy) (TerraCom 2017)
- Investigation of plant species naturally regenerating in spoil at Blair Athol Coal Mine (WSP 2018).

7 LEGISLATIVE CONTEXT

The Queensland *Environmental Protection Act 1994* (EP Act) is the key legislation for environmental management and protection in Queensland. The EP Act establishes a general environmental duty and a duty to notify environmental harm that applies to all persons and corporations.

Organisations carrying out mining activities in Queensland are legally obligated to rehabilitate the land. The EP Act requires that all areas disturbed within the relevant mining tenure must be rehabilitated to a post-mining land use (PMLU) or managed as a non-use management area (NUMA). Any undisturbed land within the relevant mining tenure must also be identified as a PMLU. NUMAs will only be considered appropriate were justified under section 126D (2) of the EP Act.

Since the preparation of the previous RMP (WSP 2018), the Queensland Government has delivered a broad package of legislative reforms to the mining sector associated with progressive rehabilitation and closure planning (PRCPs) and financial assurance. A key element of this reform package is the *Mineral and Energy Resources (Financial Provisioning) Act 2018* (MERFP Act). Passed by Parliament on 30 November 2018, the MERFP Act:

1. replaces the financial assurance arrangements for resource activities under the EP Act with a new financial provisioning scheme
2. changes how the estimated rehabilitation cost for an EA is calculated
3. amends the EP Act to introduce new requirements for the progressive rehabilitation and closure plans (PRCP) of mined land.

A PRCP is a critical element of these reforms. The MERFP Act includes transitional provisions for the application of the PRCP requirement concerning existing mines. Holders of an existing EA, such as TerraCom, for a mining activity relating to a mining lease approved through a site-specific application, will be issued with a notice from the administering authority within the first three years following the PRCP start date. The notice will specify a date by which a PRCP must be developed and submitted to the Department of Environment, Tourism, Science and Innovation (DETSI), as the administering authority, for assessment and approval.

Table 1 outlines the information requirements described in *Guideline: Progressive rehabilitation and closure plan* (the PRC plan guideline) for rehabilitation monitoring and maintenance, and where it has been addressed within this plan.

Table 1: Relationship to information requirements

Information requirements	Reference
Schedule of monitoring, reporting and review for each milestone	Section 11.3
Description of methodologies and standards, which could include field-based assessments and the application of new remote sensing, GIS and other relevant emerging technologies	Section 11.3
Monitoring that enables the repeatable collection of relevant statistically valid data	Section 11.3
Monitoring using appropriate quality assurance and data management processes and systems	Section 11.3
Regular analysis of site data including multi-year comparison trends and bench-marking against analogue/reference sites	Section 11.3.1.3
Contingency strategies if monitoring data indicates milestone criteria are not being met	Section 12.3.1.1
Post-closure monitoring to ensure milestone criteria has been demonstrated	Section 11.3 and Section 11.4

Information requirements	Reference
Intent of monitoring reports, such as provision of results and key findings	Section11.3.1.3

This updated RMP has been prepared in accordance with condition F8 of the existing EA issued 11 June 2025, as presented in Appendix A. In addition, this updated RMP provides detailed information that can also be used to assist TerraCom in the preparation of a transitional PRCP for BAC, however this RMP does not constitute a PRCP or PRCP schedule under the EP Act.

7.1 Blair Athol Coal Mine Environmental Authority

The BAC mine currently operates under EA EPML00876713, issued 11 June 2025, by the administering authority under the EP Act (Appendix A).

This updated RMP has been developed to provide an ongoing strategy and management framework for site rehabilitation work and has been developed to meet the legislative requirements under the EA. The EA conditions that have informed the content of this plan include:

F4 Rehabilitation landform criteria:

Unless otherwise permitted under the conditions of this environmental authority, all areas significantly disturbed by mining activities must be rehabilitated in accordance with Table F1 - Rehabilitation Requirements and as detailed in the Rehabilitation Management Plan described in condition F10.F8 Rehabilitation Management Plan

A Rehabilitation Management Plan developed by an appropriately qualified person must be implemented for all mining activities and reviewed and updated by 30 June every two (2) years. F9 At a minimum the Rehabilitation Management Plan must include:

a) map existing areas of rehabilitation including classification of stage (i.e. time since establishment) and quality

b) a strategy for progressive rehabilitation

c) detail the design objectives for rehabilitation of each domain to achieve rehabilitation success criteria and the identified post mining land uses

d) specify spoil characteristics, soil analysis, soil separation for use on rehabilitation

e) specify the topsoil requirements for the site and provide details of how topsoil will be managed for use in rehabilitation

f) detail any topsoil deficit and how any deficit will be managed for successful rehabilitation, including, if applicable, the proposal of surrogate growth media

g) detail rehabilitation methods applied to areas

h) detail landform design including end of mine design

i) detail how landform design will be consistent with surrounding topography

j) identify and detail planned native vegetation rehabilitation areas and corridors

k) identify at least a minimum of three (3) reference sites for use in rehabilitation monitoring

l) describe rehabilitation indicators and how these will be monitored

m) describe management actions to address unsuccessful rehabilitation or redesign; and

n) describe end of mine landform design planning and post mining land uses across the mine; and include a triple bottom line assessment (or a comparative alternative assessment method) of the proposed final landform design criteria and alternatives.

8 REHABILITATION STRATEGY

8.1 EA requirements

The EA conditions F9a – F9b requires TerraCom to plan for the following in relation to rehabilitation strategy:

- F9a: Map existing areas of rehabilitation including classification of stage (i.e. time since establishment) and quality
- F9b: A strategy for progressive rehabilitation.

These specific requirements have informed the requirements of the rehabilitation strategy for progressive rehabilitation across BAC.

8.2 Rehabilitation strategy

Rio Tinto operated BAC from 1984 until 2012 when the site was put into care and maintenance until TerraCom took over ownership in 2017 and undertook significant progressive rehabilitation in accordance with the previous EA EPML00876713 (EA 2015), the last of which was completed in 2010 with existing areas of rehabilitation including classification of staged year on year work (i.e. time since establishment), as shown on Figure 1. During the period, 1984 to present, a variety of rehabilitation methods (seeding, ground preparation, fertiliser, etc.) and rehabilitation monitoring techniques have been employed. The varying methods, along with other influential factors including terrain, soil characteristics and climate, have resulted in rehabilitation in variable conditions and stages of progressive development.

Rio Tinto mining operations ceased in November 2012, from which time the focus of site activities was keeping the operation in compliance with all respective legislation and generally in a safe, stable, and secure state. In September 2016, Rio Tinto undertook a review of the status of all areas of existing rehabilitation across the mine (Rio Tinto , 2016), to determine its status against the rehabilitation criteria within Rio Tinto's EA (EA 2015). Under Rio Tinto's EA (EA 2015) it was required that all areas significantly disturbed by mining activities, excluding residual voids and infrastructure areas, must be rehabilitated to a stable landform with a self-sustaining vegetation cover. This strategy is commensurate with a post mining land use (PMLU) associated with the development of grazing pasture and native ecosystems.

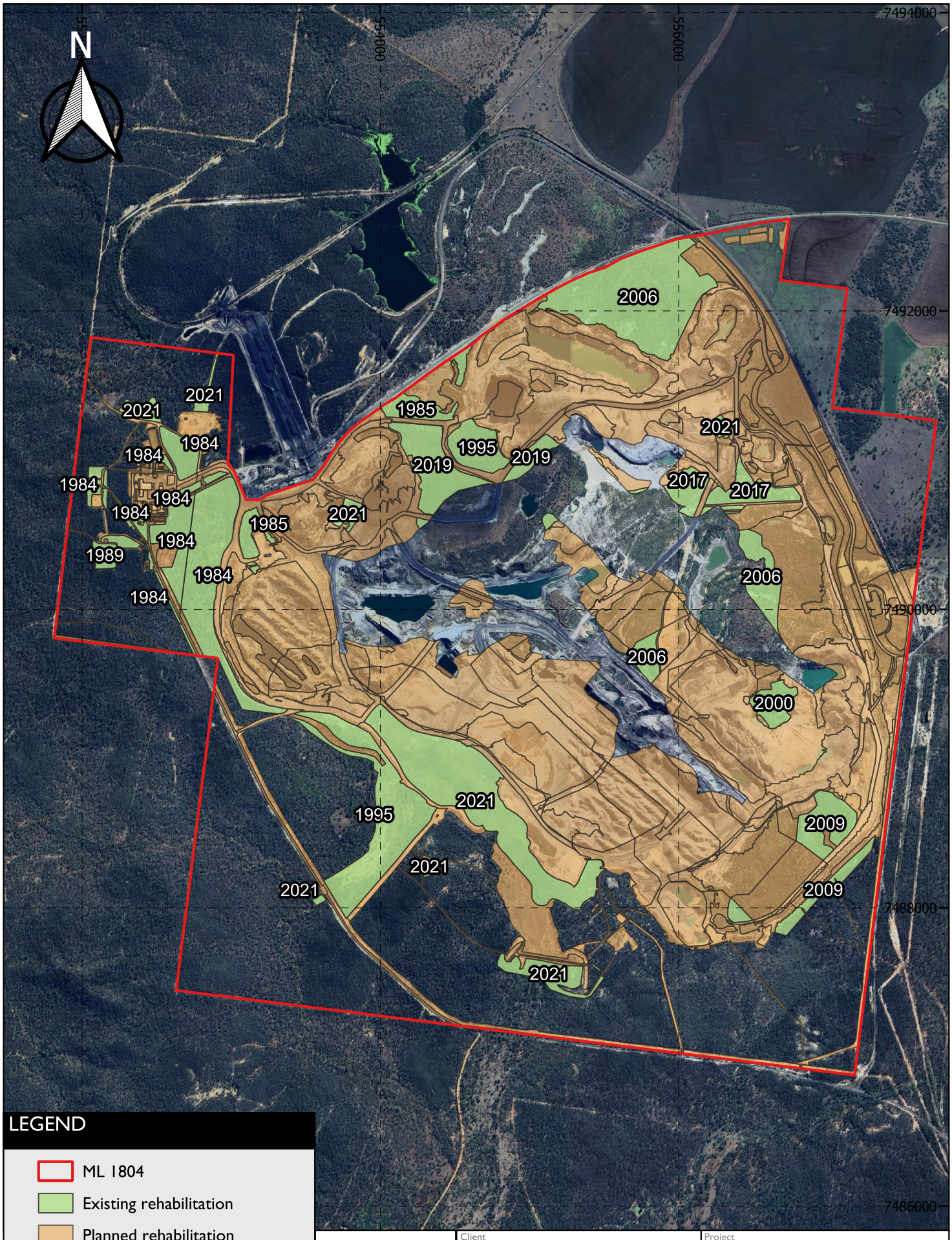
Since acquiring BAC on 31 May 2017, TerraCom have continued with the strategy of rehabilitating all post mining landform domains at BAC, excluding residual voids[1] and infrastructure areas, to a stable landform with a self-sustaining vegetation cover. This strategy is also in accordance with Table F1 of the current EA, whereby it is the goal that all areas disturbed by mining activities will be rehabilitated in a manner that ensures it is:

- safe for humans and wildlife
- stable
- able to sustain vegetation; and
- non-polluting.

To achieve this strategy, the post mining rehabilitation domains have been classified into broader landform units based on surrounding landform geomorphology, soil, and spoil types, and surrounding

[1] Residual voids are discussed in the Blair Athol Coal Mine Residual Void Management Plan (Terracom 2025)

broad vegetation communities. The goals and objectives for rehabilitation domains at BAC are further discussed in Section 4.



LEGEND

- ML 1804
- Existing rehabilitation
- Planned rehabilitation

Scale 1 : 17 500

0 0.5 1 km

SGME

Client: TerraCom Limited	Project: Rehabilitation Management Plan
Design: SGME Pty Limited 04.09.2025 Scale: 1 : 17,500 CRS: GDA2020	Title: Existing rehabilitation Figure: 1

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

9 REHABILITATION AREAS AND OBJECTIVES

9.1 EA requirements

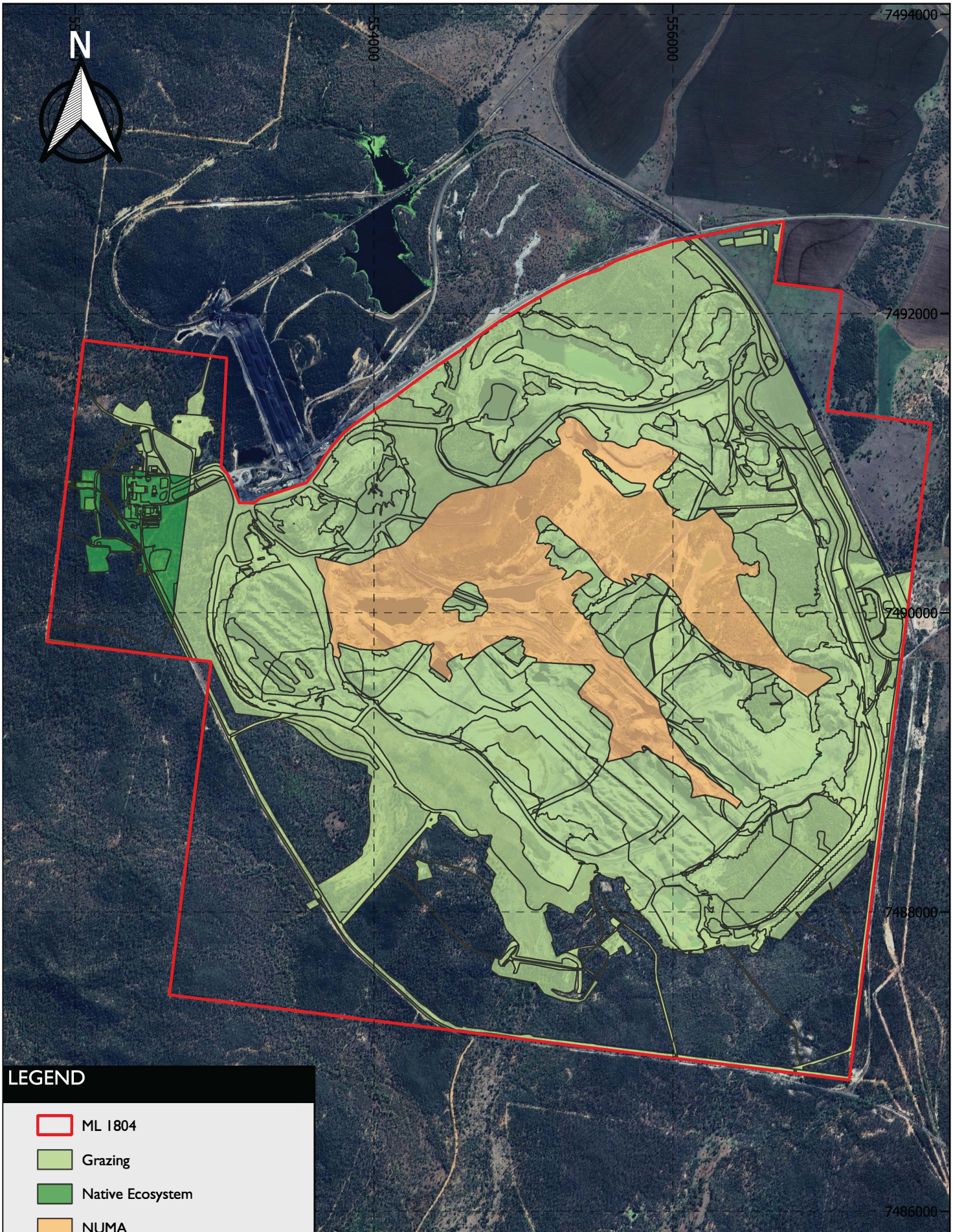
The EA conditions F9c – F9f requires TerraCom to plan for the following in relation to each rehabilitation domain:

- F9c: detail the design objectives for rehabilitation of each domain to achieve rehabilitation success criteria and the identified post mining land uses
- F9d: specify spoil characteristics, soil analysis, soil separation for use on rehabilitation
- F9e: specify the topsoil requirements for the site and provide details of how topsoil will be managed for use in rehabilitation
- F9f: detail any topsoil deficit and how any deficit will be managed for successful rehabilitation, including, if applicable, the proposal of surrogate growth media.

9.2 Rehabilitation goals and action plans

The final land use objective for each rehabilitation area is to reinstate disturbed land (excluding the residual void which is classified as a NUMA) to a PMLU of light grazing or native ecosystem. PMLUs and NUMAs identified in the final site design is in Figure 2. Relevant activities have been divided into the following rehabilitation areas, each with a common rehabilitation methodology and PMLU (Figure 3):

- IA1 — Residual void
- RA1 — Dump
- RA2 — TSF
- RA3 — CHPP
- RA4 — Infrastructure
- RA5 — Rail infrastructure
- RA6 — Road infrastructure
- RA7 — Water management
- RA8 — Existing rehabilitation (grazing)
- RA9 — Cleared area
- RA10 — Native ecosystem
- RA11 — Existing rehabilitation (native ecosystem)
- RA12 — Diversions.



LEGEND

- ML 1804
- Grazing
- Native Ecosystem
- NUMA

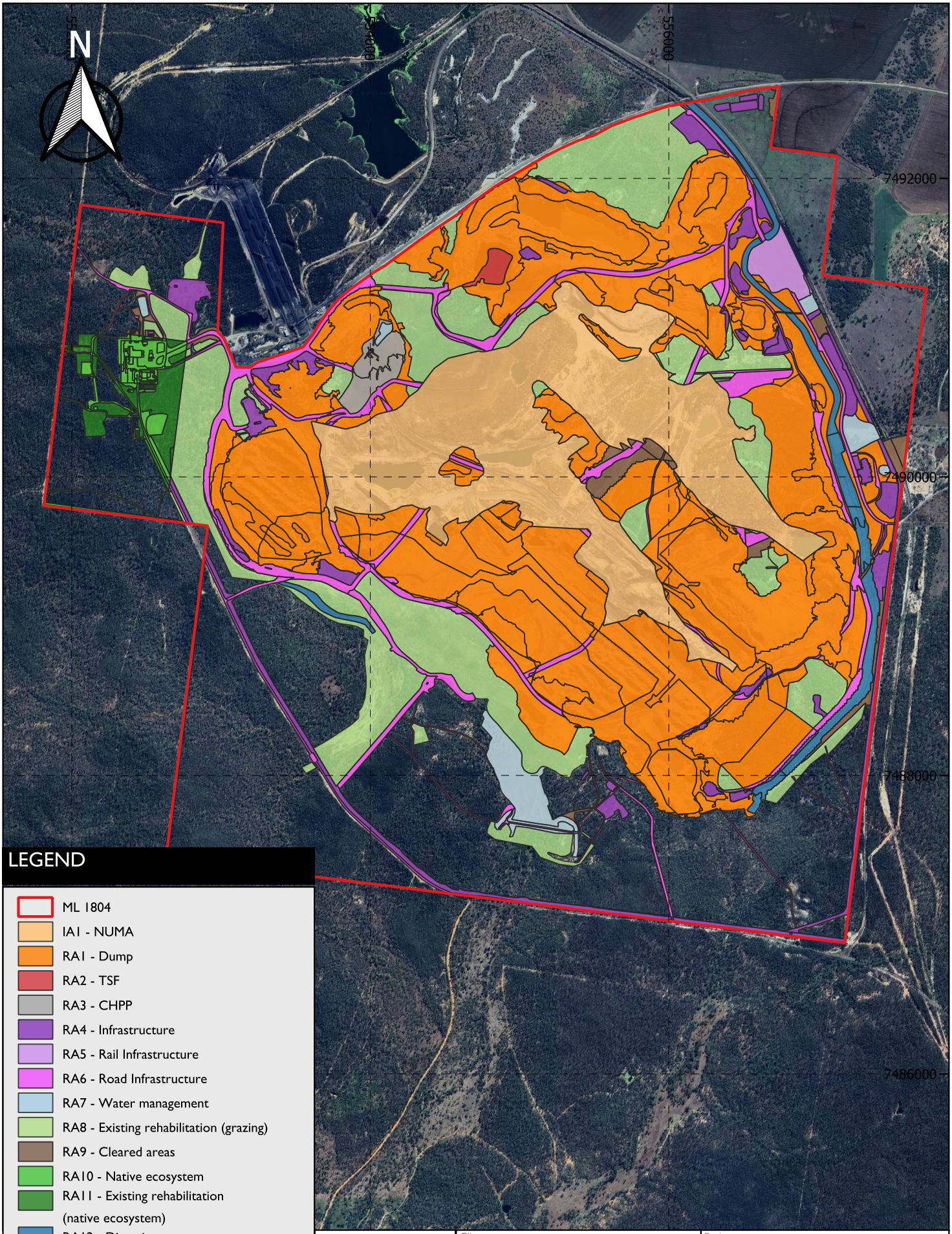
Scale 1 : 17 500

0 0.5 1 km

SGME

Client: TerraCom Limited		Project: Rehabilitation Management Plan	
Design: SGME Pty Limited 04.09.2025 Scale: 1 : 17,500 CRS: GDA2020		Title: PMLU	Figure: 2

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.



LEGEND

- ML 1804
- IA1 - NUMA
- RA1 - Dump
- RA2 - TSF
- RA3 - CHPP
- RA4 - Infrastructure
- RA5 - Rail Infrastructure
- RA6 - Road Infrastructure
- RA7 - Water management
- RA8 - Existing rehabilitation (grazing)
- RA9 - Cleared areas
- RA10 - Native ecosystem
- RA11 - Existing rehabilitation (native ecosystem)
- RA12 - Diversions

Scale 1 : 17 500

0 0.5 1 km

SGME

Client: TerraCom Limited	Project: Rehabilitation Management Plan
Design: SGME Pty Limited 04.09.2025 Scale: 1 : 17,500 CRS: GDA2020	Title: Rehabilitation areas Figure: 3

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

In 2013, Rio Tinto commissioned the development of a Revegetation Planning Report (RPR) for the mine that provided specific rehabilitation action plans for each rehabilitation domain including revegetation methods and species lists (AECOM , 2013).

In 2018 TerraCom commissioned an investigation of plant species naturally regenerating in spoil at Blair Athol Coal Mine (WSP 2018) to be used in updating the planned species mixes for each of the spoil types used in respective rehabilitation domains (WSP 2018). A Blair Athol Coal Mine Revegetation Plan (SGME 2025), in conjunction with the RMP, provides revegetation strategies for the intended PMLUs. The final land use objectives of each rehabilitation area are presented in Table 2.

Table 2: Rehabilitation area revegetation action plan

Rehabilitation area	Revegetation methods	Management actions
RA1 – Dump	• Gypsum up to 10 t/ha • Topsoil • Ripping and seeding • Seeding, season and volume to be determined.	• Focus on establishing a stable vegetated surface • Site provides biodiversity linkage for ground dwelling fauna • Weed control to be undertaken seasonally to mitigate risk of high density and distribution on areas, which are inaccessible due to safety aspects.
RA2 — TSF	• Gypsum up to 10 t/ha • Topsoil • Direct seeding inclusive of cover crop.	• Focus on establishing a stable vegetated surface • Site provides biodiversity linkage for ground dwelling fauna.
RA3 — CHPP	• Gypsum up to 10 t/ha • Topsoil • Ripping and seeding • Seeding, season and volume to be determined.	• Focus on establishing a stable vegetated surface • Site provides biodiversity linkage for ground dwelling fauna • Weed control to be undertaken seasonally to mitigate risk of high density and distribution on areas, which are inaccessible due to safety aspects.
RA4 — Infrastructure	• Gypsum up to 10 t/ha • Topsoil	• Focus on establishing a stable vegetated surface

Rehabilitation area	Revegetation methods	Management actions
	• Ripping and seeding • Seeding, season and volume to be determined.	• Site provides biodiversity linkage for ground dwelling fauna • Weed control to be undertaken seasonally to mitigate risk of high density and distribution on areas, which are inaccessible due to safety aspects.
RA5 — Rail infrastructure	• Gypsum up to 10 t/ha • Topsoil • Ripping and seeding • Seeding, season and volume to be determined.	• Focus on establishing a stable vegetated surface • Site provides biodiversity linkage for ground dwelling fauna • Weed control to be undertaken seasonally to mitigate risk of high density and distribution on areas, which are inaccessible due to safety aspects.
RA6 — Road infrastructure	• Gypsum up to 10 t/ha • Topsoil • Ripping and seeding • Seeding, season and volume to be determined.	• Focus on establishing a stable vegetated surface • Site provides biodiversity linkage for ground dwelling fauna • Weed control to be undertaken seasonally to mitigate risk of high density and distribution on areas, which are inaccessible due to safety aspects.
RA7 — Water management	• Gypsum up to 10 t/ha • Topsoil • Ripping and seeding • Seeding, season and volume to be determined.	• Focus on establishing a stable vegetated surface • Site provides biodiversity linkage for ground dwelling fauna • Weed control to be undertaken seasonally to

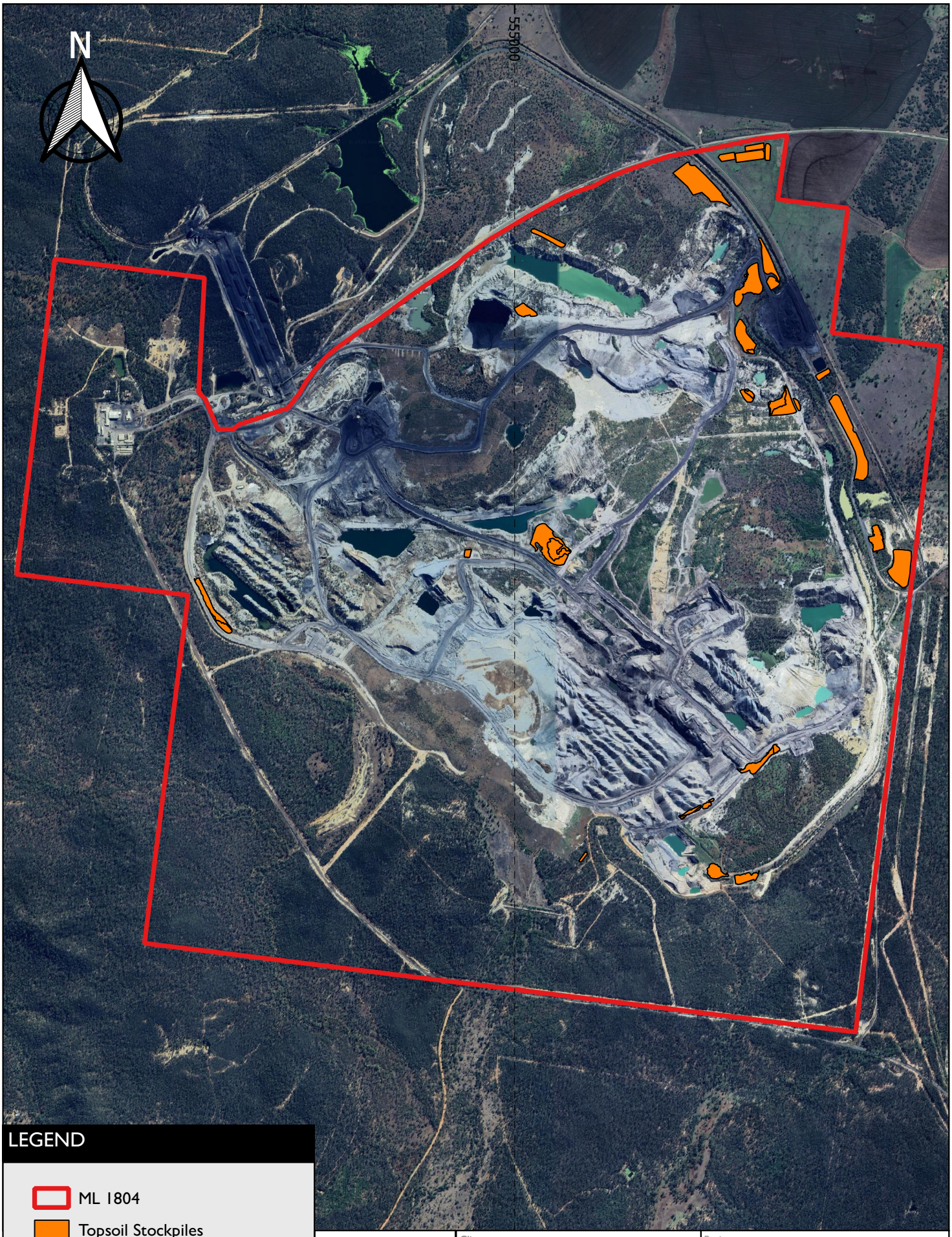
Rehabilitation area	Revegetation methods	Management actions
		mitigate risk of high density and distribution on areas, which are inaccessible due to safety aspects.
RA8 — Existing rehabilitation (grazing)	• Assessment to determine if revegetation is required.	• Focus on establishing a stable vegetated surface • Site provides biodiversity linkage for ground dwelling fauna • Weed control to be undertaken seasonally to mitigate risk of high density and distribution on areas, which are inaccessible due to safety aspects.
RA9 — Cleared area	• Gypsum up to 10 t/ha • Topsoil • Ripping and seeding • Seeding, season and volume to be determined.	• Focus on establishing a stable vegetated surface • Site provides biodiversity linkage for ground dwelling fauna • Weed control to be undertaken seasonally to mitigate risk of high density and distribution on areas, which are inaccessible due to safety aspects.
RA10 – Native ecosystem	• Gypsum up to 10 t/ha • Topsoil • Ripping and seeding • Seeding, season and volume to be determined.	• Focus on establishing a stable vegetated surface which is free of listed weed species. • Site provides native ecosystem linkage along eastern side of mine site.
RA11 — Existing rehabilitation (native ecosystem)	• Assessment to determine if revegetation is required.	• Assessment of fuel loads to mitigate risk of fire spreading from these areas.

Rehabilitation area	Revegetation methods	Management actions
		• Weed control to be undertaken seasonally to mitigate risk of high density and distribution on areas which are inaccessible due to safety aspects. • Focus on establishing a stable vegetated surface which is free of listed weed species. • Site provides native ecosystem linkage along eastern side of mine site.
RA12 — Diversions	• Gypsum up to 10 t/ha • Topsoil • Ripping and seeding • Seeding, season and volume to be determined.	• Focus on establishing a stable vegetated surface • Site provides biodiversity linkage for ground dwelling fauna • Weed control to be undertaken seasonally to mitigate risk of high density and distribution on areas, which are inaccessible due to safety aspects.

Further discussion on rehabilitation landform objectives is provided in Section 5.

9.3 Topsoil and growth media management

Growing media refers to the soil / subsoil material in which plants grow, and upon which the revegetation program is based. The Blair Athol operation recognised early on that the historical activities in the region had impacted the soil reserves for re-use in rehabilitation activities. The short-term topsoil stockpile domains at BAC are illustrated in Figure 4.



SGME	Client: TerraCom Limited	Project: Rehabilitation Management Plan	
	Design: SGME Pty Limited 4.09.2025 Scale: 1 : 17,500 CRS: GDA2020	Title: Topsoil Stockpiles	Figure: 4

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

To address the long-term requirements for topsoil, in 2017, shortly after acquiring the mine, TerraCom commissioned the Blair Athol Coal Mine Growth Media Mitigation & Management Strategy (GMMM Strategy) (TerraCom 2017). The purpose of the GMMM Strategy was twofold:

1. to enable the successful rehabilitation of Blair Athol within the budgeted financial assurance
2. to develop a growing media strategy to effectively utilise the required amount of topsoil to support ongoing progressive rehabilitation at BAC.

Topsoil stockpile report have been evaluated and amalgamated in a 2024 soil and capping material assessment report by SGME. As part of the development of the strategy, TerraCom engaged Seam Surveys Pty Ltd (August 2016) to survey and report on the current volumes of topsoil on the mine. The results of this assessment determined the final volume of topsoil at the site in 2017 totalled 1,060,994 m3 (TerraCom 2017).

To enable the existing topsoil reserves to be utilised effectively, to enable successful progressive rehabilitation of the mine, several mitigation and management measures were assessed as part of the GMMM Strategy, these included (TerraCom 2017):

1. Effectively use the remaining topsoil resources in the elevated risk zones (predominately mined areas).
2. Manage the depth of topsoil application to the original prescribed depth of 0.1m to 0.15m.
3. Ration defined areas to strip placement of topsoil – a beneficial process that reduces competition between grass species (sown into topsoil) and the tree and shrubs that are sown into bare spoil.
4. Applying ameliorants to overburden (i.e. gypsum) that improves its physical and chemical properties along with specific fertiliser types and rates.
5. Undertake trial onsite that shows satisfactory germination and survival from direct seeding into overburden.
6. Utilise specific treatments for the complex remediation projects (i.e. hydro-mulch) the diversion upgrade and tailings capping.
7. Review importation of organic complexes to enhance topsoil properties and as a potential standalone solution.

The results of the GMMM Strategy in combination with SGME topsoil accounting are summarised in Table 3. The results indicate that using a combination ameliorants and strip placement of topsoil will be required to enable progressive rehabilitation. Therefore, further assessments of spoil quality and quantity will be needed to determine the feasibility of replacing some of the soil deficit with spoil.

Table 3: Blair Athol Coal Mine Growth Media Mitigation & Management Strategy Summary Table

Growth median mitigation and management strategy		Placement @ 0.15 m	Strip placement	Hydro-mulch	Direct seed spoil	Not required
Hectares	1,688	784	165.8	17.5	48.6	672.1
Required topsoil (m^3)	1,300,350	1,176,000	124,350			

Growth median mitigation and management strategy		Placement @ 0.15 m	Strip placement	Hydro-mulch	Direct seed spoil	Not required
Available topsoil (m^3)	787,768.78					
Excess / (Deficiency) (m^3)	-512,581.22					

9.4 Soil ameliorants

The following soil ameliorants are discussed to improve succuss of revegetation and landform stability based on the limited availability of topsoil at BAC.

Where spoil is characterised as sodic (i.e. >6% Exchangeable Sodium Percentage (ESP) and/or where implementing the strip / spoil direct seeding method, it is recommended the application of Gypsum is used for sodic alkaline soils and the application of lime is used for acidic sodic soils (TerraCom 2017). The intent of adding gypsum and/or lime is to address the potential sodicity problem with the overburden as well as to support pH correction to reduce any acidic formation (tailings / rejects) (TerraCom 2017).

The rates of Gypsum and/or lime can vary depending on the nature of sodicity in the spoil however up to 10 t/ha may be required. It is recommended that Gypsum is applied via an agricultural spreader to the reshaped spoil then the area is either directly topsoiled or strip / spoiled and incorporated through ripping when seeding.

Additional soil ameliorants that can be considered by TerraCom for increasing both the quantity and quality of topsoil at BAC is the blending or mixing of biosolids or other organics into topsoil prior to spreading. This will increase the organic content of the upper horizon, increasing soil carbon levels, increase soil biology, improve soil structure, and enhance moisture holding capacity (TerraCom 2017).

10 REHABILITATION LANDFORM OBJECTIVES

10.1 EA requirements

The EA conditions F9g – F9j requires TerraCom to plan for the following in relation to rehabilitation landforms:

- F9g: detail rehabilitation methods applied to areas
- F9h: detail landform design including end of mine design
- F9i: detail how landform design will be consistent with surrounding topography
- F9j: identify and detail planned native vegetation rehabilitation areas and corridors.

10.2 Rehabilitation methods

All land available for progressive rehabilitation is rehabilitated with native grass, shrub, and tree species, as per the commitments made throughout the life of the mining activities at BAC. The aim of

the rehabilitation is to re-establish a native ecosystem on the mining leases after mining operations cease. This is achieved by the following rehabilitation methods:

1. Re-profiling of the angle of repose dragline spoil piles (overburden) remaining after the completion of the strip-mining process.
2. Overburden spoil piles are re-profiled to be stable against erosion and suitable for the re-establishment of native species and vegetation communities.
3. Water control structures are established where required depending on the landform.
4. Overburden is treated with gypsum or lime as required.
5. Prior to seeding, topsoil is replaced over the re-profiled spoil to a depth of at least 10-15cm (either directly or as per strip / spoil method).
6. The area is deep ripped by a dozer and seeded using native grasses, shrubs, and trees to establish rehabilitated vegetation communities and habitats that are:
    a) safe for humans and wildlife
    b) stable
    c) able to sustain vegetation; and
    d) non-polluting.

The BAC rehabilitation process is primarily a four-pass system with initial reshaping of spoil to the surrounding landform and appropriate rehabilitation domain, the addition of gypsum if required, topsoiling, ripping and seeding. Post rehabilitation, this process is supported by follow up monitoring and maintenance as illustrated in Figure 5.



Figure 5: Blair Athol Coal Mine Rehabilitation Work Flow

10.3 Landform design objectives

Environmental Authority Table F1 (refer to Appendix A) requires that all rehabilitated landform slope angles are not to exceed 15 percent, for both light grazing and native ecosystem PMLU's. All rehabilitation is therefore planned to conform within this parameter and is monitored via the use of LiDAR.

The rehabilitation areas (refer Figure 3) have been designed to mimic the landforms and broad vegetation types of the landscape surrounding the mine. In the first instance, landforms are generally created by the dragline, which are then reshaped using dozers to merge into the surrounding landforms. Depending on the type of spoil being rehabilitated, and the availability of topsoil, landforms are shaped into the desired rehabilitation domains.

Figure 6, Figure 7, and Figure 8 show slope percentages of rehabilitated areas from the 2023 current landform surface.



SGME	Client: TerraCom Limited	Project: Rehabilitation Management Plan	
	Design: SGME Pty Limited 04.09.2025 Scale: 1 : 7,500 CRS: GDA2020	Title: Slope	Figure: 6

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.



SGME	Client: TerraCom Limited	Project: Rehabilitation Management Plan	
	Design: SGME Pty Limited 04.09.2025 Scale: 1 : 7,500 CRS: GDA2020	Title: Slope	Figure: 7

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.



SGME	Client: TerraCom Limited	Project: Rehabilitation Management Plan	
	Design: SGME Pty Limited 04.09.2025 Scale: 1 : 7,500 CRS: GDA2020	Title: Slope	Figure: 8

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

11 REHABILITATION MONITORING

11.1 EA requirements

The EA conditions F9k – F9l requires TerraCom to plan for the following in relation to rehabilitation landforms:

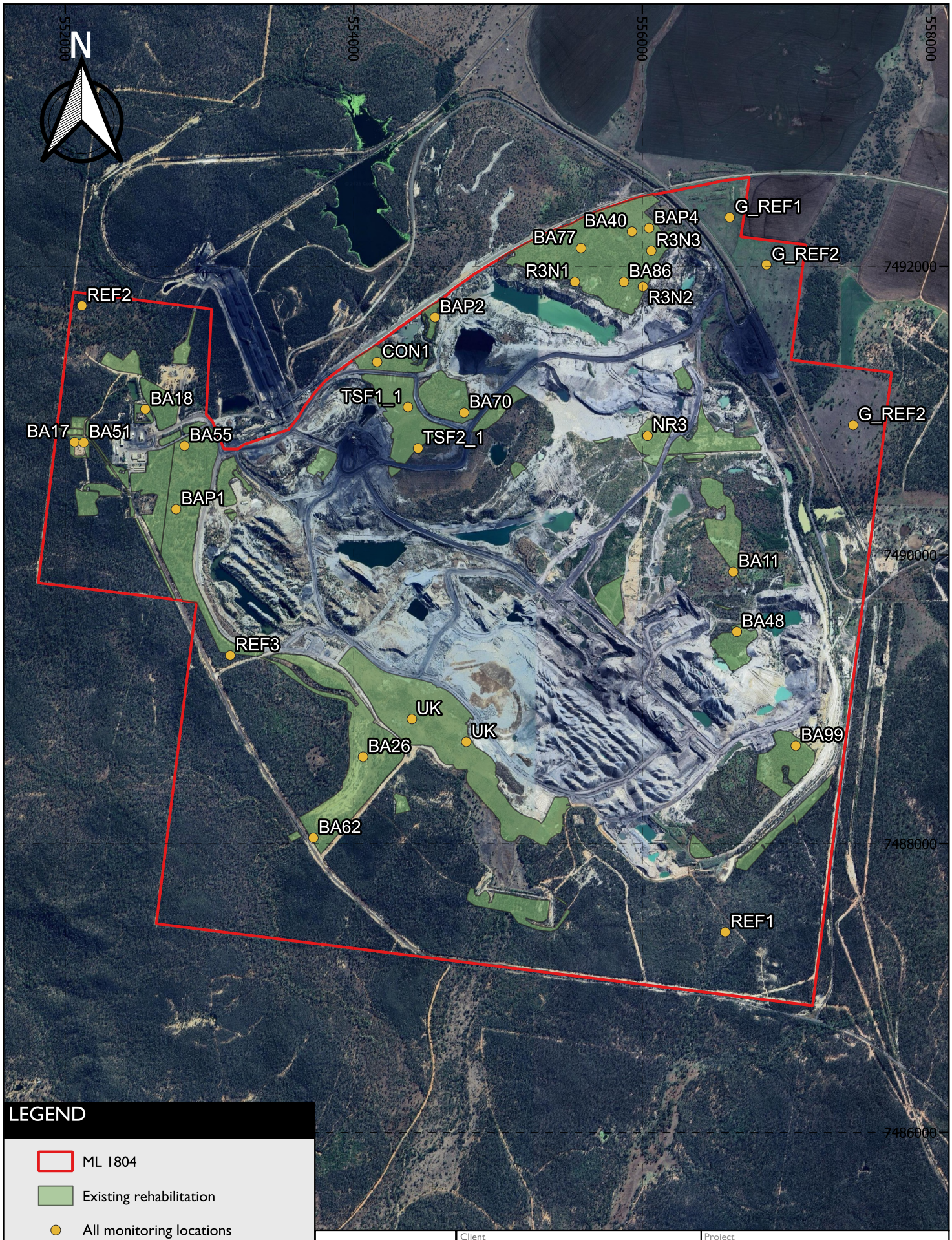
- F9k: identify at least a minimum of three (3) reference sites for use in rehabilitation monitoring
- F9l: describe rehabilitation indicators and how these will be monitored.

11.2 Rehabilitation monitoring

The current status review (Rio Tinto, 2016) noted that rehabilitation monitoring at BAC that had been undertaken from 1995 to 2012. The review noted the methods employed by the various monitoring teams differed and were not able to be directly cross referenced to assess the performance of the rehabilitation, as it related to the historic EA (2015) criteria.

To address this inconsistency, and to progress the monitoring program to include more modern standards, a revised rehabilitation monitoring program was developed by Rio Tinto for BAC in 2016. The revised Blair Athol Rehabilitation Monitoring Program (Rio Tinto 2016) introduced a strategic approach to monitoring the performance of rehabilitation using a combination of remote sensing and field survey methods. TerraCom have committed to conducting ongoing rehabilitation monitoring and performic assessments on an annual basis since acquiring the mine in accordance with the Blair Athol Rehabilitation Monitoring Program (Rio Tinto 2016).

The location of existing and planned rehabilitation monitoring sites at BAC is presented on Figure 9. In accordance with the methods outlined in the Blair Athol Rehabilitation Monitoring Program (Rio Tinto, 2016), sites are monitored for the following years post rehabilitation – years 1, 2, and 5, then every 5 years from there on (year 10, 15 and so on).



LEGEND

- ML 1804
- Existing rehabilitation
- All monitoring locations

Scale 1 : 17 500

0 0.5 1 km

	Client: TerraCom Limited	Project: Rehabilitation Management Plan	
	Design: SGME Pty Limited 04.09.2025 Scale: 1 : 17,500 CRS: GDA2020	Title: Monitoring locations	Figure: 9

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

11.3 Monitoring methods

11.3.1.1 Reference sites

The current EA (condition F9k) requires at least three reference sites be established to understand the progression and ongoing performance of rehabilitation at the mine (Appendix A). These reference sites are required for comparative analysis against newly rehabilitated sites, established after May 2017.

The EA states that:

> *"a reference site (or analogue site) may reflect the original location, adjacent area or another area where rehabilitation success has been completed for a similar biodiversity. Details of the reference site may be as photographs, computer generated images and vegetation models etc."*

In accordance with the EA, three native vegetation reference transects have been established at BAC since 2018 adjacent to the active mining areas within representative undisturbed vegetation communities within the mining lease (Appendix A). The reference sites are consistent with Regional Ecosystem 11.11.1 (*Eucalyptus crebra* +/- *Acacia rhodoxylon* woodland on old sedimentary rocks with varying degrees of metamorphism and folding).

Reference sites were selected within this regional ecosystem as it is a highly variable ecosystem, which represents a biodiversity PMLU (native ecosystems), and is representative of the natural vegetation communities near the Mine.

Reference sites were selected within this regional ecosystem as it is a highly variable ecosystem, which represents a biodiversity PMLU (native ecosystems), and is representative of the broad vegetation communities surrounding the site.

Three proposed reference sites have been selected for a grazing PMLU (refer to Figure 9). Rehabilitation monitoring will need to be completed on these sites to establish a baseline condition and confirm suitability.

Results of the reference sites will be included in the rehabilitation monitoring program to assist in assessing the trajectory of existing and future rehabilitation towards a self-sustaining ecosystem that supports a target biodiversity outcome.

11.3.1.2 Data collection and analysis

Permanent vegetation monitoring transects of 50 m in length and 10 m in width are used to measure and record species richness and relative abundance, canopy height and cover, groundcover and weed presence. Where applicable, the monitoring results are compared to the minimum requirements in the EA.

- slope stability
- presence of active gully erosion
- stable or stabilising gullies
- groundcover abundance as percentage cover
- native shrub abundance as stems per hectare (stems/ha)
- native tree diversity
- native tree abundance on rigid soils and cracking clay soils as stems/ha
- performance trajectory based on the state and transitional age.

LiDAR, and other spatial information and aerial imagery, may also be used within a desktop component of monitoring to:

- identify potential sites for landform and erosion monitoring
- generate an elevation slope model to assess landform design
- plan locations of accessible rehabilitation monitoring sites which represent:
  - rehabilitation slope
  - PMLUs of cattle grazing and native ecosystem.

11.3.1.3 Annual monitoring report inclusions

An annual report on monitoring results must be produced which includes:

- descriptions of the methods used
- descriptions and photographs of the monitoring sites
- results of assessments
- comparisons of vegetation to reference sites and statistical analyses
- assessments of chemical, physical and fertility characteristics of the soil
- identification of characteristics which are not consistent with the rehabilitation objectives
- descriptions of trends between soil and vegetation measurements as identified by statistical analyses
- establishment statuses of seed species
- descriptions of management and land use potential
- descriptions and graphical representations of the progression of erosion features
- locations of erosion in relation to rehabilitation
- descriptions and a map of the blocks and transect locations of reference sites and rehabilitation
- recommendations for appropriate management of weeds and erosion.

11.4 Performance criteria

The rehabilitation completion criteria for slope, landform stability and vegetation were historically listed in BAC's Environmental Authority (2015 EA). Separate criteria were prescribed for pre 2003 and post 2003 rigid and cracking clay soils.

Rehabilitation requirements and performance criteria are defined in EA condition Table F1 (Table 4). The results of progressive rehabilitation continue to be assessed against these performance criteria to identify those sites that are indicating successful development towards progressive rehabilitation, and those that require ongoing monitoring, and those that require maintenance or further rework. It is important that each annual rehabilitation monitoring report updates the overall performance areas of rehabilitation to assist in ongoing planning and management of rehabilitation.

Table 4: Rehabilitation requirements

Post mining land use	Mine domain	Goal	Objective	Indicator	Acceptance criteria
Grazing	All areas disturbed by mining activities	Safe for humans and wildlife	Safety hazards in rehabilitation are not significantly different to surrounding unmined land subject to the same land use	Hazard assessment	No significant difference
		Stable	Rehabilitation is geotechnically stable	Factor of safety	≥1.5
			Rehabilitation is erosionally stable	Erosion	No gully erosion
				Slope gradient	Rehabilitated landform: <15% Ramp 3: <30%
				Groundcover	>50%
		Non-polluting	Rainfall runoff from rehabilitation achieves water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
			Deep drainage from rehabilitation achieves relevant water quality	EC	Not significantly different to: (a) the EPP (Water) schedule documents water

Post mining land use	Mine domain	Goal	Objective	Indicator	Acceptance criteria
			objectives for groundwater		quality objectives for relevant groundwater chemistry zones; or (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines
		Able to sustain the agreed post-mining land use	Rehabilitation is suitable for sustainable light grazing	Land suitability assessment for light grazing	Land suitability class ≤3 or not different from pre-mining class if ≥4. *LSA Framework for Open-Cut Coal Mine Rehabilitation 2018 (A rule-set for land suitability assessment beef cattle grazing on land rehabilitated after open-cut coal mine in the Bowen Basin Queensland*) unless otherwise agreed in writing between the administering authority and the environmental authority holder.
Native ecosystem	Areas disturbed by mining activities that are located on State	Safe for humans and wildlife	Construct landforms that do not pose unacceptable hazards to humans, stock and wildlife.	Safety hazards in rehabilitation are not significantly different to surrounding unmined land	Hazard assessment

Post mining land use	Mine domain	Goal	Objective	Indicator	Acceptance criteria
	Forest Land			subject to the same land use	
		Stable	Demonstrate geotechnical stability.	Factor of safety	≥1.5
				Erosion	No gully erosion
			Not exhibiting excessive erosion	Slope gradient	Rehabilitated landform: <15%
				Groundcover	>50%
		Able to sustain vegetation	Rehabilitation landform (including land cover and water) is suitable for providing native ecosystem	Vegetation assessment	A vegetation assessment is completed by an APQ using a methodology as outlined in the Queensland Mine Rehabilitation Commissioner technical paper 'Evaluating methods for assessing native ecosystem mine rehabilitation success' (March 2023).
			Achieve self-sustaining systems that doesn't require additional maintenance except that of surrounding areas (e.g., weed and fire control via grazing/pastoral management etc.).		>70% total cover across rehabilitation area, includes multilevel canopy, groundcover, and leaf litter. At least four native tree or shrub species across the rehabilitation area.

Post mining land use	Mine domain	Goal	Objective	Indicator	Acceptance criteria
					Evidence of recruitment of native tree species over a representative climatic period.
		Non-polluting	Rainfall runoff from rehabilitation achieves water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
			Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: (a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines

11.5 Transitional age

To determine appropriate management actions, it is also important to gain an understanding of the trajectory of each rehabilitation monitoring site as it relates to its state and transitional age, as listed in Table 5. The transitional age is based on a fundamental hierarchy of the development of rehabilitation as it aligns to the transitional continuum towards achieving completion criteria. The Rehabilitation State and Transition model, as shown in Figure 9: Existing and planned monitoring sites, is used to plot transitional age, as it relates to its performance against the rehabilitation hierarchy, and the sites actual rehabilitation age.

The purpose of plotting a site's transitional age against the rehabilitation age, is essential to highlighting if a site is on the trajectory towards achieving the performance criteria, or if a site is perhaps lagging in a transitional stage. If a site is lagging, it may need intervention (i.e. maintenance

or rework) to enable it to improve its trajectory. Ongoing monitoring for sites should be based on the transitional age (refer Table 5) in accordance with the overarching rehabilitation monitoring program (i.e. 1, 2, 5, 10 + years) until progressive certification is achieved.

Table 5: Rehabilitation transitional age indicators

Indicators	Transitional ages (years)
Stability	1
Cover	2
Species Diversity	3
Shrub Abundance	5
Tree Abundance	7

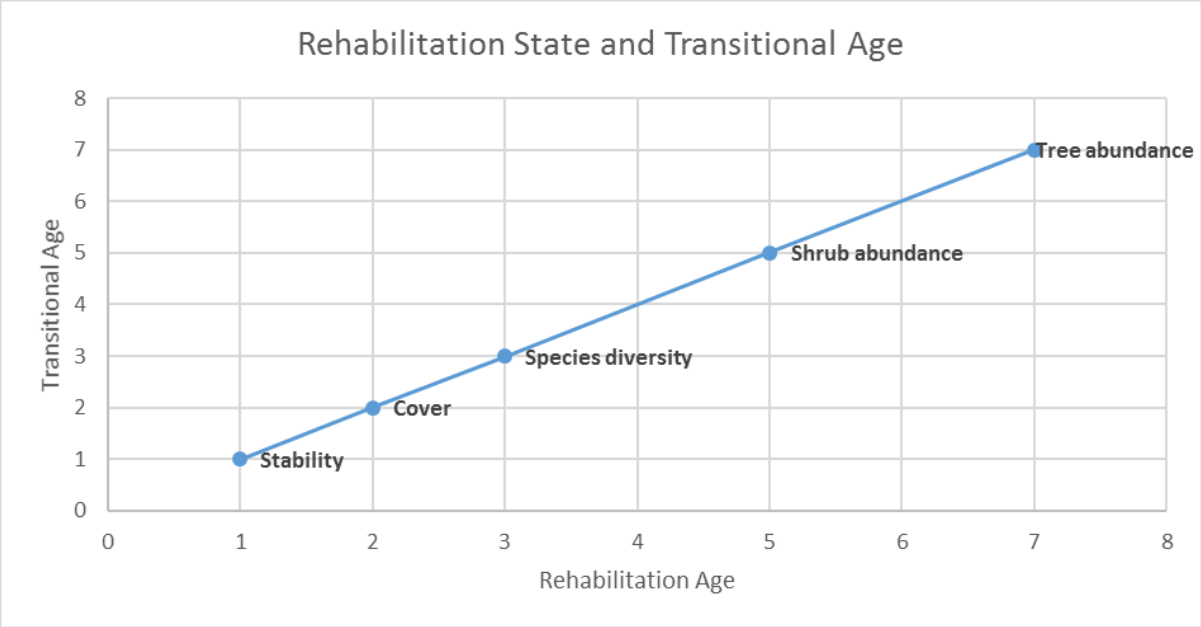


Figure 10: Blair Athol Rehabilitation state and transitional age model

11.6 Gully erosion

Environmental authority Condition F5 requires all successfully rehabilitated land to have no active gully erosion. Furthermore, the EA requires that gully erosion must be assessed by annually documented inspections and gully dimensions must be quantitatively assessed for a minimum of two years both containing a minimum of two rainfall events of more than 25 millimetres in less than three hours.

Gully erosion is to be assessed by an AQP via visual inspections and classified as either active or stabilising. A review of aerial photography and a landform analysis using light detection and ranging

(LiDAR) are to be done to identify differences between locations. Following this assessment, recommendations and management strategies are to be made accordingly.

12 REHABILITATION MANAGEMENT ACTIONS

12.1 EA requirements

The EA conditions F9m – F9n requires TerraCom to plan for the following in relation to rehabilitation management actions:

- F9m: Describe management actions to address unsuccessful rehabilitation or redesign; and
- F9n: Describe end of mine landform design planning and post mining land uses across the mine; and include a triple bottom line assessment (or a comparative alternative assessment method) of the proposed final landform design criteria and alternatives.

12.2 Management actions

12.3 Rehabilitation status

To determine if rework, maintenance, or ongoing monitoring is required for areas of rehabilitation, information is taken from the:

- State and transition model (refer Section 11)
- Gully erosion monitoring (refer Section 11.6)
- Results of annual rehabilitation monitoring – including conformance to rehabilitation milestones (refer Section 11.4)
- Recent spatial data and aerial imagery.

Appropriate recommendations are then provided based on the factors that are limiting a site's development. An example of the types of actions that may be required to manage areas of rehabilitation depending on their status have been provided in Table 6.

Table 6: Rehabilitation Management Actions

Rehabilitation status	Recommended actions
Rework	Major works associated with reshaping landforms and gully remediation
Maintenance	Minor works associated with gully remediation, groundcover maintenance, reseeding and planting
Monitor	Site is on a trajectory towards completion criteria and requires ongoing monitoring
Acceptable	Site meets all performance criteria, recommend progressive certification

12.3.1.1 Maintenance measures

Maintenance measures must be implemented where failures in fulfilling completion criteria occur, such as:

- insufficient drainage;
- insufficient vegetation cover;
- issues with soil fertility and erosive potential;
- occurrence of significant gully erosion;
- erosion control mechanism failure;

- sedimentation; and
- adverse effects from extreme climatic conditions or weather events.

12.4 End of mine landform planning

The end of mine landform planning and post mining land use (PMLU) design objectives for progressive rehabilitation of each mine closure domain, has been revised by TerraCom to be grazing and native ecosystem outcome focused.

Of interest, residual voids will also occur on the site due to the nature of the coal seam (confined basin) and the previous removal of 20–30 metres of coal seam creating a sunken landform. This will create areas that can be classed as non-use management areas (NUMA), although the voids have been shown to be an aquatic habitat refuge and of potential biodiversity value. The Residual Void Management Plan (WSP, 2020), has identified that the water quality of the pit lake(s) to be contained in the residual void domain is likely to be the limiting factor regarding use of residual water bodies for PMLU. The resulting pit lake(s) is likely to exhibit poor water quality over time and is unlikely to be suitable for use as a recreational area or for stock watering and native fauna watering. Although, it has been shown to provide an aquatic habitat refuge for more mobile native fauna species. The final salinity of the pit lake(s) is also likely to be too high to support freshwater fish species but will continue to function as an aquatic habitat refuge.

The presence of a final pit lake with poor water quality in the residual void is unavoidable. Therefore, the preferable land use management strategy is to minimise the area of the residual void and the pit lake, to maximise the amount of rehabilitation for grazing and native ecosystem within the residual void domain – noting that for legacy rehabilitation areas, it may not be possible to reduce the area of the void.

The final mine landform will consist of light grazing and native ecosystem PMLU's, as well as a final void (NUMA) which is identified within the EA (June 2025). The rehabilitation goals and objectives for all rehabilitation areas to be consistent with the four broad rehabilitation goals guided by the rehabilitation objectives, as listed in Table 4.

13 PLAN REVIEW AND UPDATE

The EA condition F8 requires TerraCom to revise and update this Rehabilitation Management Plan:

- The Rehabilitation Management Plan developed by an appropriately qualified person must be implemented for all mining activities and reviewed and updated by 30 June every 2 years.

14 REFERENCES

AECOM . (2013). *Revegetation Planning Report.* Brisbane : AECOM.

AECOM. (2013). *Blair Athol Micro-habitat Planning Report .* Brisbane : AECOM.

Rio Tinto . (2016). *Blair Athol Coal Mine - Rehabilitation Monitoring Program .* Brisbane : WSP Parsons Brinckerhoff .

Rio Tinto . (2016). *Blair Athol Coal Mine Rehabilitation Status Review 2016.* Brisbane: WSP Parsons Brinckerhoff.

WSP. (2017). *Blair Athol Coal Mine Rehabilitation Monitoring Report .* Brisbane: WSP.

WSP Parsons Brinckerhoff . (2016). *Blair Athol Coal Mine Rehabilitation Monitoring Report.* Brisbane : WSP Parsons Brinckerhoff .

Blair Athol Coal Mine – Environmental Management System

TerraCom

APPENDIX A – ENVIRONMENTAL AUTHORITY



Permit

Environmental Protection Act 1994

Environmental authority EPML00876713

This environmental authority is issued by the administering authority under Chapter 5 of the Environmental Protection Act 1994.

Environmental authority number: EPML00876713

Environmental authority takes effect on 11 June 2025.

Environmental authority holder(s)

Name(s)	Registered address
Orion Mining Pty Ltd	Blair Athol Mine Access Road, Clermont QLD 4721

Environmentally relevant activity and location details

Environmentally relevant activity/activities	Location(s)
Ancillary 08 - Chemical Storage 1: Storing a total of 50t or more of chemicals of dangerous goods class 1 or class 2, division 2.3 under subsection (1)(a)	ML1804
Ancillary 31 - Mineral processing 2: Processing, in a year, the following quantities of mineral products, other than coke (b) more than 100,000t	ML1804
Ancillary 63 - Sewage Treatment 1: Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of (b-i) more than 100 but not more than 1500EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme	ML1804
Schedule 3 13: Mining black coal	ML1804

Additional information for applicants

Environmentally relevant activities

The description of any environmentally relevant activity (ERA) for which an environmental authority (EA) is issued is a restatement of the ERA as defined by legislation at the time the EA is issued. Where there is any inconsistency between that description of an ERA and the conditions stated by an EA as to the scale, intensity or manner of carrying out an ERA, the conditions prevail to the extent of the inconsistency.

An EA authorises the carrying out of an ERA and does not authorise any environmental harm unless a condition stated by the EA specifically authorises environmental harm.

Queensland Government

A person carrying out an ERA must also be a registered suitable operator under the *Environmental Protection Act 1994* (EP Act).

Mobile and temporary activities

If you operate a mobile and temporary environmentally relevant activity (ERA), other than regulated waste transport, you are required to maintain a work diary. You must:

- use the approved form for a work diary (ESR/2015/1696);
- keep the work diary records for 2 years after the last entry;
- inform the administering authority within 7 days of the work diary being lost or stolen;
- record the information required in the work diary for each location within 1 day of leaving the location.

Contaminated land

It is a requirement of the EP Act that an owner or occupier of land give written notice to the administering authority if they become aware of the following:

- the presence of, or happening of an event involving, a hazardous contaminant on the land that is causing, or is reasonably likely to cause, serious or material environmental harm (notice must be given within 24 hours); or
- if the land is contaminated land – a change in the condition of the land that is causing, or is reasonably likely to cause, serious or material environmental harm (notice must be given within 24 hours); or
- a notifiable activity (as defined in Schedule 3) having been carried out, or is being carried out, on the land (notice must be given within 20 business days).

For further information, including the form for giving written notice, refer to the Queensland Government website www.qld.gov.au, using the search term 'duty to notify'.

Take effect

Please note that, in accordance with section 200 of the EP Act, an EA has effect:

a) if the authority is for a prescribed ERA and it states that it takes effect on the day nominated by the holder of the authority in a written notice given to the administering authority – on the nominated day; or

b) if the authority states a day or an event for it to take effect – on the stated day or when the stated event happens; or

c) otherwise – on the day the authority is issued.

However, if the EA is authorising an activity that requires an additional authorisation (a relevant tenure for a resource activity, a development permit under the *Planning Act 2016* or an SDA Approval under the *State Development and Public Works Organisation Act 1971*), this EA will not take effect until the additional authorisation has taken effect.

If this EA takes effect when the additional authorisation takes effect, you must provide the administering authority written notice within 5 business days of receiving notification of the related additional authorisation taking effect.

The anniversary day of this environmental authority is the same day each year as the effective date. The payment of the annual fee will be due each year on this day. An annual return will be due each year on 01 April.

If you have incorrectly claimed that an additional authorisation is not required, carrying out the ERA without the additional authorisation is not legal and could result in your prosecution for providing false or misleading

information or operating without a valid environmental authority.

	11 June 2025
Signature	Date

Alison Cummings
Department of the Environment, Tourism, Science and Innovation
Delegate of the administering authority
Environmental Protection Act 1994

Enquiries:
Business Centre (Coal)
Department of the Environment, Tourism, Science and Innovation
PO Box 3028
EMERALD QLD 4720
Phone: (07) 4987 9320
Email: CRMining@des.qld.gov.au

Obligations under the *Environmental Protection Act 1994*

In addition to the requirements found in the conditions of this environmental authority, the holder must also meet their obligations under the EP Act, and the regulations made under the EP Act. For example, the holder must comply with the following provisions of the Act:

- general environmental duty (section 319)
- duty to notify environmental harm (section 320-320G)
- offence of causing serious or material environmental harm (sections 437-439)
- offence of causing environmental nuisance (section 440)
- offence of depositing prescribed water contaminants in waters and related matters (section 440ZG)
- offence to place contaminant where environmental harm or nuisance may be caused (section 443)

Other permits required

This permit only provides an approval under the *Environmental Protection Act 1994*. In order to lawfully operate you may also require permits / approvals from your local government authority, other business units within the department and other State Government agencies prior to commencing any activity at the site. For example, this may include permits / approvals with your local Council (for planning approval), the Department of Transport and Main Roads (to access State controlled roads), the Department of Resources (to clear vegetation), and the Department of Agriculture and Fisheries (to clear marine plants or to obtain a quarry material allocation).

Obligations under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)

Matters of national environmental significance (MNES) are regulated under the Commonwealth EPBC Act rather than under state legislation. You may need to submit a referral if your project potentially impacts any matters protected under the EPBC Act. For more information on self-assessments, and referral and assessment processes please visit the Department of Climate Change, Energy, the Environment and Water webpage, https://www.dcceew.gov.au/environment/epbc/advice.

Obligations under the *Aboriginal Cultural Heritage Act 2003* and *Torres Strait Islander Cultural Heritage Act 2003* (the Cultural Heritage Acts)

The Cultural Heritage Acts require anyone who carries out a land-use activity to exercise a duty of care. This 'duty of care' means land users must take all reasonable and practicable measures to ensure their activity does not harm Aboriginal or Torres Strait Islander cultural heritage and applies to any activity where Aboriginal or Torres Strait Islander cultural heritage is located. For more information on your obligations under this legislation, please visit the Department of Women, Aboriginal and Torres Strait Islander Partnerships and Multiculturalism webpage at, https://www.tatsipca.qld.gov.au/.

Conditions of environmental authority

The environmentally relevant activities conducted at the locations as described above may be conducted in accordance with the following site-specific conditions of approval. This environmental Authority consists of the following Schedules:

- Schedule A – General
- Schedule B – Air
- Schedule C – Water
- Schedule D – Acoustic
- Schedule E – Waste
- Schedule F – Land
- Schedule G – Regulated Structures
- Schedule H – Sewage Treatment
- Schedule I – Groundwater
- Definitions
- Figures

Conditions of environmental authority

Schedule A: General	
Condition number	**Condition**
A1	Although this environmental authority authorises environmental harm to the extent stated in the conditions, all reasonable and practicable measures must be taken to prevent or minimise environmental harm caused by the activities.
A2	**Maintenance of measures, plant and equipment** All measures, plant and equipment necessary to comply with this authority must be: (a) installed in a proper and efficient condition; (b) maintained in a proper and efficient condition; (c) operated in a proper and efficient manner; and (d) properly calibrated.
A3	**Monitoring** The results and analysis of all monitoring and investigations required by this environmental authority must be: (a) kept for a period of at least **five years**; (b) be provided to the administering authority within a timeframe nominated by the administering authority; and (c) provided to the administering authority in the format requested.
A4	Any records kept or created in relation to this authority must be: (a) kept for a period of at least **five years**; and (b) provided to the administering authority on request.
A5	All monitoring and investigations required by this environmental authority must be undertaken by an appropriately qualified person.
A6	Upon request from the administering authority, copies of all records, plans and other documentation required by the conditions of this environmental authority must be made available and provided to the administering authority within: (a) **ten (10) business days**; or (b) an alternative timeframe agreed between the administering authority and the environmental authority holder.
A7	**Risk management** The holder of this environmental authority must develop and implement a risk management system for mining activities to the Standard for Risk Management (ISO31000:2009), or the latest edition of an Australian Standard for risk management, to the extent relevant to environmental management.
A8	Where a condition of this environmental authority requires compliance with a standard, policy or guideline published externally to this environmental authority and the standard is amended or changed subsequent to the issue of this environmental authority, the holder of this environmental authority must: (a) comply with the amended or changed standard, policy or guideline within two years of the amendment or change being made, unless a different period is specified in the amended standard or relevant legislation, or where the amendment or change relates specifically to regulated structures; and

	(b) until compliance with the amended or changed standard, policy or guideline is achieved, continue to remain in compliance with the corresponding provision that was current immediately prior to the relevant amendment or change.
A9	**Third-party Audits** The environmental authority must: (a) ensure that an appropriately qualified third party conducts and documents an audit of compliance with all conditions of the environmental authority by 15 December 2018; and (b) ensure that further audits in accordance with **condition A9(a)** are conducted at intervals not exceeding once every two years from completion of initial audit.
A10	**Notification of emergencies, incidents and exceptions** The holder of this environmental authority must notify the administering authority by written notification within **24 hours**, after becoming aware of any emergency or incident which results in the release of contaminants not in accordance, or reasonably expected to be not in accordance with, the conditions of this environmental authority.
A11	Within **10 business days** following the initial notification of an emergency or incident, or receipt of monitoring results, whichever is the latter, further written advice must be provided to the administering authority, including the following: (a) results and interpretation of any samples taken and analysed; (b) outcomes of actions taken at the time to prevent or minimise unlawful environmental harm; and (c) proposed actions to prevent a recurrence of the emergency or incident.
A12	**Complaints** A record must be kept in a single location of all complaints received about the activities.
A13	The record required by **condition A12** must include: (a) name, address and contact number for the complainant; (b) time and date of complaint; (c) investigations undertaken; (d) conclusions formed; (e) actions taken to resolve the complaint; (f) any abatement measures implemented; and (g) person responsible for resolving the complaint.
A14	The administering authority must be notified that a complaint has been made, within **48 hours** of receiving the complaint.
A15	When requested by the administering authority, monitoring must be undertaken to investigate any complaint arising from the activity: (a) in the manner requested by the administering authority; and (b) within a reasonable timeframe nominated by or agreed to by the administering authority.
A16	**Scope of activity** This environmental authority authorises the mining of no more than **11 million tonnes** of run of mine (ROM) coal per annum.
A17	The maximum area of disturbance that must not be exceeded in carrying out the mining activity is depicted in **Figure 1 – Blair Athol Mine authorised disturbance footprint**.

Schedule B: Air	
Condition number	**Condition**
B1	**Dust and particulate matter monitoring** The environmental authority holder must ensure that the dust and particulate matter emissions generated by the mining activities do not cause exceedances of the following levels when measured at any sensitive or commercial place: (a) Dust deposition of 120 milligrams per square metre per day, averaged over one month, when monitored in accordance with the most recent version of Australian Standard AS3580.10.1 Methods for sampling and analysis of ambient air-Determination of particulate matter-Deposited matter - Gravimetric method. (b) A concentration of particulate matter with an aerodynamic diameter of less than 10 micrometres (PM10) suspended in the atmosphere of 50 micrograms per cubic metre over a **24-hour** averaging time, when monitored in accordance with the most recent version of either: (i) Australian Standard AS3580.9.6 Methods for sampling and analysis of ambient air-Determination of suspended particulate matter-PM10 high volume sampler with size selective inlet - Gravimetric method; or (ii) Australian Standard AS3580.9.9 Methods for sampling and analysis of ambient air-Determination of suspended particulate matter-PM10 low volume sampler-Gravimetric method. (c) A concentration of particulate matter suspended in the atmosphere of 90 micrograms per cubic metre over a **1 year** averaging time, when monitored in accordance with the most recent version of AS/NZS3580.9.3:2003 Methods for sampling and analysis of ambient air- Determination of suspended particulate matter-Total suspended particulate matter (TSP)-High volume sampler gravimetric method.
B2	**Odour nuisance** The release of noxious or offensive odour or any other noxious or offensive airborne contaminants resulting from the mining activities must not cause an environmental nuisance at any sensitive or commercial place.
B3	When requested by the administering authority, odour monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive or commercial place, and the results must be notified within **14 days** to the administering authority following completion of monitoring.
B4	If the administering authority determines that **condition B2** is not being met, then the environmental authority holder must: (a) address the complaint including the use of appropriate dispute resolution if required; and (b) immediately implement odour abatement measures so that emissions of odour from the activity do not result in further environmental nuisance.

Schedule C: Surface Water	
Condition number	**Condition**
C1	**Contaminant release** Contaminants that will or have the potential to cause environmental harm must not be released directly or indirectly to any waters as a result of authorised activities, except as permitted under the conditions of this environmental authority.
C2	Unless otherwise permitted under the conditions of this environmental authority, the release of mine affected water to waters must only occur from the release points specified in **Table C1 (Mine affected release points, Sources and Receiving Waters)** and depicted in **Figure X** attached to this environmental authority.

Table C1 (Mine affected release points, sources and receiving waters) (1)					
Release Point (RP)	Latitude (GDA2020)	Longitude (GDA2020)	Mine affected water source and location	Monitoring Point	Receiving waters description
Note: (1) There is no current authorised release point for Blair Athol Mine on ML1804.					

C3	The release of mine affected water to internal water management infrastructure installed and operated in accordance with a water management plan that complies with **condition C24** is permitted.
C4	The release of mine affected water to waters in accordance with **condition C2** must not exceed the release limits stated in **Table C2 (Mine affected release limits)** when measured at the monitoring points specified in **Table C1 (Mine affected release points, sources and receiving waters)** for each quality characteristic.

Table C2 (Mine affected release limits)		
Quality Characteristic	Release limits	Monitoring frequency
Electrical conductivity (microsiemens per centimetre)	1000	Daily during release (the first sample must be taken within 2 hours of commencement of release)
pH (pH Unit)	6.5 (minimum), 9.0 (maximum)	Daily during release (the first sample must be taken within 2 hours of commencement of release)
Turbidity (NTU)	Current limit or limit derived from suspended solids limit and demonstrated correlation between turbidity to suspended solids historical monitoring data for dam water. To be provided to the administering authority following approval of a release point.	Daily during release (first sample within 2 hours of commencement of release)
Suspended Solids (mg/L)	1000	Daily during release (first sample within 2 hours of commencement of release)

Sulfate (mg/L)	500	Daily during release (first sample within 2 hours of commencement of release)

C5	The release of mine affected water to waters from the release points must be monitored at the locations specified in **Table C1 (Mine affected release points, sources and receiving waters)** for each quality characteristic and at the frequency specified in **Table C2 (Mine affected release limits)** and **Table C3 (Release contaminant trigger investigation levels)**.

Table C3 (Release contaminant trigger investigation levels)

Quality Characteristic (1), (2)	Trigger Levels (micrograms per litre)	Comment on Trigger level	Monitoring Frequency
Aluminium	55	For aquatic ecosystem protection, based on SMD guideline	Commencement of release and thereafter weekly during release
Arsenic	13	For aquatic ecosystem protection, based on SMD guideline	
Cadmium	0.2	For aquatic ecosystem protection, based on SMD guideline	
Chromium	1	For aquatic ecosystem protection, based on SMD guideline	
Copper	2	For aquatic ecosystem protection, based on LOR for ICPMS	
Iron	300	For aquatic ecosystem protection, based on low reliability guideline	
Lead	4	For aquatic ecosystem protection, based on SMD guideline	
Mercury	0.2	For aquatic ecosystem protection, based on LOR for CV FIMS	
Nickel	11	For aquatic ecosystem protection, based on SMD guideline	
Zinc	8	For aquatic ecosystem protection, based on SMD guideline	
Boron	370	For aquatic ecosystem protection, based on SMD guideline	
Cobalt	90	For aquatic ecosystem protection, based on low reliability guideline	
Manganese	1900	For aquatic ecosystem protection, based on SMD guideline	

Molybdenum	34	For aquatic ecosystem protection, based on low reliability guideline	
Selenium	10	For aquatic ecosystem protection, based on LOR for ICPMS	
Silver	1		
Uranium	1		
Vanadium	10		
Ammonia	900	For aquatic ecosystem protection, based on SMD guideline	
Nitrate	1100	For aquatic ecosystem protection, based on ambient Qld WQ Guidelines (2006) for TN	
Petroleum hydrocarbons (C6-C9)	20		
Petroleum hydrocarbons (C10-C36)	100		
Fluoride (total)	2000	Protection of livestock and short term irrigation guideline	
Sodium	Limit to be determined based on receiving water reference data and achievable best practice sedimentation control and treatment. To be provided to the administering authority following approval of a release point.		

Notes:
(1) All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal/metalloids apply if dissolved results exceed trigger.
(2) The quality characteristics required to be monitored as per **Table C3 (Release contaminant trigger investigation levels)** can be reviewed once the results of **two years** monitoring data is available, or if sufficient data is available to adequately demonstrate negligible environmental risk, and it may be determined that a reduced monitoring frequency is appropriate or that certain quality characteristics can be removed from **Table C3 (Release contaminant trigger investigation levels)** by amendment.
(3) SMD - slightly moderately disturbed level of protection, guideline refers ANZECC and ARMCANZ (2000).
(4) LOR - typical reporting for method stated. ICPMS/CV FIMS – analytical method required to achieve LOR.

C6	If quality characteristics of the release exceed any of the trigger levels specified in **Table C3 (Release contaminant trigger investigation levels)** during a release event, the environmental authority holder must compare the downstream results in the receiving waters to the trigger values specified in Table C3 and; (1) where the trigger values are not exceeded then no action is to be taken. (2) where the downstream results exceed the trigger values specified **Table C3 (Release contaminant trigger investigation levels)** for any quality characteristic, compare the results of the downstream site to the data from background monitoring sites; (a) if the result is less than the background monitoring site data, then no action is to be taken. (b) if the result is greater than the background monitoring site data, complete an investigation into the potential for environmental harm and provide a written report to the administering authority within **90 days** of receiving the result, outlining (i) details of the investigations carried out; and (ii) actions taken to prevent environmental harm.

	Note: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with **C6(2)(b)(ii)** of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.
C7	If an exceedance in accordance with condition **C6(2)(b)** is identified, the holder of the authority must notify the administering authority within **24 hours** of receiving the result.
C8	**Mine affected water release events** The holder must ensure a stream flow gauging station/s is installed, operated and maintained to determine and record stream flows at the locations and flow recording frequency specified in **Table C3 (Release contaminant trigger investigation levels)**.
C9	Notwithstanding any other condition of this environmental authority, the release of mine affected water to waters in accordance with **condition C2** must only take place during periods of natural flow in accordance with the receiving water flow criteria for discharge specified in **Table C4 (Mine affected water release during flow events)** for the release point(s) specified in **Table C1 (Mine affected release points, sources and receiving waters)**.

Table C4 (Mine affected water release during flow events)

Receiving water description	Release Point	Gauging station description	Latitude (GDA94)	Longitude (GDA94)	Minimum Flow in Receiving Water Required for a Release Event	Flow recording Frequency
Bath Creek	TBA	Gauging station 1	-22° 32' 16.8''	147° 32' 16.8''	3.6 cubic metres per second	Continuous (minimum daily)

C10	The release of mine affected water to waters in accordance with **condition C2** must not exceed the Maximum Release Rate for each receiving water flow criterion for discharges specified in **Table C4 (Mine affected water release during flow events)** when measured at the monitoring points specified in **Table C1 (Mine affected release points, sources and receiving waters)**.
C11	The daily quantity of mine affected water released from each release point must be measured and recorded at the monitoring points in **Table C1 (Mine affected release points, sources and receiving waters)**.
C12	Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters, or cause a material build-up of sediment in such waters.
C13	**Notification of release event** The authority holder must notify the administering authority as soon as practicable (no later than **6 hours** of having commenced releasing mine affected water to the receiving environment). Notification must include the submission of written verification to the administering authority of the following information (a) release commencement date/time (b) expected release cessation date/time (c) release point/s (d) release volume (estimated) (e) receiving water/s including the natural flow rate (f) any details (including available data) regarding likely impacts on the receiving water(s).

	Note: Notification to the administering authority must be via an email to WaTERS.
C14	The authority holder must notify the administering authority as soon as practicable (nominally within **24 hours** after cessation of a release) of the cessation of a release notified under **condition C13** and within **28 days** provide the following information in writing: (a) release cessation date/time (b) natural flow volume in receiving water (c) volume of water released (d) details regarding the compliance of the release with the conditions of Department Interest: Water of this environmental authority (i.e. contamination limits, natural flow, discharge volume) (e) all in-situ water quality monitoring results (f) any other matters pertinent to the water release event.
C15	**Notification of release event exceedance** If the release limits defined in **Table C2 (Mine affected release limits)** are exceeded, the holder of the environmental authority must notify the administering authority within **24 hours** of receiving the results.
C16	The authority holder must, within **28 days** of a release that exceeds the conditions of this authority, provide a report to the administering authority detailing: (a) the reason for the release (b) the location of the release (c) all water quality monitoring results (d) any general observations (e) all calculations (f) any other matters pertinent to the water release event.
C17	**Receiving Environment Monitoring and Contaminant Trigger Levels** The quality of the receiving waters must be monitored at the locations specified in **Table C8 (Receiving water upstream background sites and downstream monitoring points)** for each quality characteristic and at the monitoring frequency stated in **Table C7 (Receiving waters contaminant trigger levels)**.

Table C7 (Receiving waters contaminant trigger levels)

Quality Characteristic	Trigger Level	Monitoring Frequency
pH	6.5 - 8.0	Daily during the release
Electrical Conductivity (microsiemens per centimetre)	1000	
Suspended solids (mg/L)	1000	
Sulfate (mg/L)	250	

Table C8 (Receiving water upstream background sites and downstream monitoring points)

Monitoring point	Receiving Waters Location	Latitude	Longitude	Monitoring frequency
Upstream Background Monitoring Points				

Monitoring Point 1	Washpool Creek, 10,700m upstream of GS1	-22° 40’ 02.3’’	147° 31’ 52.7’’	Daily during release
Monitoring Point 2	Back Creek, 6,600m upstream of GS 1	-22° 41’ 17.5’’	147° 33’ 16’’	Daily during release
Monitoring Point 3	Breaker Creek	-22° 41’ 10.1’’	147° 30’ 40.7’’	Daily during release
Downstream Monitoring Points				
Monitoring Point 4	Breaker Creek Diversion	-22° 42’ 53’’	147° 31’ 17’’	Daily during release
Monitoring Point 5	Bath Creek East	-22° 43’ 27’’	147° 32’ 53’’	Daily during release
Monitoring Point 6	Bath Creek Down Stream	-22° 44’ 59’’	147° 32’ 13’’	Daily during release
Note: The data from background monitoring points must not be used where they are affected by releases from other mines.				

C18	If quality characteristics of the receiving water at the downstream monitoring points exceed any of the trigger levels specified in **Table C7 (Receiving waters contaminant trigger levels)** during a release event, the environmental authority holder must compare the downstream results to the upstream results in the receiving waters and: (1) where the downstream result is the same or a lower value than the upstream value for the quality characteristic then no action is to be taken. (2) where the downstream results exceed the upstream results, complete an investigation in accordance with the ANZECC and ARMCANZ 2000 methodology, into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining; (i) details of the investigations carried out; and (ii) actions taken to prevent environmental harm. [Note: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with **C18(2)(ii)** of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.]
C19	All determinations of water quality monitoring must be performed by an appropriately qualified person.
C20	**Receiving Environment Monitoring Program (REMP)** The environmental authority holder must implement a Receiving Environment Monitoring Program (REMP) to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity. This must include monitoring the effects of the mine on the receiving environment periodically (under natural flow conditions) and while mine affected water is being discharged from the site. For the purposes of the REMP, the receiving environment is the waters of the Bath Creek and connected or surrounding waterways within **12 kilometres** downstream of the release. The REMP should encompass any sensitive receiving waters or environmental values downstream of the authorised mining activity that will potentially be directly affected by an authorised release of mine affected water.
C21	A report outlining the findings of the REMP, including all monitoring results and

	interpretations must be prepared annually. This must include an assessment of background reference water quality, the condition of downstream water quality compared with water quality objectives, and the suitability of current discharge limits to protect downstream environment values.
C22	**Water reuse** Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this authority and deposited into artificial water storage structures, such as farm dams or tanks, or used directly at properties owned by the environmental authority holder or a third party (with the consent of the third party).
C23	The following information must be recorded in relation to all water monitoring required under the conditions of this environmental authority and submitted to the administering authority in the specified format with each annual return: (a) the date on which the sample was taken (b) the time at which the sample was taken (c) the monitoring point at which the sample was taken (d) the measured or estimated daily quantity of the contaminants released from all release points (e) the release flow rate at the time of sampling for each release point (f) the results of all monitoring and details of any exceedances with the conditions of this environmental authority (g) water quality monitoring data must be provided to the administering authority in the specified electronic format upon request.
C24	**Water Management Plan** A Water Management Plan developed by an appropriately qualified person must be implemented for all stages of the mining activity.
C25	**Stormwater and water sediment controls** An Erosion and Sediment Control Plan must be developed by an appropriately qualified person and implemented for all stages of the mining activities on the site to minimise erosion and the release of sediment to receiving waters and contamination of storm water.
C26	Stormwater, other than mine affected water, is permitted to be released to waters from: (a) Erosion and sediment control structures that are installed and operated in accordance with the Erosion and Sediment Control Plan required by **condition C25**. (b) Water management infrastructure that is installed and operated, in accordance with a Water Management Plan that complies with **condition C24**, for the purpose of ensuring water does not become mine-affected water.

Schedule D: Acoustic	
Condition number	**Condition**
D1	**Noise limits** The holder of this environmental authority must ensure that noise generated by the mining activities does not cause an environmental nuisance at any sensitive place or commercial place.
D2	When requested by the administering authority, noise monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive place, and the results must be notified within **14 business days** to the administering authority following completion of monitoring.
D3	If monitoring indicates exceedance of the noise limits in **Table D1 - Noise limits**, then the environmental authority holder must: (a) address the complaint including the use of appropriate dispute resolution if required; or (b) immediately implement noise abatement measures so that noise from the activity does not result in further environmental nuisance.
D4	If monitoring indicates that noise from the mining activity is causing an environmental nuisance, then the environmental authority holder must: (a) address the complaint including the use of appropriate dispute resolution if required (b) immediately implement noise abatement measures so that emissions of noise from the activity do not result in further environmental nuisance.
D5	**Airblast overpressure nuisance** The holder of this environmental authority must ensure that blasting does not cause the limits for peak particle velocity and air blast overpressure in **Table D2 - Blasting noise limits** to be exceeded at any sensitive place or commercial place.
D6	**Monitoring and reporting** Noise monitoring and recording must include the following descriptor characteristics and matters: (a) LAN,T (where N equals the statistical levels of 1, 10 and 90 and T = 15 mins) (b) background noise LA90 (c) the level and frequency of occurrence of impulsive or tonal noise and any adjustment and (d) penalties to statistical levels (e) atmospheric conditions including temperature, relative humidity and wind speed and directions (f) effects due to any extraneous factors such as traffic noise (g) location, date and time of monitoring (h) if the complaint concerns low frequency noise, Max LpLIN,T and one third octave band measurements in dB(LIN) for centre frequencies in the 10 - 200 Hz range.

Table D1 (Noise limits)						
Sensitive place						
Noise level dB(A) measured as:	Monday to Saturday			Sundays and public holidays		
	7am to 6pm	6pm to 10pm	10pm to 7am	9am to 6pm	6pm to 10pm	10pm to 9am
LAeq, adj, 15 mins	CV = 50 AV = 5	CV = 45 AV = 5	CV = 40 AV = 0	CV = 45 AV = 5	CV = 40 AV = 5	CV = 35 AV = 0
LA1, adj, 15mins	CV = 55 AV = 10	CV =50 AV = 10	CV = 45 AV= 5	CV = 50 AV = 10	CV = 45 AV = 10	CV = 40 AV = 5
Commercial place						
Noise level dB(A) measured as:	Monday to Saturday			Sundays and public holidays		
	7am to 6pm	6pm to 10pm	10pm to 7am	7am to 6pm	6pm to 10pm	10pm to 7am
LAeq, adj, 15 mins	CV = 55 AV = 10	CV = 50 AV = 10	CV = 45 AV = 5	CV = 50 AV = 10	CV = 45 AV = 10	CV = 40 AV = 5

Notes:

(1) CV = Critical Value
(2) AV = Adjustment Value
(3) To calculate noise limits in Table D1:
    a. If bg ≤ (CV - AV):
    b. Noise limit = bg + AV
    c. If (CV - AV) /-- LESS THAN --/ bg ≤ CV:
    d. Noise limit = CV If bg /-- GREATER THAN --/ CV:
    e. Noise limit = bg + 0
(4) In the event that measured bg (LA90, adj, 15 mins) is less than 30 dB(A), then 30 dB(A) can be substituted for the measured background level
(5) bg = background noise level (LA90, adj, 15 mins) measured over 3-5 days at the nearest sensitive receptor
(6) If the project is unable to meet the noise limits as calculated above alternative limits may be calculated using the processes outlined in the “Planning for Noise Control” guideline.

Table D2 (Blasting noise limits)		
Blasting noise limits	Sensitive or commercial place	
	7am to 6pm	6pm to 7am
Airblast overpressure	115 dB (Linear) Peak for 9 out of 10 consecutive blasts initiated and not greater than 120 dB (Linear) Peak at any time	No blasting
Ground vibration peak particle velocity	5mm/second peak particle velocity for 9 out of 10 consecutive blasts and not greater than 10 mm/second peak particle velocity at any time	No blasting

Schedule E: Waste	
Condition number	**Condition**
E1	All general and regulated waste must only be removed and transported from site by a person who has the authority to transport such wastes to a facility that is lawfully able to accept the waste under the *Environmental Protection Act 1994*.
E2	**Storage of tyres** Tyres stored awaiting disposal or transport for take-back and, recycling, or waste to- energy options, should be stockpiled in volumes less than 3 metres in height and 200 square metres in area and at least 10 metres from any other tyre storage area.
E3	All reasonable and practicable fire prevention measures must be implemented, including removal of grass and other materials within a **ten** (**10) metre** radius of the scrap tyre storage area.
E4	**Disposal of tyres and conveyor belts** Disposing of scrap tyres and conveyor belts resulting from the mining activities in spoil emplacements is acceptable, provided they are placed as deep in the spoil as reasonably practicable.
E5	Scrap tyres resulting from the mining activities disposed within the operational land must not impede saturated aquifers or compromise the stability of the consolidated landform.
E6	The location of tyre burial sites must be recorded.
E7	**Burning Waste** Unless otherwise permitted by the conditions of this environmental authority or with prior approval from the administering authority and in accordance with a relevant standard operating procedure, waste must not be burnt.
E8	The holder of this environmental authority may burn vegetation in accordance with the plan of operations, provided the activity does not cause environmental harm at any sensitive or commercial place.
E9	**Mine waste and rejects management** Waste products generated on or after the 30 August 2017 from the washing of coal must be disposed of within mining voids and covered with spoil to a depth of at least 5m.
E10	A Waste Rock, Spoil and Rejects Disposal Plan must be implemented and include, where relevant, at least: (a) effective characterisation of the waste rock, spoil and rejects to predict under the proposed placement and disposal strategy the quality of runoff and seepage generated concerning potentially environmentally significant effects including salinity, acidity, alkalinity and dissolved metals, metalloids and non-metallic inorganic substances; (b) a program of progressive sampling and characterisation to identify dispersive and non-dispersive spoil and the salinity, acid and alkali producing potential and metal concentrations of waste rock, spoil and rejects; (c) a materials balance and disposal plan demonstrating how potentially acid forming and acid forming waste rock, spoil and rejects will be selectively placed and/or encapsulated to minimise the potential generation of acid mine drainage; (d) where relevant, a sampling program to verify encapsulation and/or placement of potentially acid- forming and acid-forming waste rock, spoil and rejects; (e) how often the performance of the plan will be assessed; (f) the indicators or other criteria on which the performance of the plan will be assessed;

	(g) a rehabilitation strategy; and (h) monitoring or rehabilitation, research and/or trials to verify the requirements and methods for decommissioning and final rehabilitation of the placed materials, including the prevention and management of acid mine drainage, erosion minimisation and establishment of vegetation cover.
E11	The Waste Rock, Spoil and Rejects Disposal Plan developed by an appropriately qualified person must be implemented for all mining activities and reviewed and updated by 30 June every **two (2) years.**
E12	Tailings dewatering cells must be designed and constructed to ensure that any runoff or seepage is contained within the mine water management system.

Schedule F: Land	
Condition number	**Condition**
F1	**Cover Material** The topsoil requirements for rehabilitation of the mine and the availability of suitable topsoil on site must be detailed in a Rehabilitation Management Plan .
F2	Where a surrogate material (growth media) is proposed to be used for rehabilitation either in combination with, or instead of, topsoil, it must be demonstrated as being suitable for rehabilitation at the completion of rehabilitation trials.
F3	A description of the rehabilitation trials and monitoring results must be included in the Rehabilitation Management Plan .
F4	**Rehabilitation landform criteria** Unless otherwise permitted under the conditions of this environmental authority, all areas significantly disturbed by mining activities must be rehabilitated in accordance with **Table F1 - Rehabilitation Requirements** and as detailed in the Rehabilitation Management Plan described in **condition F10**. The final landform design is depicted in **Figure 2**.

Table F1 (Rehabilitation Requirements)					
Post Mining Land Use	**Mine domain**	**Goal**	**Objective**	**Indicator**	**Acceptance criteria**
Grazing	All areas disturbed by mining activities	Safe for humans and wildlife	Safety hazards in rehabilitation are not significantly different to surrounding unmined land subject to the same land use	Hazard assessment	No significant difference
		Stable	Rehabilitation is geotechnically stable	Factor of safety	≥1.5
			Rehabilitation is erosionally stable	Erosion	No gully erosion
				Slope gradient	Rehabilitated landform: <15%
					Ramp 3: <30%
				Groundcover	>50%
		Non-polluting	Rainfall runoff from rehabilitation achieves water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values

			Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: (a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines
		Able to sustain the agreed post-mining land use	Rehabilitation is suitable for sustainable light grazing	Land suitability assessment for light grazing	Land suitability class ≤3 or not different from pre-mining class if ≥4. *LSA Framework for Open-Cut Coal Mine Rehabilitation 2018 (A rule-set for land suitability assessment beef cattle grazing on land rehabilitated after open-cut coal mine in the Bowen Basin Queensland)* unless otherwise agreed in writing between the administering authority and the environmental authority holder.
Native ecosystem	Areas disturbed by mining activities that are located on State Forest Land	Safe for humans and wildlife	Construct landforms that do not pose unacceptable hazards to humans, stock and wildlife.	Safety hazards in rehabilitation are not significantly different to surrounding unmined land subject to the same land use	Hazard assessment
		Stable	Demonstrate geotechnical stability.	Factor of safety	≥1.5
				Erosion	No gully erosion

			Not exhibiting excessive erosion	Slope gradient	Rehabilitated landform: <15%
				Groundcover	>50%
		Able to sustain vegetation	Rehabilitation landform (including land cover and water) is suitable for providing native ecosystem	Vegetation assessment	A vegetation assessment is completed by an APQ using a methodology as outlined in the Queensland Mine Rehabilitation Commissioner technical paper 'Evaluating methods for assessing native ecosystem mine rehabilitation success' (March 2023).
			Achieve self-sustaining systems that doesn't require additional maintenance except that of surrounding areas (e.g., weed and fire control via grazing/pastoral management etc.).		>70% total cover across rehabilitation area, includes multilevel canopy, groundcover, and leaf litter. At least four native tree or shrub species across the rehabilitation area. Evidence of recruitment of native tree species over a representative climatic period.
		Non-polluting	Rainfall runoff from rehabilitation achieves water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
			Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: (a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines

Non-use Management Area (NUMA)	Final void	Safe for humans and wildlife, stable and non-polluting	Construct landforms that do not pose unacceptable hazards to humans, stock and wildlife	Highwall Criteria	(a) Maximum slope of 30% when measured from highwall toe to crest. (b) Buttressing at a minimum offset of 30m at the toe section of the highwall. (c) Fencing and warning signage posted at 50m intervals above the final void (d) Must be safe, stable and non-polluting.
				Low Wall Criteria	(a) Maximum slope of 15% slope. (b) Must be safe, stable, non-polluting.
			Demonstrate geotechnical stability Not exhibiting excessive erosion	Erosion	No gully erosion
			Maintain regional surface and groundwater quality	Maximum predicted water level (mAHD)	284.1
				Void maximum surface area	(a) Maximum NUMA extent no greater than 291.6 ha projected surface area. (b) Must be safe, stable and non-polluting
			Provide flood immunity.	Flood immunity	Upgrades of Eastern and Western Diversion Drains (EDD and WDD) and levees must provide flood

					immunity to NUMA up to PMF flood. There must be no ingress.

F5	Successfully rehabilitated land must have no active gully erosion. Erosion must be assessed by annual documented inspections. Gully dimensions must be quantitatively assessed for a minimum of **two years** both containing a minimum of two rainfall events of more than 25 millimetres in less than three hours.
F6	**Rehabilitation activities** Progressive rehabilitation of land disturbed by resource activities must be rehabilitated in accordance with **Table F1 – Rehabilitation Requirements** and must commence within **2 years** of when areas become available within the operational land.
F7	The environmental authority holder must provide written notification to the administering authority that details how the progressive rehabilitation has been completed with each annual return.
F8	**Rehabilitation Management Plan** A Rehabilitation Management Plan developed by an appropriately qualified person must be implemented for all mining activities and reviewed and updated by **30 June** every **two (2) years**.
F9	At a minimum, the Rehabilitation Management Plan must include: (a) map existing areas of rehabilitation including classification of stage (i.e. time since establishment) and quality; (b) a strategy for progressive rehabilitation; (c) detail the design objectives for rehabilitation of each domain to achieve rehabilitation success criteria and the identified post mining land uses; (d) specify spoil characteristics, soil analysis, soil separation for use on rehabilitation; (e) specify the topsoil requirements for the site and provide details of how topsoil will be managed for use in rehabilitation; (f) detail any topsoil deficit and how any deficit will be managed for successful rehabilitation, including, if applicable, the proposal of surrogate growth media; (g) detail rehabilitation methods applied to areas; (h) detail landform design including end of mine design; (i) detail how landform design will be consistent with surrounding topography; (j) identify and detail planned native vegetation rehabilitation areas and corridors; (k) identify at least a minimum of three (3) reference sites for use in rehabilitation monitoring; (l) describe rehabilitation indicators and how these will be monitored; (m) describe management actions to address unsuccessful rehabilitation or redesign; and (n) describe end of mine landform design planning and post mining land uses across the mine; and include a triple bottom line assessment (or a comparative alternative assessment method) of the proposed final landform design criteria and alternatives.
F10	**Exchange Sodium Percentage** Coal washery wastes and spoil with exchangeable sodium percentage (ESP) >30 percent must be covered with a minimum of one metre of benign material (i.e. with ESP <15 percent) prior to rehabilitation commencing.

F11	**Closure Management Plan** A Closure Management Plan developed by an appropriately qualified person must be implemented for all mining activities and reviewed and updated by **30 June** every **two (2) years**.
F12	At a minimum, the Closure Management Plan must include: (a) final landform design demonstrating rehabilitation requirements; (b) a schedule of rehabilitation that is integrated with the mine plan and identifies how rehabilitation will be completed progressively throughout the life of the mine; (c) the operation, monitoring and maintenance details of the following: (i) spontaneous combustion; (ii) wastewater collection and reticulation systems; (iii) wastewater treatment systems; (iv) groundwater quality monitoring network; (v) surface water quality; (vi) groundwater quality; (vii) seepage rates; (viii) erosion rates; (ix) integrity and stability of slopes, ramps and voids; and (x) the health and resilience of vegetation cover. (d) schematic representations of the proposed final landform including, landform type, slope, regional ecosystems, drainage designs and any post mining land or infrastructure use agreed with the landowner/holder and the administering authority; (e) details of the progressive rehabilitation program designed to demonstrate the trajectory of rehabilitated areas towards rehabilitation requirements; and (f) detail outlining potential residual risk with proposed strategies to reduce or manage these risks.
F13	**Residual void outcome** Residual voids must not cause any serious environmental harm to land, surface waters or any recognised groundwater aquifer, other than the environmental harm constituted by the existence of the residual void itself and subject to any other condition within this environmental authority.
F14	**Residual void design** Residual voids must comply with the design criteria specified in **Table F1 – Rehabilitation Requirements** and as detailed in the Residual Void Management Plan described in **condition F16**.
F15	**Residual Void Management Plan** A Residual Void Management Plan developed by an appropriately qualified person must be implemented for all mining activities and reviewed and updated by **30 June** every **two (2) years**.
F16	At a minimum, the Residual Void Management Plan must include: (a) options available for minimising final void area and volume; (b) design objectives for rehabilitation of final voids; (c) void hydrology, addressing the long-term water balance in the voids, connections to groundwater resources and water quality parameters in the long term; (d) pit wall stability, considering the effects of long-term erosion and weathering of the pit wall and the effects of significant hydrological events; (e) options available for minimising risk of flood interaction for all flood events up to and including the Probable Maximum Flood level; (f) void capability to support native flora and fauna; and

	(g) void rehabilitation success criteria and final void areas and volumes to meet the outcomes defined in the Rehabilitation Management Plan described in **condition F9.**
F17	**Acid rock drainage and leachate management** Subject to the release limits defined in **Table C2 - Mine affected release limits**, all reasonable and practicable measures must be implemented to prevent hazardous leachate being directly or indirectly released or likely to be released as a result of the activity to any groundwater or watercourse.

Schedule G: Regulated structures	
Condition number	**Condition**
G1	**Assessment of consequence category** The consequence category of any structure must be assessed by a suitably qualified and experienced person in accordance with the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933) at the following times: (a) prior to the design and construction of the structure, if it is not an existing structure; or (b) prior to any change in its purpose or the nature of its stored contents.
G2	A consequence assessment report and certification must be prepared for each structure assessed and the report may include a consequence assessment for more than one structure.
G3	Certification must be provided by the suitably qualified and experienced person who undertook the assessment, in the form set out in the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933).
G4	**Design and construction of a regulated structure** **Conditions G5** to **G9** inclusive do not apply to existing structures.
G5	All regulated structures must be designed by, and constructed under the supervision of, a suitably qualified and experienced person in accordance with the requirements of the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933).
G6	Construction of a regulated structure is prohibited unless: (a) the holder has submitted a consequence category assessment report and certification to the administering authority; and (b) certification for the design, design plan and the associated operating procedures has been certified by a suitably qualified and experienced person in compliance with the relevant condition of this authority.
G7	Certification must be provided by the suitably qualified and experienced person who oversees the preparation of the design plan in the form set out in the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933) and must be recorded in the Register of Regulated Structures.
G8	Regulated structures must: (a) be designed and constructed in compliance with the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933); (b) be designed and constructed with due consideration given to ensuring that the design integrity would not be compromised on account of: (i) floodwaters from entering the regulated dam from any watercourse or drainage line; and (ii) wall failure due to erosion by floodwaters arising from any watercourse or drainage line; and (c) have the floor and sides of the dam designed and constructed to prevent or minimise the passage of the wetting front and any entrained contaminants through either the floor or sides of the dam during the operational life of the dam and for any period of decommissioning and rehabilitation of the dam.
G9	Certification by the suitably qualified and experienced person who supervises the construction must be submitted to the administering authority on the completion of construction of the regulated structure, and state that:

	(a) the 'as constructed' drawings and specifications meet the original intent of the design plan for that regulated structure; and (b) construction of the regulated structure is in accordance with the design plan.
G10	**Notification of affected persons** All affected persons must be provided with a copy of the emergency action plan in place for each regulated structure: (a) for existing structures that are regulated structures, within **10 business days** of this condition taking effect; (b) prior to the operation of the new regulated structure; and (c) if the emergency action plan is amended, within **5 business days** of it being amended.
G11	**Operation of a regulated structure** Operation of a regulated structure, except for an existing structure, is prohibited unless the holder has submitted to the administering authority in respect of regulated structure, all of the following: (a) one paper copy and one electronic copy of the design plan and certification of the 'design plan' in accordance with **condition G6**; (b) a set of 'as constructed' drawings and specifications; (c) certification of the 'as constructed drawings and specifications' in accordance with **condition G9**; (d) where the regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, a copy of the certified system design plan; (e) the requirements of this authority relating to the construction of the regulated structure have been met; (f) the holder has entered the details required under this authority, into a Register of Regulated Structures; and (g) there is a current operational plan for the regulated structure.
G12	For existing structures that are regulated structures: (a) where the existing structure that is a regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, the holder must submit to the administering authority within **12 months** of the commencement of this condition a copy of the certified system design plan including that structure; and (b) there must be a current operational plan for the existing structures.
G13	Each regulated structure must be maintained and operated, for the duration of its operational life until decommissioned and rehabilitated, in compliance with the current operational plan and, if applicable, the current design plan and associated certified 'as constructed' drawings.
G14	**Mandatory reporting level** **Conditions G15** to **G16** inclusive only apply to Regulated Structures which have not been certified as low consequence category for 'failure to contain - overtopping'.
G15	The Mandatory Reporting Level (the MRL) must be marked on a regulated dam in such a way that during routine inspections of that dam, it is clearly observable.
G16	The holder must, as soon as practicable but within 48 hours of becoming aware, notify the administering authority when the level of the contents of a regulated dam reaches the MRL.
G17	The holder must, immediately on becoming aware that the MRL has been reached, act to prevent the occurrence of any unauthorised discharge from the regulated dam.
G18	The holder must record any changes to the MRL in the Register of Regulated Structures.

G19	The holder must assess the performance of each regulated dam or linked containment system over the preceding November to May period based on actual observations of the available storage in each regulated dam or linked containment system taken prior to **1 July** of each year.
G20	By **1 November** of each year, storage capacity must be available in each regulated dam (or network of linked containment systems with a shared DSA volume), to meet the Design Storage Allowance (DSA) volume for the dam (or network of linked containment systems).
G21	The holder must, as soon as practicable but within 48 hours of becoming aware that the regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on **1 November** of any year, notify the administering authority.
G22	The holder must, immediately on becoming aware that a regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on **1 November** of any year, act to prevent the occurrence of any unauthorised discharge from the regulated dam or linked containment systems.
G23	**Annual Inspection report** Each regulated structure must be inspected each calendar year by a suitably qualified and experienced person.
G24	At each annual inspection, the condition and adequacy of all components of the regulated structure must be assessed and a suitably qualified and experienced person must prepare an annual inspection report containing details of the assessment and include a recommendations section, with any recommended actions to ensure the integrity of the regulated structure or a positive statement that no recommendations are required.
G25	The suitably qualified and experienced person who prepared the annual inspection report must certify the report in accordance with the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933).
G26	The holder must within **20 business days** of receipt of the annual inspection report, provide to the administering authority: (a) The recommendations section of the annual inspection report; (b) If applicable, any actions being taken in response to those recommendations; and (c) If, following receipt of the recommendations and (if applicable) recommended actions, the administering authority requests a copy of the annual inspection report from the holder, provide this to the administering authority within **10 business days** of receipt of the request.
G27	**Transfer arrangements** The holder must provide a copy of any reports, documentation and certifications prepared under this authority, including but not limited to any Register of Regulated Structures, consequence assessment, design plan and other supporting documentation, to a new holder on transfer of this authority.
G28	**Register of Regulated Structures** A Register of Regulated Structures must be established and maintained by the holder for each regulated structure.
G29	The holder must provisionally enter the required information in the Register of Regulated Structures when a design plan for a regulated dam is submitted to the administering authority.
G30	The holder must make a final entry of the required information in the Register of Regulated Structures once compliance with **conditions G11** and **G12** has been achieved.
G31	The holder must ensure that the information contained in the Register of Regulated Structures is current and complete on any given day.
G32	All entries in the Register of Regulated Structures must be approved by the chief executive officer for the holder of this authority, or their delegate, as being accurate and correct.

G33	The holder must, at the same time as providing the annual return, supply to the administering authority a copy of the records contained in the Register of Regulated Structures, in the electronic format required by the administering authority.
G34	**Transitional arrangements** All existing structures that have not been assessed in accordance with either the Manual or the former Manual for Assessing Hazard Categories and Hydraulic Performance of Dams must be assessed and certified in accordance with the Manual within 6 months of amendment of the authority adopting this schedule.
G35	All existing structures must subsequently comply with the timetable for any further assessments in accordance with the Manual specified in **Table G1 (Transitional hydraulic performance requirements for existing structures)**, depending on the consequence category for each existing structure assessed in the most recent previous certification for that structure.
G36	**Table G1 (Transitional hydraulic performance requirements for existing structures)** ceases to apply for a structure once any of the following events has occurred: (a) it has been brought into compliance with the hydraulic performance criteria applicable to the structure under the Manual; or (b) it has been decommissioned; or (c) it has been certified as no longer being assessed as a regulated structure.
G37	Certification of the transitional assessment required by **G34** and **G35** (as applicable) must be provided to the administering authority within **6 months** of amendment of the authority adopting this schedule.

Table G1 (Transitional hydraulic performance requirements for existing structures)			
Transition period for existing structures to achieve the requirements of the Manual for Assessing Consequence Categories and Hydraulic Performance of Dams			
Compliance with criteria	High consequence	Significant consequence	Low consequence
>90 percent and a history of good compliance performance in last 5 years	No transition required	No transition required	No transitional conditions apply. Review consequence assessment every 7 years.
>70 percent - ≤90 percent	Within 7 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Within 10 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	No transitional conditions apply. Review consequence assessment every 7 years.
>50-≤70 percent	Within 5 years unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Within 7 years unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Review consequence assessment every 7 years.
≤50 percent	Within 5 years or as per compliance requirements (e.g. TEP timing)	Within 5 years or as per compliance requirements (e.g. TEP timing).	Review consequence assessment every 5 years.
Regulated levee designed to prevent the ingress of clean flood water <100 percent compliant	Within 5 years unless otherwise agreed with the administering authority		
Note: Levees designed for the diversion of contaminated waters or protection of the structural integrity of a dam is not to be considered as part of this provision. These levees are considered a key design element of the relevant dam and transitional periods should as such align to that relevant compliance criteria and consequence category.			

Schedule H: Sewage treatment	
Condition number	**Condition**
H1	All effluent released from the sewage treatment plant must be evaporated in an impervious pond.
H2	Dried sewage sludge must be buried within spoil emplacements, records of the disposal volumes and locations must be kept.
H3	The Sewage Treatment Management Plan must be implemented for all mining activities and reviewed and updated by **30 June** every **two (2) years**.

Schedule I: Groundwater	
Condition number	**Condition**
I1	The holder of this environmental authority must not release contaminants to groundwater.
I2	A groundwater monitoring program to monitor water quality and standing water level in any aquifers likely to be impacted by mining activities must be implemented for all mining activities and reviewed and updated by **30 June** every **two (2) years**.
I3	**Groundwater monitoring** Groundwater must be monitored: (a) at the locations and frequencies identified in **Table I1 (Groundwater monitoring locations and frequency)**; and (b) for the quality characteristics specified in **Table I2 (Groundwater quality trigger thresholds)** and (c) for the standing water levels stated in **Table I3 (Groundwater standing water level trigger thresholds)**.
I4	All groundwater sampling and monitoring methods must be in accordance with the latest version of the administering authority's '*Monitoring and Sampling Manual 2018: Environmental Protection (Water) Policy 2009*' unless otherwise approved by the administering authority.
I5	**Groundwater quality** Results of monitoring of groundwater quality from compliance bores identified in **Table I1 (Groundwater monitoring locations and frequency)** must not exceed any of the limits defined in **Table I2 (Groundwater quality trigger thresholds)** on more than **three (3)** consecutive monitoring occasions.
I9	**Bore construction, maintenance and decommissioning** The construction, maintenance and management of groundwater bores (including groundwater monitoring bores) must be undertaken in a manner that prevents or minimizes impacts to the environment and ensures the integrity of the bores to obtain accurate monitoring.
I10	**Transitional arrangements** By **30 June 2026**, the environmental authority holder must: (a) prepare a hydrogeological numerical groundwater model in accordance with the most recent version of the '*Australian Groundwater Modelling Guidelines*' (2012); and (b) submit a report to the administering authority proposing groundwater level trigger thresholds, derived from the results of the groundwater model, to populate **Table I3 (Groundwater standing water level trigger thresholds).**

Table I1 (Groundwater monitoring locations and frequency)					
Monitoring point	Location (GDA2020)		Hydrogeological Unit	Surface RL (mAHD)	Monitoring frequency
	Latitude	Longitude			
Reference bore-					
GW04B	-22.69090	147.55675	Permian conglomerate	314	Quarterly
Compliance bores					
BA Station (Mayes Bore)	-22.67855	147.55946	Tertiary Basalt	324	Quarterly
Curtis Windmill	-22.66615	147.56694	Tertiary Basalt	325	Quarterly

Notes:

[1] Monitoring is not required where a bore has been removed as a direct result of the mining activity.
[2] RL must be measured to the nearest 5cm from the top of the bore casing.
[3] Reference sites must:
(a) have a similar flow regime
(b) be from the same bio-geographic and climatic region
(c) have similar geology, soil types and topography
(d) not be so close to the test sites that any disturbance at the test site also results in a change at the reference site.

Table I2 (Groundwater quality trigger thresholds)				
Parameter	Units	Trigger value		Trigger type
		Curtis Windmill	BA Station	
EC	µS/cm	**883**	**631**	**Bore specific**
pH	pH units	6.5-8.5	6.5-8.5	WQO*
Sulfate	mg/L	**19**	**24**	**Bore specific**
Metals (dissolved)				
Aluminium	mg/L	0.055	0.055	ANZG
Arsenic	mg/L	0.013	**0.027**	ANZG and **bore specific**
Boron	mg/L	0.94	0.94	ANZG
Cadmium	mg/L	0.0002	0.0002	ANZG
Chromium	mg/L	0.001	0.001	ANZG
Copper	mg/L	**0.005**	**0.004**	**Bore specific**

Lead	mg/L	0.0034	0.0034	ANZG
Manganese	mg/L	1.9	1.9	ANZG
Mercury	mg/L	0.00006	0.00006	ANZG
Molybdenum	mg/L	0.034	0.034	ANZG
Nickel	mg/L	**0.012**	0.011	**Bore specific** and ANZG
Silver	mg/L	0.0005	0.0005	ANZG
Vanadium	mg/L	0.006	0.006	ANZG
Zinc	mg/L	**0.021**	**0.009**	**Bore specific**
Iron	mg/L	*Iron is monitored for interpretation purposes*		
Major ions	mg/L	*Calcium, Magnesium, Potassium, Sodium, Chloride, Bicarbonate and Carbonate are monitored for interpretation purposes*		

Table I3 (Groundwater standing water level trigger thresholds)			
Monitoring location	Hydrogeological Unit	Baseline water level (mAHD)	Standing water level trigger threshold (mAHD)
BA Station (Mayes Bore)	Tertiary Basalt	TBD	TBD
Curtis Windmill	Tertiary Basalt	TBD	TBD
GW04B	Permian Conglomerate	TBD	TBD

Definitions

Key terms and/or phrases used in this document are defined in this section. Where a term is not defined, the definition in the *Environmental Protection Act 1994*, its regulations or environmental protection policies must be used. If a word remains undefined it has its ordinary meaning.

"**20th percentile flow**" means the 20th percentile of all daily flow measurements (or estimations) of daily flow over a 10 year period for a particular site. The 20th percentile calculation should only include days where flow has been measured (or estimated), i.e. not dry weather days.

"**acid mine drainage**" means drainage that is characterised by low pH, elevated metal concentrations, high sulfate concentrations and high salinity.

"**acceptance criteria**" means the measures by which the actions implemented to rehabilitate the land are deemed to be complete. The acceptance criteria indicate the success of the rehabilitation outcome or remediation of areas which have been significantly disturbed by the mining activities. Acceptance criteria may include information regarding:

(a) vegetation establishment, survival and succession
(b) vegetation productivity, sustained growth and structure development
(c) fauna colonisation and habitat development
(d) ecosystem processes such as soil development and nutrient cycling, and the recolonisation of specific fauna groups such as collembola, mites and termites which are involved in these processes
(e) microbiological studies including recolonisation by mycorrhizal fungi, microbial biomass and respiration
(f) effects of various establishment treatments such as deep ripping, topsoil handling, seeding and fertiliser application on vegetation growth and development
(g) resilience of vegetation to disease, insect attack, drought and fire
(h) vegetation water use and effects on ground water levels and catchment yields.

"**administering authority**" means the Department of Environment and Heritage Protection or its successor.

"**affected person**" is someone whose drinking water can potentially be impacted as a result of discharges from a dam or their life or property can be put at risk due to dwellings or workplaces being in the path of a dam break flood.

"**airblast overpressure**" means energy transmitted from the blast site

within the atmosphere in the form of pressure waves. The maximum excess pressure in this wave, above ambient pressure is the peak airblast overpressure measured in decibels linear (dBL).

"**ambient (or total) noise**" at a place, means the level of noise at the place from all sources (near and far), measured as the Leq for an appropriate time interval.

"**annual exceedance probability or AEP**" the probability that at least one event in excess of a particular magnitude will occur in any given year.

"**annual inspection report**" means an assessment prepared by a suitably qualified and experienced person containing details of the assessment against the most recent consequence assessment report and design plan (or system design plan);

(a) against recommendations contained in previous annual inspections reports;
(b) against recognised dam safety deficiency indicators;
(c) for changes in circumstances potentially leading to a change in consequence category;
(d) for conformance with the conditions of this authority;

(e) for conformance with the 'as constructed' drawings;
(f) for the adequacy of the available storage in each regulated dam, based on an actual observation or observations taken after 31 May each year but prior to 1 November of that year, of accumulated sediment, state of the containment barrier and the level of liquids in the dam (or network of linked containment systems);
(g) for evidence of conformance with the current operational plan.

"**appropriately qualified person**" means a person who has professional qualifications, training, skills or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis on performance relative to the subject matter using the relevant protocols, standards, methods or literature.

"**assessed or assessment**" by a suitably qualified and experienced person in relation to a consequence assessment of a dam, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit of the assessment:

(a) exactly what has been assessed and the precise nature of that determination;
(b) the relevant legislative, regulatory and technical criteria on which the assessment has been based;
(c) the relevant data and facts on which the assessment has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and
(d) the reasoning on which the assessment has been based using the relevant data and facts, and the relevant criteria.

"**associated works**" in relation to a dam, means:

(a) operations of any kind and all things constructed, erected or installed for that dam;
(b) and any land used for those operations.

"**authority**" means an environmental authority or a development approval.

"**background**" with reference to the water schedule means the average of samples taken prior to the commencement of mining from the same waterway that the current sample has been taken.

"**blasting**" means the use of explosive materials to fracture:

(a) rock, coal and other minerals for later recovery or
(b) structural components or other items to facilitate removal from a site or for reuse.

"**certified**" with respect to watercourse diversions, means assessed and approved by a suitably qualified and experienced person. In relation to 'as constructed' drawings and specifications, the certification must be by the suitably qualified person who supervised the construction of the watercourse diversion, or re-establishment of the watercourse.

"**certification**" means assessment and approval must be undertaken by a suitably qualified and experienced person in relation to any assessment or documentation required by this Manual, including design plans, 'as constructed' drawings and specifications, construction, operation or an annual report regarding regulated structures, undertaken in accordance with the Board of Professional Engineers of Queensland Policy Certification by RPEQs (ID: 1.4 (2A)).

"**certifying, certify or certified**" have a corresponding meaning as 'certification'.

"**chemical**" means:

(a) an agricultural chemical product or veterinary chemical product within the meaning of the Agricultural and Veterinary Chemicals Code Act 1994 (Commonwealth), or

(b) a dangerous good under the Australian Code for the Transport of Dangerous Goods by Road and Rail approved by the Australian Transport Council, or
(c) a lead hazardous substance within the meaning of the Workplace Health and Safety Regulation 1997, or
(d) a drug or poison in the Standard for the Uniform Scheduling of Drugs and Poisons prepared by the Australian Health Ministers' Advisory Council and published by the Commonwealth, or
(e) any substance used as, or intended for use as:
(i) pesticide, insecticide, fungicide, herbicide, rodenticide, nematicide, miticide, fumigant or related product, or
(ii) a surface active agent, including, for example, soap or related detergent, or
(iii) a paint solvent, pigment, dye, printing ink, industrial polish, adhesive, sealant, food additive, bleach, sanitiser, disinfectant, or biocide, or
(iv) a fertiliser for agricultural, horticultural or garden use, or
(v) a substance used for, or intended for use for mineral processing or treatment of metal, pulp and paper, textile, timber, water or wastewater, or
(vi) manufacture of plastic or synthetic rubber.

"**competent person**" means a person with the demonstrated skill and knowledge required to carry out the task to a standard necessary for the reliance upon collected data or protection of the environment.

"**commercial place**" means a work place used as an office or for business or commercial purposes, which is not part of the mining activity and does not include employees accommodation or public roads.

"**compliance bore**" refers to a groundwater monitoring bore which is the subject of compliance requirements for groundwater quality and/or level.

"**construction or constructed**" in relation to a dam includes building a new dam and modifying or lifting an existing dam, but does not include investigations and testing necessary for the purpose of preparing a design plan.

"**consequence**" in relation to a structure as defined, means the potential for environmental harm resulting from the collapse or failure of the structure to perform its primary purpose of containing, diverting or controlling flowable substances.

"**consequence category**" means a category, either low, significant or high, into which a dam is assessed as a result of the application of tables and other criteria in the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933).

"**dam**" means a land-based structure or a void that contains, diverts or controls flowable substances, and includes any substances that are thereby contained, diverted or controlled by that land-based structure or void and associated works.

"**dam crest volume**" means the volume of material (liquids and/or solids) that could be within the walls of a dam at any time when the upper level of that material is at the crest level of that dam. That is, the instantaneous maximum volume within the walls, without regard to flows entering or leaving (for example, via spillway).

"**design plan**" is a document setting out how all identified consequence scenarios are addressed in the planned design and operation of a regulated structure.

"**design storage allowance or DSA**" means an available volume, estimated in accordance with the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933) published by the administering authority, must be provided in a dam as at 1 November each year in order to prevent a discharge from that dam to an annual exceedance probability (AEP) specified in that Manual.

"**designer**" for the purposes of a regulated dam, means the certifier of the design plan for the regulated dam.

"**development approval**" means a development approval under the Planning Act 2016 (or under the repealed Sustainable Planning Act 2009 or Integrated Planning Act 1997) in relation to a matter that involves an environmentally relevant activity under the Environmental Protection Act 1994.

"**disturbance**" of land includes:

(a) compacting, removing, covering, exposing or stockpiling of earth
(b) removal or destruction of vegetation or topsoil or both to an extent where the land has been made susceptible to erosion
(c) carrying out mining within a watercourse, waterway, wetland or lake
(d) the submersion of areas by tailings or hazardous contaminant storage and dam/structure walls
(e) temporary infrastructure, including any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc) which is to be removed after the mining activity has ceased
(f) releasing of contaminants into the soil, or underlying geological strata.

However, the following areas are not included when calculating areas of 'disturbance':

(a) areas off lease (e.g. roads or tracks which provide access to the mining lease)
(b) areas previously disturbed which have achieved the rehabilitation outcomes
(c) by agreement with the administering authority, areas previously disturbed which have not achieved the rehabilitation objective(s) due to circumstances beyond the control of the mine operator (such as climatic conditions)
(d) areas under permanent infrastructure. Permanent infrastructure includes any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc) which is to be left by agreement with the landowner
(e) disturbance that pre-existed the grant of the tenure.

"**EC**" means electrical conductivity.

"**effluent**" means treated waste water released from sewage treatment plants.

"**environmental offset**" has the meaning in section 7 of the Environmental Offsets Act 2014.

"**environmental authority**" means an environmental authority granted in relation to an environmentally relevant activity under the Environmental Protection Act 1994.

"**emergency action plan**" means documentation forming part of the operational plan held by the holder or a nominated responsible officer, that identifies emergency conditions that sets out procedures and actions that will be followed and taken by the dam owner and operating personnel in the event of an emergency. The actions are to minimise the risk and consequences of failure, and ensure timely warning to affected persons and the implementation of protection measures. The plan must require dam owners to annually review and update contact information where required.

"**environmental authority holder**" means the holder of this environmental authority.

"**equilibrium**" means a state where 'balance' is achieved despite changing variables.

"**existing structure**" means a structure that prior to 30 August 2017 meets any or both of the following, a structure:

(a) with a design that is in accordance with the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1934, Version 8.0, 05 JUL 2017) and that is considerably in progress;

(b) that is under considerable construction or that is constructed.

"**extreme storm storage**" - means a storm storage allowance determined in accordance with the criteria in the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933) published by the administering authority.

"**flare pit**" means containment area where any hydrocarbon that is discovered in an over-pressured reservoir during a drilling operation is diverted to, and combusted. The flare pit is only used during the drilling and work over process on a petroleum well.

"**flowable substance**" means matter or a mixture of materials which can flow under any conditions potentially affecting that substance. Constituents of a flowable substance can include water, other liquids fluids or solids, or a mixture that includes water and any other liquids fluids or solids either in solution or suspension.

"**foreseeable future**" is the period used for assessing the total risk of an event occurring. Permanent structures and ecological sustainability should be expected to still exist at the end of a 150 year foreseeable future with an acceptable risk of failure before that time.

"**infrastructure**" means water storage dams, roads and tracks, buildings and other structures built for the purpose of mining activities but does not include other facilities required for the long term management of mining impacts or the protection of potential resources. Such other facilities include dams containing hazardous waste, waste rock dumps, voids, or ore stockpiles and buildings as well as other structures whose ownership can be transferred and which have a residual beneficial use for the next owner of the operational land or the background land owner.

"**hazard category**" means a category, either low, significant or high, into which a dam is assessed as a result of the application of tables and other criteria in *Manual for Assessment Hazard Categories and Hydraulic Performance of Dams*.

"**hazardous waste**" means any substance, whether liquid, solid or gaseous, derived by or resulting from, the processing of minerals that tends to destroy life or impair or endanger health.

"**holder**" means:

(a) where this document is an environmental authority, any
(b) person who is the holder of, or is acting under, that
(c) environmental authority; or
(d) where this document is a development approval, any person who is the registered operator for that development approval.

"**hydraulic performance**" means the capacity of a regulated dam to contain or safely pass flowable substances based on the design criteria specified for the relevant consequence category in the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933).

"**hydrogeological unit**" is any soil or rock unit or zone that by virtue of its hydraulic properties has a distinct influence on the storage or movement of groundwater.

"**infrastructure**" means water storage dams, levees, roads and tracks, buildings and other structures built for the purpose of the mining activity.

"**interpretation bore**" means a monitoring bore located outside of any potential influence or impact by the mining activity, that is used for comparative and interpretative purposes and represents natural background quality and levels similar to the hydrogeological units of the compliance bores.

"**LA 10, adj, 10 mins**" means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 10% of any 10-minute measurement period, using Fast response.

"**LA 1, adj, 10 mins**" means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 1% of any 10-minute measurement period, using Fast response.

"**LA, max adj, T**" means the average maximum A-weighted sound pressure level, adjusted for noise character and measured over any 10 minute period, using Fast response.

"**land**" in the 'land schedule' of this document means land excluding waters and the atmosphere, that is, the term has a different meaning from the term as defined in the Environmental Protection Act 1994. For the purposes of the Acts Interpretation Act 1954, it is expressly noted that the term 'land' in this environmental authority relates to physical land and not to interests in land.

"**land capability**" as defined in the DME 1995 Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland.

"**land suitability**" as defined in the DME 1995 Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland.

"**land use**" term to describe the selected post mining use of the land, which is planned to occur after the cessation of mining operations.

"**leachate**" means a liquid that has passed through or emerged from, or is likely to have passed through or emerged from, a material stored, processed or disposed of at the operational land which contains soluble, suspended or miscible contaminants likely to have been derived from the said material.

"**levee**" means an embankment that only provides for the containment and diversion of stormwater or flood flows from a contributing catchment, or containment and diversion of flowable materials resulting from releases from other works, during the progress of those stormwater or flood flows or those releases; and does not store any significant volume of water or flowable substances at any other times.

"**low consequence dam**" means any dam that is not a high or significant consequence category as assessed using the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933).

"**mandatory reporting level or MRL**" means a warning and reporting level determined in accordance with the criteria in the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933) published by the administering authority.

"**manual**" means the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933) published by the administering authority, as amended from time to time.

"**mandatory reporting level**" means the volume below the spillway crest, equivalent to the lower of the AEP, 72 hour storm or the AEP wave allowance (AEP is the annual exceedance probability).

"**measures**" includes any measures to prevent or minimise environmental impacts of the mining activity such as bunds, silt fences, diversion drains, capping, and containment systems.

"**mine affected water**":

(a) means the following types of water:
(i) pit water, tailings dam water, processing plant water
(ii) water contaminated by a mining activity which would have been an environmentally relevant activity under Schedule 2 of the Environmental Protection Regulation 2008 if it had not formed part of the mining activity
(iii) rainfall runoff which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated, excluding rainfall runoff discharging through release points associated with erosion

and sediment control structures that have been installed in accordance with the standards and requirements of an Erosion and Sediment Control Plan to manage such runoff, provided that this water has not been mixed with pit water, tailings dam water, processing plant water or workshop water
(iv) groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated
(v) groundwater from the mine's dewatering activities
(vi) a mix of mine affected water (under any of paragraphs i)-v) and other water.

(b) does not include surface water runoff which, to the extent that it has been in contact with areas disturbed by mining activities that have not yet been completely rehabilitated, has only been in contact with:
(i) land that has been rehabilitated to a stable landform and either capped or revegetated in accordance with
the acceptance criteria set out in the environmental authority but only still awaiting maintenance and monitoring of the rehabilitation over a specified period of time to demonstrate rehabilitation success, or
(ii) land that has partially been rehabilitated and monitoring demonstrates the relevant part of the landform with which the water has been in contact does not cause environmental harm to waters or groundwater, for example:
    a. areas that are been capped and have monitoring data demonstrating hazardous material adequately contained with the site
    b. evidence provided through monitoring that the relevant surface water would have met the water quality parameters for mine affected water release limits in this environmental authority, if those parameters had been applicable to the surface water runoff, or
(iii) both.

"**minimise**" is to reduce to the smallest possible amount or degree.

"**mineral**" means a substance which normally occurs naturally as part of the earth's crust or is dissolved or suspended in water within or upon the earth's crust and includes a substance which may be extracted from such a substance, and includes-

(a) clay if mined for use for its ceramic properties, kaolin and bentonite
(b) foundry sand
(c) hydrocarbons and other substances or matter occurring in association with shale or coal and necessarily mined, extracted, produced or released by or in connection with mining for shale or coal or for the purpose of enhancing the safety of current or future mining operations for coal or the extraction or production of mineral oil there from
(d) limestone if mined for use for its chemical properties
(e) marble
(f) mineral oil or gas extracted or produced from shale or coal by in situ processes
(g) pea;
(h) salt including brine
(i) shale from which mineral oil may be extracted or produced
(j) silica, including silica sand, if mined for use for its chemical properties
(k) rock mined in block or slab form for building or monumental purposes
(l) but does not include-
(m) living matter
(n) petroleum within the meaning of the Petroleum Act 1923
(o) soil, sand, gravel or rock (other than rock mined in block or slab form for building or monumental purposes) to be used or to be supplied for use as such, whether intact or in broken form and
(p) water.

"**modification or modifying**" (see definition of 'construction')

"**monitoring bore**" means a groundwater bore that provides access to groundwater for measuring its quality and level; and allows groundwater samples to be withdrawn for laboratory analysis.

"**NATA**" means National Association of Testing Authorities, Australia.

"**natural flow**" means the flow of water through waters caused by nature.

"**non-polluting**" means having no adverse impacts upon the receiving environment.

"**noxious**" means harmful or injurious to health or physical wellbeing, other than trivial harm.

"**offensive**" means causing reasonable offence or displeasure; is disagreeable to the sense; disgusting, nauseous or repulsive, other than trivial harm.

"**operational plan**" includes:

(a) normal operating procedures and rules (including clear documentation and definition of process inputs in the DSA);
(b) contingency and emergency action plans including operating procedures designed to avoid and/or minimise environmental impacts including threats to human life resulting from any overtopping or loss of structural integrity of the regulated structure.

"**peak particle velocity (ppv)**" means a measure of ground vibration magnitude which is the maximum rate of change of ground displacement with time, usually measured in millimetres/second (mms- 1).

"**permanent watercourse diversion**" is as defined in Definitions, within the *Guideline: Works that interfere with water in a watercourse for a resource activity— watercourse diversions authorised under the Water Act 2000* or subsequent versions

"**pre-existing watercourse**" is the section of watercourse from which the flow of water will be diverted as a result of the construction and operation of a watercourse diversion.

"**protected area**" means - a protected area under the Nature Conservation Act 1992 or:

(a) a marine park under the Marine Parks Act 2004 or
(b) a World Heritage Area

"**progressive rehabilitation**" means rehabilitation (defined below) undertaken progressively or a staged approach to rehabilitation as mining operations are ongoing.

"**receiving waters**" means the waters into which this environmental authority authorises releases of mine affected water.

"**reference site**" (or analogue site) may reflect the original location, adjacent area or another area where rehabilitation success has been completed for a similar biodiversity. Details of the reference site may be as photographs, computer generated images and vegetation models etc.

"**register of Regulated Structures**" includes:

(a) Date of entry in the register;
(b) Name of the structure, its purpose and intended/actual contents;
(c) The consequence category of the dam as assessed using the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933);
(d) Dates, names, and reference for the design plan plus dates, names, and reference numbers of all document(s) lodged as part of a design plan for the dam;

(e) Name and qualifications of the suitably qualified and experienced person who certified the design plan and 'as constructed' drawings;
(f) For the regulated dam, other than in relation to any levees –
(i) The dimensions (metres) and surface area (hectares) of the dam measured at the footprint of the dam;
(ii) Coordinates (latitude and longitude in GDA94) within five metres at any point from the outside of the dam including its storage area
(iii) Dam crest volume (megalitres);
(iv) Spillway crest level (metres AHD).
(v) Maximum operating level (metres AHD);
(vi) Storage rating table of stored volume versus level (metres AHD);
(vii) Design storage allowance (megalitres) and associated level of the dam (metres AHD);
(viii) Mandatory reporting level (metres AHD);
(g) The design plan title and reference relevant to the dam;
(h) The date construction was certified as compliant with the design plan;
(i) The name and details of the suitably qualified and experienced person who certified that the constructed dam was compliant with the design plan;
(j) Details of the composition and construction of any liner;
(k) The system for the detection of any leakage through the floor and sides of the dam;
(l) Dates when the regulated dam underwent an annual inspection for structural and operational adequacy, and to ascertain the available storage volume for 1 November of any year;
(m) Dates when recommendations and actions arising from the annual inspection were provided to the administering authority;
(n) Dam water quality as obtained from any monitoring required under this authority as at 1 November of each year.

"**regulated structure**" means any structure in the significant or high consequence category as assessed using the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933) published by the administering authority. A regulated structure does not include:

- a fabricated or manufactured tank or container, designed and constructed to an Australian Standard that deals with strength and structural integrity of that tank or container;
- a sump or earthen pit used to store residual drilling material and drilling fluid only for the duration of drilling and well completion activities;
- a flare pit.

"**rehabilitation**" the process of reshaping and revegetating land to restore it to a stable landform and in accordance with the acceptance criteria set out in this environmental authority and, where relevant, includes remediation of contaminated land.

"**revegetation**" is the re-establishment of vegetation1 of a species and density of cover similar to surrounding undisturbed areas or the landform that existed before mining activities on soil surfaces associated with the construction or rehabilitation of a watercourse diversion.

"**RL**" means reduced level, relative to mean sea level as distinct from depths to water.

"**representative**" means a sample set which covers the variance in monitoring or other data either due to natural changes or operational phases of the mining activities.

"**residual drilling material**" means waste drilling materials including muds and cuttings or cement returns from well holes and which have been left behind after the drilling fluids are pumped out.

"**residual void**" means an open pit resulting from the removal of ore and/or waste rock which will remain following the cessation of all mining activities and completion of rehabilitation processes.

"**saline drainage**" The movement of waters, contaminated with salt(s), as a result of the mining activity.

"**self-sustaining**" means an area of land which has been rehabilitated and has maintained the required acceptance criteria without human intervention for a period nominated by the administering authority.

"**sensitive place**" means;

(a) a dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises or
(b) a motel, hotel or hostel or
(c) an educational institution or
(d) a medical centre or hospital or
(e) a protected area under the Nature Conservation Act 1992, the Marine Parks Act 1992 or a World Heritage Area or
(f) a public park or gardens.

Note: The definition of 'sensitive place' and 'commercial place' is based on Schedule 1 of EPP Noise. That is, a sensitive place is inside or outside on a dwelling, library and educational institution, childcare or kindergarten, school or playground, hospital, surgery or other medical institution, commercial and retail activity, protected area or an area identified under a conservation plan under Nature Conservation Act 1992 as a critical habitat or an area of major interest, marine park under Marine Parks Act 2004, park or garden that is outside of the mining lease and open to the public for the use other than for sport or organised entertainment. A commercial place is inside or outside a commercial or retail activity.

A mining camp (i.e., accommodation and ancillary facilities for mine employees or contractors, or both, associated with the mine the subject of the environmental authority) is not a sensitive place for that mine or= mining project, whether or not the mining camp is located within a mining tenement that is part of the mining project the subject of the environmental authority. For example, the mining camp might be located on neighbouring land owned or leased by the same company as one of the holders of the environmental authority for the mining project, or a related company. Accommodation for mine employees or contractors is a sensitive place if the land is held by a mining company or related company, and if occupation is restricted to the employees, contractors and their families for the particular mine or mines which are held by the same company or a related company.

For example, a township (occupied by the mine employees, contractors and their families for multiple mines that are held by different companies) would be a sensitive place, even if part or all of the township is constructed on land owned by one or more of the companies.

"**significant disturbance**" - includes land

(a) if it is contaminated land or
(b) it has been disturbed and human intervention is needed to rehabilitate it to a state required under the relevant environmental authority or
(c) if the environmental authority does not require the land to be rehabilitated to a particular state - to its state immediately before the disturbance.

Some examples of disturbed land include:

- areas where soil has been compacted, removed, covered, exposed or stockpiled
- areas where vegetation has been removed or destroyed to an extent where the land has been made susceptible to erosion; (vegetation and topsoil)

- areas where land use suitability or capability has been diminished
- areas within a watercourse, waterway, wetland or lake where mining activities occur
- areas submerged by tailings or hazardous contaminant storage and dam walls in all cases
- areas under temporary infrastructure. Temporary infrastructure includes any infrastructure (roads, tracks, bridges, culverts, dams, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc) which is to be removed after mining activities have ceased or
- areas where land has been contaminated and a suitability statement has not been issued

However, the following areas are not included:
- areas off lease (e.g. roads or tracks which provide access to the mining lease)
- areas previously significantly disturbed which have achieved the rehabilitation outcomes
- by agreement with the Department of Environment and Resource Management, areas previously significantly disturbed which have not achieved the rehabilitation objective(s) due to circumstances beyond the control of the mine operator (such as climatic conditions)
- areas under permanent infrastructure. Permanent infrastructure includes any infrastructure (roads, tracks, bridges, culverts, dams, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc) which is to be left by agreement with the landowner. The agreement to leave permanent infrastructure must be recorded in the Landowner Agreement and lodged with the Department of Environment and Resource Management
- disturbances that pre-existed the grant of the tenure unless those areas are disturbed during the term of the tenure.

"**spillway**" means a weir, channel, conduit, tunnel, gate or other structure designed to permit discharges form the dam, normally under flood conditions or in anticipation of flood conditions.

"**stable**" means geotechnical stability of the rehabilitated landform where instability related to the excessive settlement and subsidence caused by consolidation / settlement of the wastes deposited, and sliding / slumping instability has ceased.

"**structure**" means dam or levee.

"**suitably qualified and experienced person**" in relation to regulated structures means a person who is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the Professional Engineers Act 2002, and has demonstrated competency and relevant experience:

- for regulated dams, an RPEQ who is a civil engineer with the required qualifications in dam safety and dam design
- for regulated levees, an RPEQ who is a civil engineer with the required qualifications in the design of flood protection embankments.

Note: It is permissible that a suitably qualified and experienced person obtain subsidiary certification from an RPEQ who has demonstrated competence and relevant experience in either geomechanics, hydraulic design or engineering hydrology.

"**system design plan**" means a plan that manages an integrated containment system that shares the required DSA and/or ESS volume across the integrated containment system.

"**temporary watercourse diversion**" s as defined in Definitions, within the Guideline: Works that interfere with water in a watercourse for a resource activity— watercourse diversions authorised under the Water Act 2000 or subsequent versions.

"**the Act**" means the *Environmental Protection Act 1994*.

"**tolerable limits**" means that a range of values could be accepted to achieve an overall environmental management objective (e.g. a range of settlement of a tailing capping could still meet the objective of draining the cap quickly, preventing pondage and limiting infiltration and percolation).

"**trivial harm**" means environmental harm which is not material or serious environmental harm and will not cause actual or potential loss or damage to property of an amount of, or amounts totalling more than $5,000.

"**void**" means any constructed, open excavation in the ground.

"**watercourse**" has the same meaning given in the Water Act 2000.

"**waters**" includes all or any part of a river, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, unconfined water in natural or artificial watercourses, bed and banks of a watercourse, dams, nontidal or tidal waters (including the sea), stormwater channel, stormwater drain, roadside gutter, stormwater run-off, and groundwater.

"**water year**" means the 12-month period from 1 July to 30 June.

"**wet season**" means the time of year, covering one or more months, when most of the average annual rainfall in a region occurs. For the purposes of DSA determination this time of year is deemed to extend from 1 November in one year to 31 May in the following year inclusive.

Figure 1 – Blair Athol Mine authorised disturbance footprint

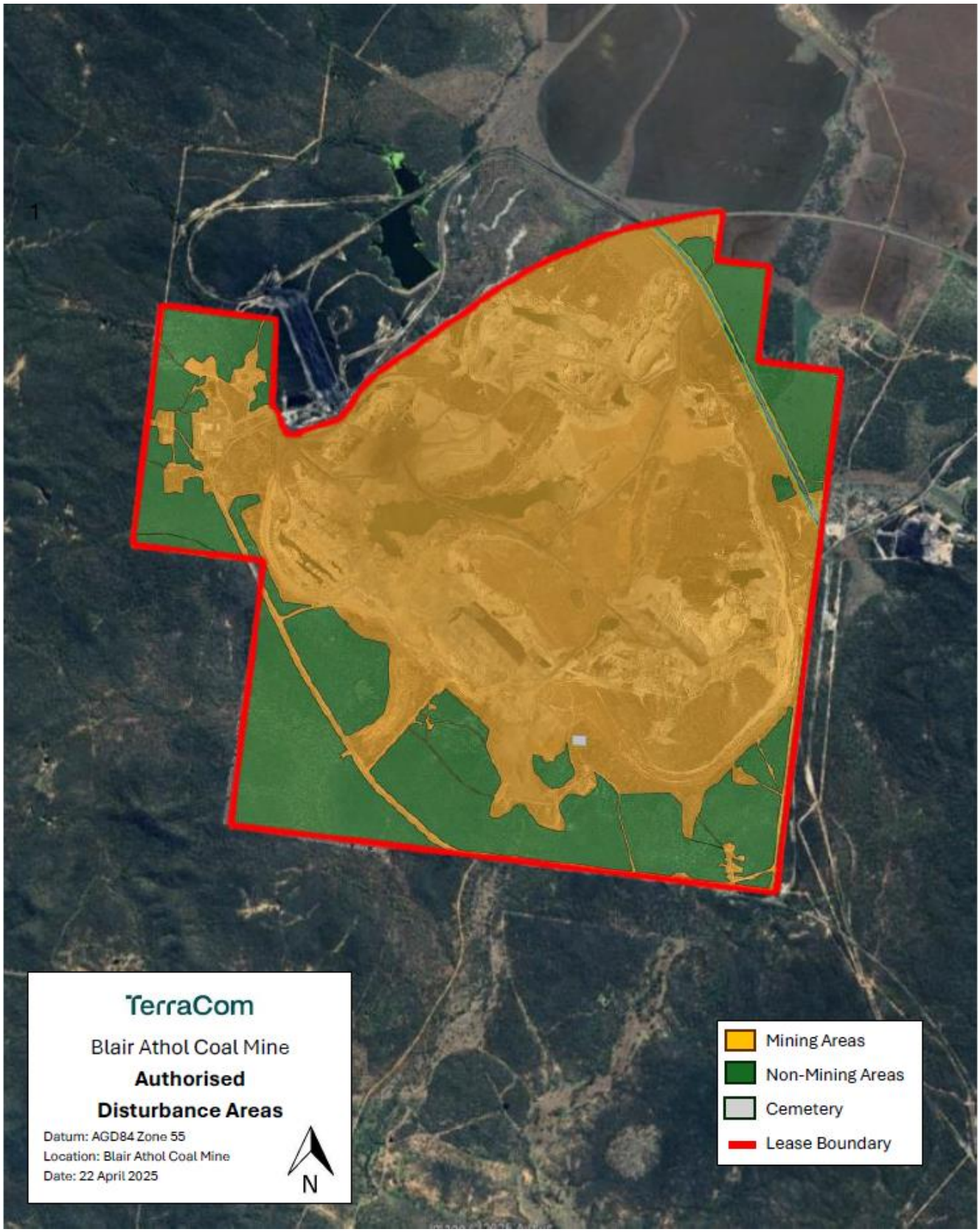
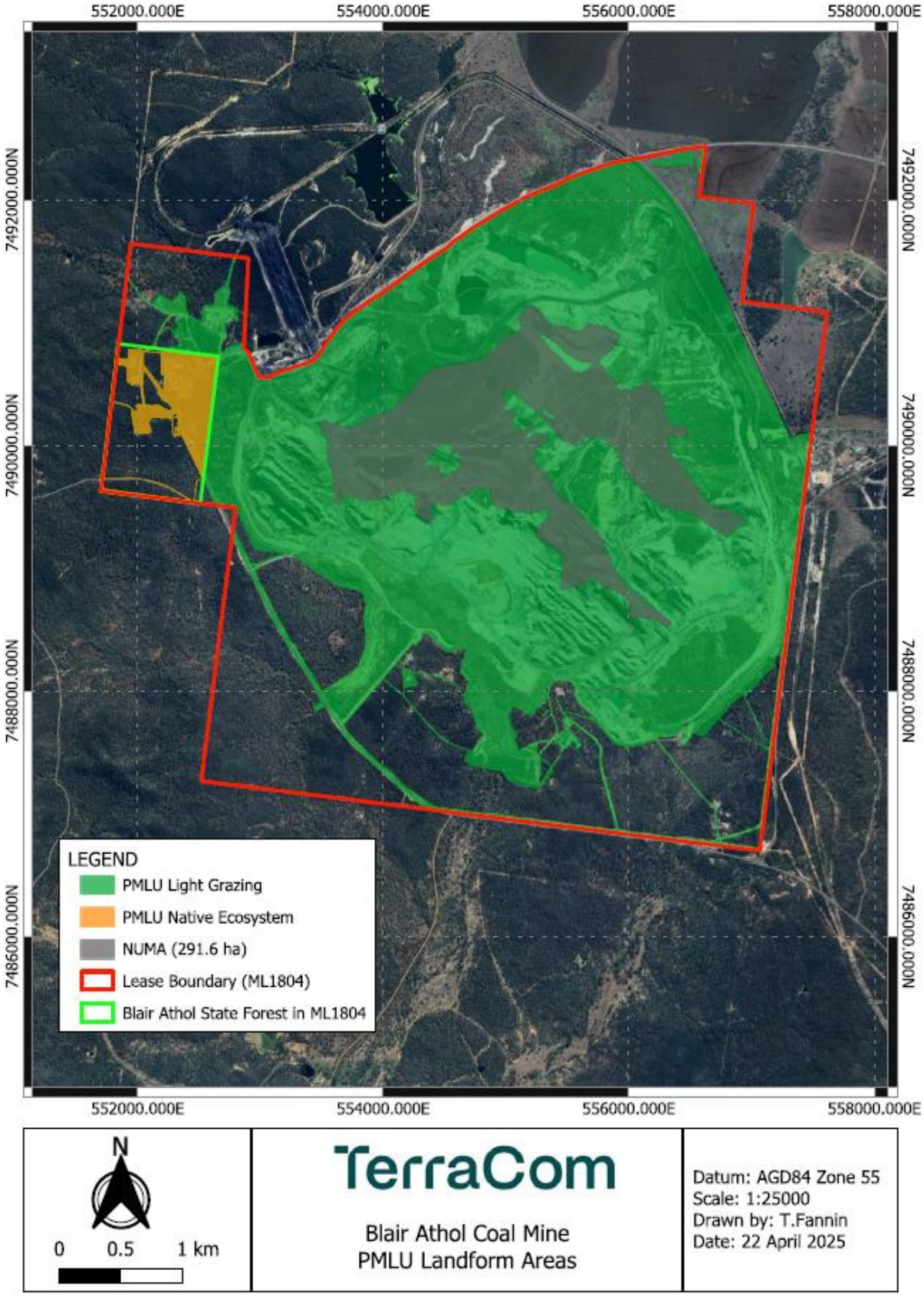
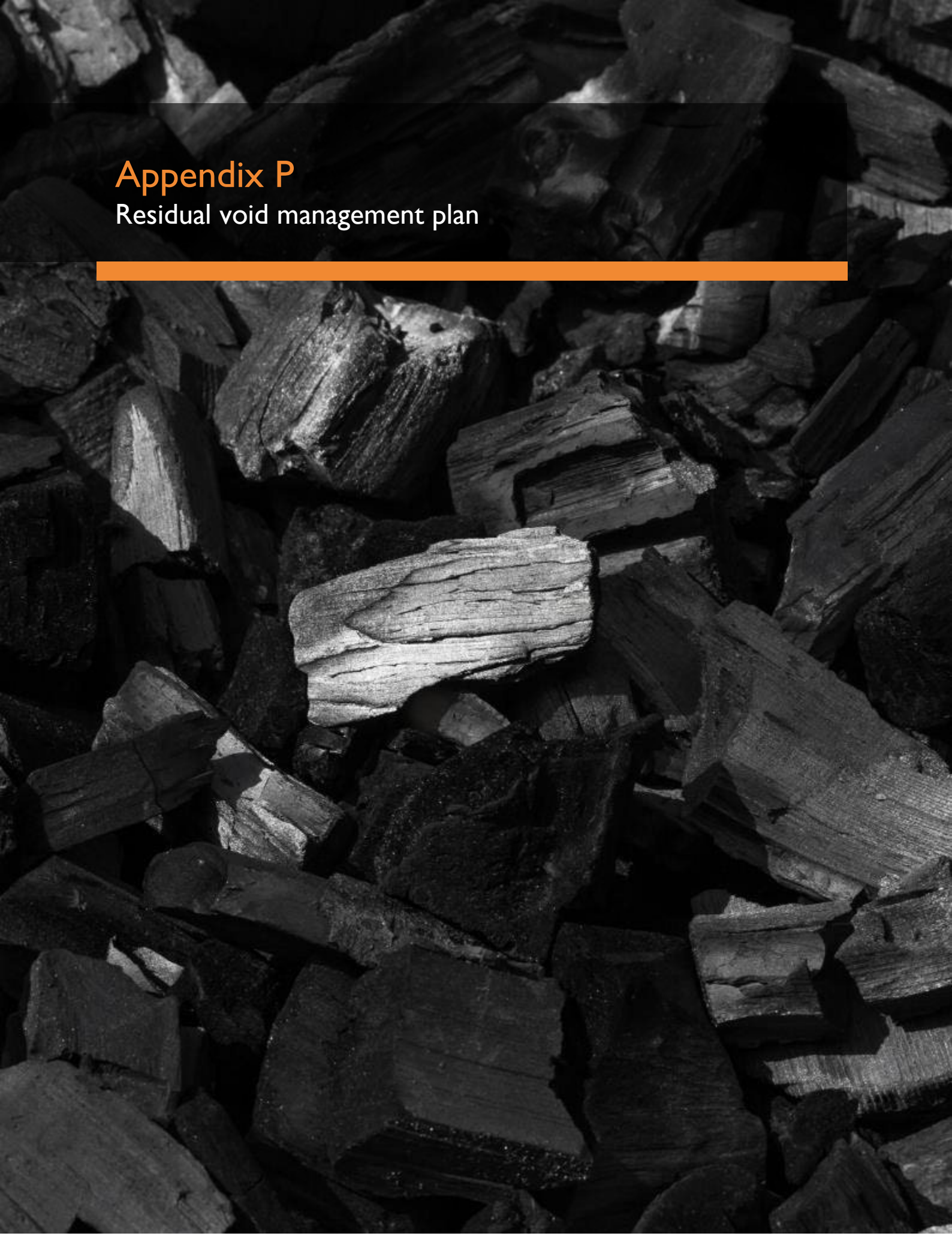


Figure 2 – Blair Athol Mine PMLU Landform Areas



END OF ENVIRONMENTAL AUTHORITY



Appendix P
Residual void management plan

This page is intentionally blank.

Blair Athol Coal Mine – Environmental Management System

TerraCom

Residual Void Management Plan

Document Number:	**EMS-PLN-1.6**
Document Version:	**0**
Effective Date:	**30/09/2025**
Document Owner:	**Technical Services Manager**



TABLE OF CONTENTS

1 PURPOSE 4
2 SCOPE 4
3 PROCEDURE 4
4 ACCOUNTABILITIES 4
5 DOCUMENT INFORMATION 4
5.1 DEFINITIONS 4
5.2 RELATED DOCUMENTS 5
5.3 REFERENCE MATERIAL 6
5.4 DOCUMENT VERSION AND HISTORY 7
6 INTRODUCTION 8
6.1 PURPOSE AND SCOPE 8
7 LEGISLATIVE REQUIREMENTS 9
7.1 LEGISLATIVE CONTEXT 9
7.2 BLAIR ATHOL COAL MINE ENVIRONMENTAL AUTHORITY 9
8 EXISTING ENVIRONMENT 12
8.1 SURROUNDING FEATURES AND LAND USE 12
8.2 CLIMATE 12
8.3 BACKGROUND WATER QUALITY 13
8.4 GEOLOGY AND GEOCHEMISTRY 14
8.5 HYDROLOGY 17
8.6 HYDROGEOLOGY 18
8.6.1 GROUNDWATER RESOURCES 18
8.6.2 GROUNDWATER QUALITY 20
8.6.3 GROUNDWATER INFLOW TO FINAL VOID 22
9 LAND USE OPTIONS — RESIDUAL VOID 25
9.1 LAND USE OPTIONS 25
9.2 RESIDUAL VOID AREA MINIMISATION 25
10 HYDROLOGY AND WATER QUALITY 26
10.1 FINAL VOID WATER LEVELS 26
10.1.1 FLOOD EVENTS 26
10.2 FINAL VOID WATER QUALITY 27
11 GEOTECHNICAL STABILITY OF THE VOID 28

11.1 EA REQUIREMENTS 28
11.2 MINING SPOIL 28
11.3 HIGHWALLS 29
12 VOID CAPABILITY TO SUPPORT FLORA AND FAUNA 30
12.1 REHABILITATED LANDFORM 30
12.2 RESIDUAL PIT LAKE 30
13 FINAL RESIDUAL VOID REHABILITATION PERFORMANCE AND SUCCESS CRITERIA 31
13.1 REHABILITATED SPOIL 31
13.2 RESIDUAL HIGHWALLS AND END WALLS 31
13.3 RESIDUAL PIT LAKE 31
13.4 REVIEW AND CORRECTIVE ACTIONS 32
13.5 RECOMMENDATIONS 33
14 REFERENCES 34
APPENDIX A — FIGURES 35
APPENDIX B — ENVIRONMENTAL AUTHORITY 36
APPENDIX C — JBT 2012 GROUNDWATER INVESTIGATION 37
APPENDIX D — BMT WBM 2012 FINAL LANDFORM WATER STUDY 38
APPENDIX E — GEOTECHNICAL STUDIES 39

1 PURPOSE

The purpose of the void management plan.is to guide strategy for the long-term management of the final void at the Blair Athol Coal Mine (BACM) in accordance with Environmental Authority (EA) EPML00876713 issued 11 June 2025

2 SCOPE

The scope of the void management plan is to identify options for final use(s) of the void following completion of open cut mining at BACM, including minimisation of the final void volume, potential environmental impacts associated with the final void and strategies to minimise potential impacts and identify success criteria and monitoring requirements as per the conditions as set out in the EA EPML00876713.

3 PROCEDURE

The procedure is to review relevant site information and regulatory guidelines and assign management plan procedures that align with these components.

4 ACCOUNTABILITIES

Role	Accountabilities
NOTE	Only use this table if there is a role that is not mentioned in the S55 Mgt Structure e.g. Shotfirer, Document Controller

5 DOCUMENT INFORMATION

5.1 Definitions

Term	Definition
BACM	Blair Athol Coal Mine
EA	Environmental Authority
EP Act	Environmental Protection Act
RVMP	Residual Void Management Plan
NUMA	Non-use management area
PMLU	Post-mining land-use
PAF	Potential acid-forming
NAF	Non-acid forming

Term	Definition
TSF	Tailings storage facility
AMD	Acid mine drainage
TDS	Total dissolved solids
EC	Electrical conductivity
pH	Potential of hydrogen
ha	Hectares
Ca	Calcium
Mg	Magnesium
Na	Sodium
K	Potassium
Cl	Chloride
HCO_3	Carbonate
SO_4	Sulphate
mAHD	Metres above height datum
ha	Hectares
L/m	Litre per minute
Ml	Mega litres
%	Percent

5.2 Related Documents

Reference	Title
SGME 2025	Blair Athol Progressive Rehabilitation and Closure Plan
EPML00876713	Environmental Authority

5.3 Reference Material

Reference	Title
BMT-WBM (2012)	BAC Final Landform Water Study. Report to Rio Tinto Coal Australia, November 2012.
(DEHP) (2018)	Environmental Authority EPML00876713 – Blair Athol Coal Mine, January 11, 2018.
JBT Consulting, (2012)	Blair Athol Mine Closure Groundwater Investigation, September 2012.
Queensland Government (1994)	Environmental Protection Act.
Rio Tinto (2006).	Geotechnical Characteristics, Blair Athol Coal Project.
Rio Tinto (2010).	Blair Athol Coal Project Mine Closure Plan, December 2010.
Rio Tinto (2012).	Blair Athol Mine. Ramp 1 South West Contingency 4 (R1SWC4). Geotechnical Review, 20 February 2012.
Rio Tinto (2016).	Blair Athol Acid & Metalliferous Drainage Management. HSEQ MS – Guideline. BAM-10-GUI-EV-0029_1, 21 July 2016.
TerraCom (2018).	Disposal Plan. Overburden, Interburden, Spoil, Coal Washery Coarse Rejects and Tailings. Blair Athol Mine, 21 May 2018.
URS (2006)	Assessment of water and sediment quality of Stockpile Dam and Environment Dam for EPA Hazardous Dam Classification. Letter report from URS to Blair Athol Coal Mine, Document No. 311006, 31 October 2006.

Reference	Title
WSP (2018),	Rehabilitation Management Plan Blair Athol Coal Mine Draft. June 2018.

5.4 Document Version and History

Only the history of the current version is recorded below. For prior version histories, please contact the site Document Controller.

Version	Date	Change Details
A	15/06/2018	Draft (WSP Pty Limited)
B	28/06/2018	Final (WSP Pty Limited)
C	04/09/2025	Revision (SGME Pty Limited)

6 INTRODUCTION

This Blair Athol Coal Mine (Blair Athol) Residual Void Management Plan (RVMP) has been prepared for TerraCom Ltd (TerraCom), to guide strategy for the long-term management of the final void at the Blair Athol Coal Mine (BACM) in accordance with Environmental Authority (EA) EPML00876713 issued 11 June 2025, as presented in Appendix A.

TerraCom acquired Blair Athol Coal Mine through its wholly owned subsidiary Orion Mining Limited in May 2017, following grant of Title Transfer from the Queensland

The acquisition of the Blair Athol Coal Mine brings the following benefits:

- progressive rehabilitation of one of Queensland's oldest coal mines
- resumption of coal mining, and local and export sales from the Blair Athol Coal mine, providing local, state and federal economies with increased economic activity, employment, royalties and taxation
- forecast positive cash flow through a low overhead structure and operational efficiencies.

In accordance with the EA, this RVMP includes specific details for ongoing management and monitoring of mine voids, with the intention of preventing any serious environmental harm to land, surface waters or groundwater across the mine site.

6.1 Purpose and scope

The purpose of this RVMP is to identify options for final use(s) of the void following completion of open cut mining at BACM, including minimisation of the final void volume, potential environmental impacts associated with the final void and strategies to minimise potential impacts and identify success criteria and monitoring requirements as per the conditions as set out in the EA EPML00876713 (Appendix B).

7 LEGISLATIVE REQUIREMENTS

7.1 Legislative context

The Queensland *Environmental Protection Act 1994* (EP Act) is the key legislation for environmental management and protection in Queensland. The EP Act establishes a general environmental duty and a duty to notify environmental harm that applies to all persons and corporations.

The EP Act requires that all areas disturbed within the relevant mining tenure must be rehabilitated to a post-mining land use (PMLU) or managed as a non-use management area (NUMA). NUMAs are only considered appropriate where justified under section 126D(2) of the EP Act.

7.2 Blair Athol Coal Mine Environmental Authority

Blair Athol Coal Mine currently operates under EA EPML00876713, which was issued 11 June 2025 by DETSI, under Section 258 of the EP Act.

This RVMP has been developed to provide a strategy and framework for residual void management and has been developed to meet the legislative requirements under the EA EPML00876713. The EA conditions that have informed the content of this plan include:

F13 *Residual void outcome*

Residual voids must not cause any serious environmental harm to land, surface waters or any recognised groundwater aquifer, other than the environmental harm constituted by the existence of the residual void itself and subject to any other condition within this environmental authority. F14 Residual void design

> *Residual voids must comply with the design criteria specified in Table F1 – Rehabilitation Requirements and as detailed in the Residual Void Management Plan described in condition F16 (*Refer Table 1).

Table 1: Table F1 — NUMA rehabilitation requirements

Post mining land use	Mine domain	Goal	Objective	Indicator	Acceptance criteria
NUMA	Final void	Safe for humans and wildlife, stable and non-polluting	Construct landforms that do not pose unacceptable hazards to humans, stock and wildlife	Highwall Criteria	(a) Maximum slope of 30% when measured from highwall toe to crest. (b) Buttressing at a minimum offset of 30m at the toe section of the highwall. (c) Fencing and warning signage posted at 50m intervals above the final void (d) Must be safe, stable and non-polluting.
				Low Wall Criteria	(a) Maximum slope of 15% slope. (b) Must be safe, stable, non-polluting.
			Demonstrate geotechnical stability Not exhibiting excessive erosion	Erosion	No gully erosion
			Maintain regional surface and groundwater quality	Maximum predicted water level (mAHD)	284.1
				Void maximum surface area	(a) Maximum NUMA extent no greater than 291.6 ha projected surface area. (b) Must be safe, stable and non-polluting

Post mining land use	Mine domain	Goal	Objective	Indicator	Acceptance criteria
			Provide flood immunity.	Flood immunity	Upgrades of Eastern and Western Diversion Drains (EDD and WDD) and levees must provide flood immunity to NUMA up to PMF flood. There must be no ingress.

F15 Residual Void Management Plan

A Residual Void Management Plan developed by an appropriately qualified person must be updated and submitted to the administering authority for approval by 30 June 2018. The Residual Void Management Plan must be reviewed and updated by 30 June every 2 years and made available to the administering authority on request.

F16 At a minimum the Residual Void Management Plan must include:

a) options available for minimising final void area and volume;

b) design objectives for rehabilitation of final voids;

c) void hydrology, addressing the long-term water balance in the voids, connections to groundwater resources and water quality parameters in the long term;

d) pit wall stability, considering the effects of long-term erosion and weathering of the pit wall and the effects of significant hydrological events;

e) options available for minimising risk of flood interaction for all flood events up to and including the Probable Maximum Flood level;

f) void capability to support native flora and fauna; and

g) void rehabilitation success criteria and final void areas and volumes to meet the outcomes defined in the Rehabilitation Management Plan described in Condition F9.

8 EXISTING ENVIRONMENT

The BACM is located in Central Queensland, approximately 20 km north-west of the town of Clermont (Appendix A - Figure 1).

8.1 Surrounding features and land use

BACM is located in a landscape of gently sloping country derived from sedimentary rocks intersected by volcanic intrusions generally to the north of the mine. Large areas of the surrounding countryside have been cleared for low-intensity grazing and broad acre field cropping with only small remnant areas of native woodland vegetation remaining mostly on upper slopes and along watercourses.

The land covered by the mining lease is situated on the eastern flank of the Drummond Range, which forms the watershed of the Fitzroy and Burdekin River systems. Adjoining the mining lease to the north-east are dryland farming areas on fertile basalt derived soils. The remainder of the surrounding land use is forested or partially cleared grazing land.

8.2 Climate

This climatic description of the region in which the project site is located has been compiled using data from the Bureau of Meteorology (BOM) weather station at Clermont Post Office (Station No. 035019) from 1870 to February 2018. Clermont experiences a sub-humid climate with hot, wet summers and cold, dry winters.

Long term climate statistics are shown in Table 2. Annual average rainfall for Clermont is 665.6 mm, with the dry season peaking between July and September, and the wet season peaking from December through to March.

The coldest mean daily temperatures occur in July, with a mean minimum of 6.7ºC and a mean maximum of 23.1ºC. The hottest months occur in December (mean minimum of 20.8ºC and a mean maximum of 34.8ºC) and January (mean minimum of 21.6ºC and a mean maximum of 34.3ºC), with January also the highest rainfall month (average rainfall 117.0 mm). The mean daily evaporation, as measured by the Class A evaporation pan, is 5.7 mm/day (2,082 mm/yr).

Evaporation generally exceeds rainfall by approximately 3:1; annual humidity is generally between 38-63 percent and winds are predominately from the south-east (Rio Tinto 2010).

Table 2: Long term climate statistics BOM Clermont

Month	Temperature (°C)		Rainfall (mm)	
	Mean Maximum	Mean Minimum	Mean	Highest Monthly
Jan	34.3	21.6	117.0	516.0
Feb	33.0	21.1	114.4	428.0
Mar	32.0	19.4	74.6	403.4
Apr	29.5	15.7	38.4	274.2

Month	Temperature (°C)		Rainfall (mm)	
	Mean Maximum	Mean Minimum	Mean	Highest Monthly
May	26.1	11.4	34.1	234.4
Jun	23.1	8.1	33.5	307.2
Jul	23.1	6.7	25.3	192.5
Aug	25.3	8.3	18.7	171.2
Sep	28.8	12.1	20.1	184.9
Oct	31.9	16.3	35.2	165.2
Nov	33.9	19.0	57.0	263.9
Dec	34.8	20.8	91.5	670.7
Annual			665.6	1295.4

Rainfall records are also available for Blair Athol from 1913 to 2010, which reported a slightly lower average annual rainfall of 623.7 mm.

8.3 Background water quality

The catchment area upstream of BACM comprises a number of ephemeral streams; Breaker, Bath and Washpool Creeks. Infrequent rainfall events result in sporadic flows preceded by long dry periods. Upstream catchments vary between timbered hills (Breaker Creek, Washpool Creek, Washpool Creek West) to broad acre cropping (Bath Creek, Washpool Creek East), with variable surface water quality associated with each land use.

Rio Tinto (2010) sourced background water quality from two creeks within the local area considered representative of the catchments upstream of BACM, Sandy Creek (timbered hills) and Wolfgang Creek (grazing and cropping land). The regional background water quality was monitored during flows by the Queensland Government between 1962 and 2001. The water quality data is summarised in Table 3.

Table 3: Water quality monitoring data for local creeks (1962-2001)

Parameter	Sandy Creek			Wolfgang Creek		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Suspended solids (mg/L)	2	1760	222	20	220	87
pH	6.1	8.4	7.6	7.8	8.9	8.35

Parameter	Sandy Creek			Wolfgang Creek		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Total dissolved salts (mg/L)	45.4	771	286	243	1367	927.6
Electrical conductivity (µS/cm)	61	1176	440	335	2630	1622
Total sulfate (mg/L)	1.5	175	31	5	64	24

The results generally reflect higher salinities in the cleared farming land.

8.4 Geology and geochemistry

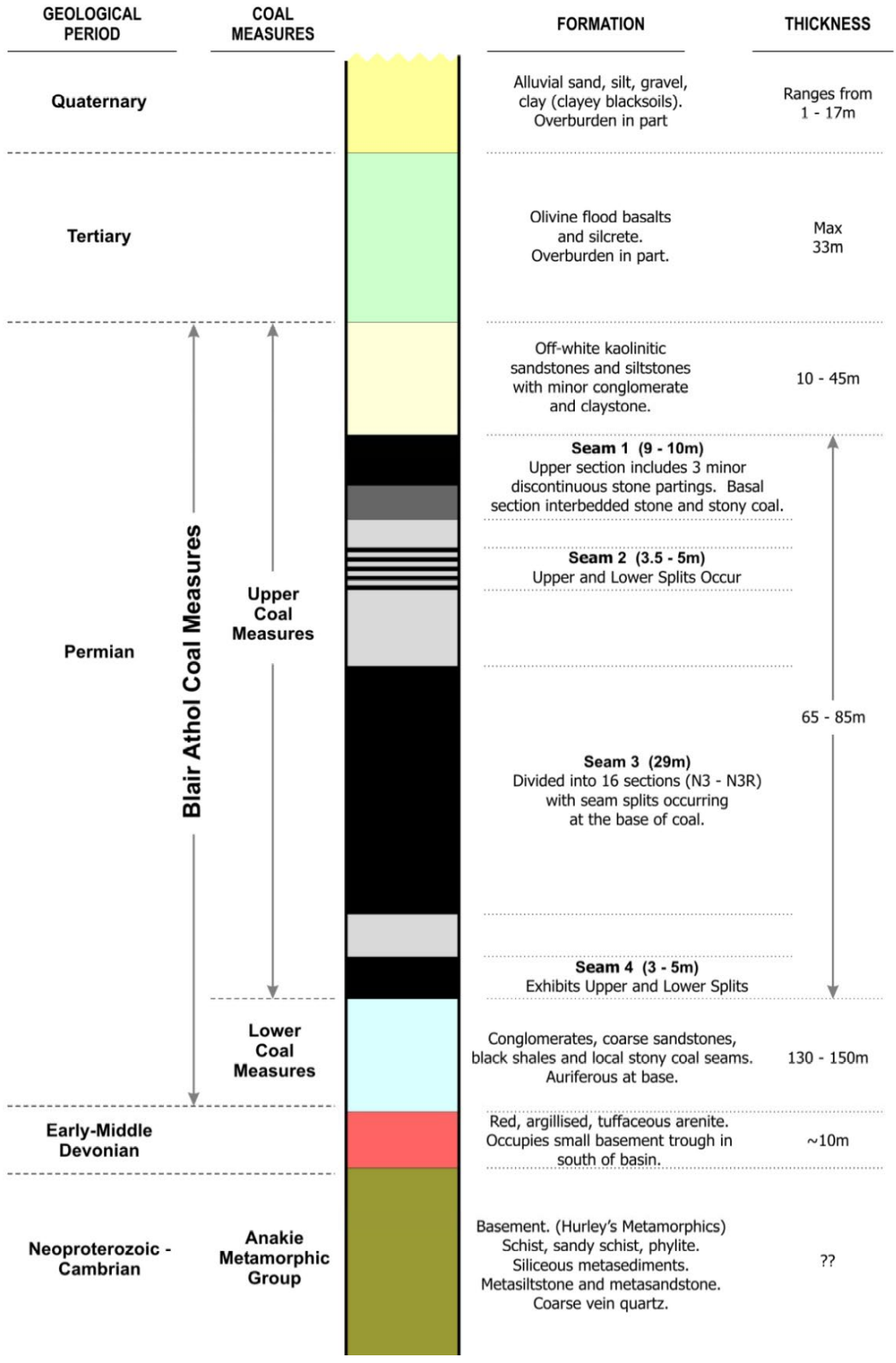
The Blair Athol Mine is in the Blair Athol Basin, an isolated Permian aged basin near the western edge of the northern Bowen Basin, on the northern extension of the Dennison Trough.

The Permian coal basins in the Blair Athol Basin contain Lower Permian Blair Athol Coal Measures, which overlie the Proterozoic/ Cambrian Anakie Metamorphic Group (tightly folded mica, quartz-mica and quartz-chlorite schist, with phyllite, slate and quartzite). The Permian sequence comprises a lower basal conglomerate, which is a quartzose and lithic pebble to cobble conglomerate, thought to be of glacial origin. The basal conglomerate is overlain by the Permian coal-bearing sequence, which includes laminated sandstone and siltstone, coal seams, carbonaceous siltstone and mudstone, and minor conglomerate (refer stratigraphic section, Figure 1).

During the Tertiary (Late Eocene to Middle Oligocene), basalt filled the area from east to west, with initial deposition focused on a deep paleochannel to the east of Clermont. The basalt is derived from nearby volcanoes, the remnants of which are still visible today as andesitic plugs including Mt Oscar and Wolfang Peak. The basalt encountered in the north and north east of the site represents the marginal extent of basalt, with the basalt thickening to the north and north-east of the site.

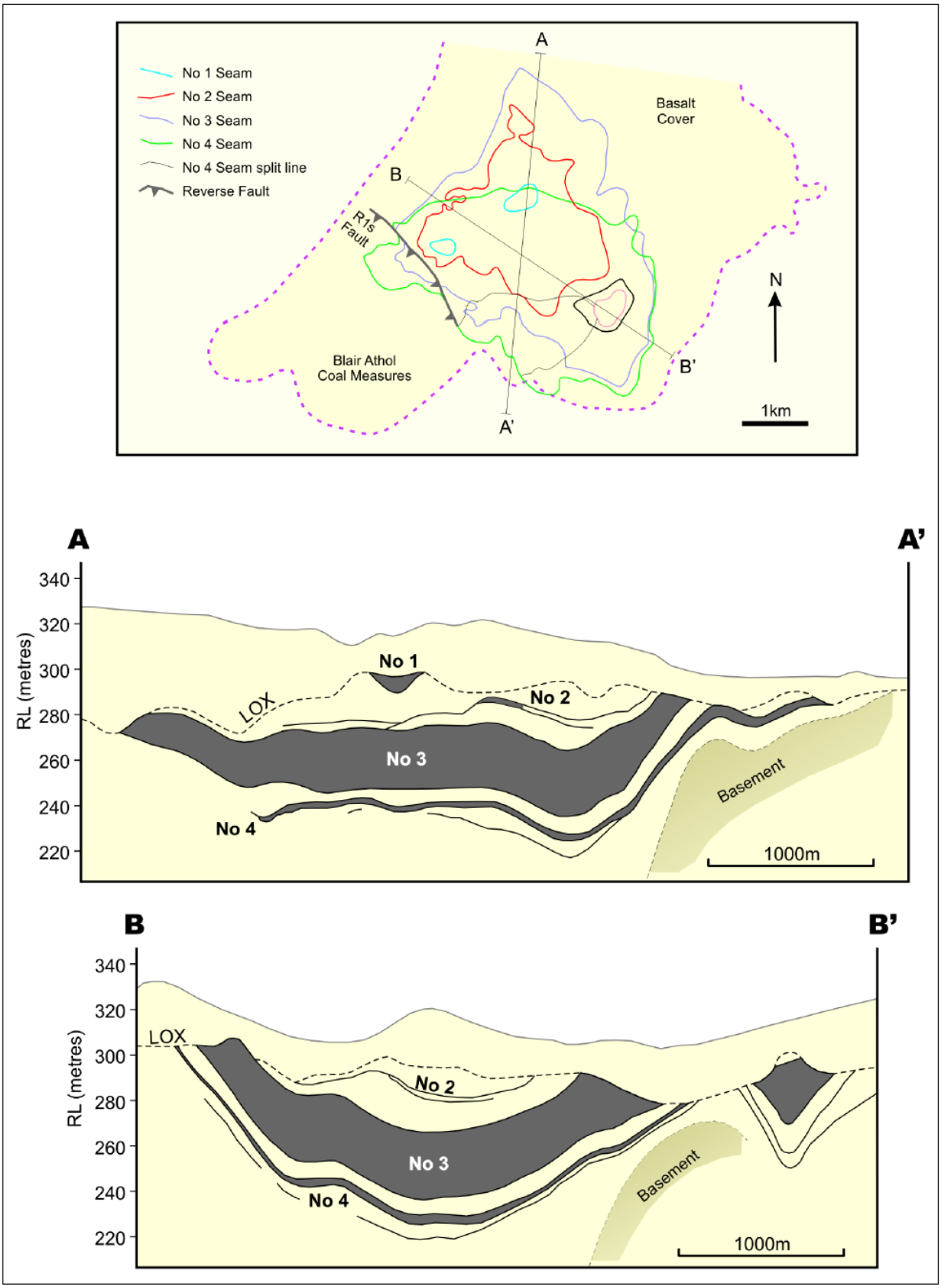
The stratigraphic sequence in the Blair Athol Basin comprises five lithological units (RTCA 2011). These are shown as a stratigraphic section in Figure 1.

Schematic cross sections through the basin, showing the general basin geometry and the coal measures sequence, are shown on Figure 2.



Source: Rio Tinto 2010

Figure 1: BACM mine area stratigraphy



Source: Rio Tinto 2010a

Figure 2: Schematic cross sections showing the coal sequence and seams

Extensive geochemical waste characterisation was undertaken by Rio Tinto during site operations (Rio Tinto 2016). Sulfides were identified in several coal units and the following specific waste types were calculated to be potentially acid forming (PAF):

- Seam 3 roof coal
- Seam 4 interburden coal interface (roof and floor)
- Coal washery coarse rejects
- Coal washery fine tailings

The overburden spoil and interburden were identified to be non-acid forming (NAF) due to an absence of sulphide in these units.

The highest acid mine drainage (AMD) risk on the site was considered to be the tailings storage facility (TSF) in Ramp 2, as the concentration of sulphide-containing coal tailings and rejects in this area increases the potential for AMD formation, although in 2010 no acidic run-off had been detected. The pit faces, spoil piles and coal stockpiles were also considered areas with the potential for AMD generation; however, the risk of AMD-related environmental impacts from these areas was regarded as low.

The benign overburden and interburden contains sodic sandstone units, which may pose salinity and sodicity issues, leading to saline drainage and erosion risk through dispersive spoil. Spontaneous combustion of remnant coal disposed of as mineral waste also present a risk at BACM.

8.5 Hydrology

Prior to mining, three main creeks and their tributaries crossed the BACM site, Bath Creek, Washpool Creek and Breaker Creek. These watercourses have been diverted around the mine site to prevent flooding of the mining areas and rail infrastructure, and to harvest water for use at the mine. Figure 2 (Appendix A) shows the hydrology of the site. Site hydrology has remained unchanged since the study undertaken by BMT WBM in 2012, and that the diversions proposed in the Rio Tinto Mine Closure Plan (Rio Tinto 2010) have not yet been constructed.

The total catchment area of the mine and upstream catchment is approximately 65 km^2 (including the areas within and outside the mining leases). At present, runoff water from undisturbed catchments north, west and east of the mine is diverted around the site via diversions to the Environmental Dam. There are currently four primary creek diversions on BACM:

- Rail Loop Diversion (Breaker Creek Diversion): located north of the rail loop and is a diversion for Breaker Creek North. This diversion protects the rail loop infrastructure and diverts Breaker Creek North into Washpool Creek West for improved water harvesting for the West Dam.
- Eastern Diversion Drain: transfers overflow from West Dam around the north of the mining area and collects clean water entering the site from the north (Washpool Creek), which is diverted around the mining area by the Eastern Diversion where Bath Creek joins the diversion. The diversion diverts flows around the Ramp 5 mining areas, and into the Environmental Dam before running off lease via the original Bath Creek channel, if the Environmental Dam fills and spills.
- Western Diversion Drain: diverts Breaker Creek around the Ramp 1 South mining area and into Bath Creek.

As of 2010, the Environmental Dam could hold approximately 600 Ml of water and had a surface area of 56.9 ha. The dam wall was designed to contain 900 Ml; however, it will start to spill once water reaches the spillways, i.e. 600Ml. The Environmental Dam spillway was the former licensed discharge point from the mining operation.

Mining of Seam No. 4 coal resources in the South Pit (Figure 1) will require a new section of diversion to be constructed. It is proposed to alter the Eastern Diversion Drain to direct the surface water flow into Bath Creek East (Figure 2 – Appendix A).

With the diversions in place, the mining area forms an internally draining "sink". Several voids on site are currently partially filled with water and serve to capture and contain mine water and localised runoff from areas disturbed by mining, including the TSF and industrial area.

There is no current authorised discharge point from BACM and release is only allowed during periods of natural flow with water quality that meets Table C2 in the EA.

8.6 Hydrogeology

The hydrogeology section has been derived from information contained in JBT (2012).

8.6.1 Groundwater resources

The following geological units are considered distinct hydrostratigraphic units in the vicinity of the BACM (JBT 2012):

- Basement Rocks
- Permian Sediments
- Tertiary Basalts
- Tertiary / Quaternary Alluvium
- Tailings and Spoil

The Tertiary Basalts are the only unit in the area with sufficient yield and size to be considered an aquifer. Descriptions of each hydrostratigraphic unit follow.

8.6.1.1 Basement rocks

Proterozoic-Cambrian metamorphics occur at surface or close to surface at a number of locations in the Clermont area, including the western and southern portions of the Blair Athol Mining Lease. A number of regional groundwater monitoring bores are screened within basement metamorphics at shallow depth. In these bores, the weathered metamorphics show a response to rainfall recharge that is similar to other watertable bores. However, the bore yields within the metamorphics are low and the unit is not regarded as an aquifer. The Proterozoic-Cambrian metamorphics are regarded as the hydraulic basement to other groundwater units in the region (JBT 2012).

Water level response in regional basement monitoring bores indicates that the basement rocks, especially where they occur at surface, are recharged via direct rainfall infiltration (JBT 2012). However, the storage of the rocks is low relative to other groundwater units in the area, so much rainfall in basement outcrop areas will report as runoff to surface drainage systems.

8.6.1.2 Permian sediments

Groundwater has been encountered in all coal seams during exploration drilling, but groundwater occurrence is more pervasive in Seams 3 and 4. The coal seams are water-bearing units but are not considered aquifers as the yields are too low and too short- lived (JBT 2012). The coal seams have not been observed to provide significant rates of seepage to the open pits during mining, and generally the seepage rates encountered were insufficient to provide a reliable water supply to the mining operation (JBT 2012).

The Blair Athol Basin is a relatively isolated groundwater system, at least in the sense of groundwater within the coal seams. Recharge mechanisms are unknown, however based on recharge mechanisms observed at other Bowen Basin coal mines it is speculated that recharge to the coal seams occurs in marginal areas of the basin where the coal seams subcrop, or via downward drainage from overlying groundwater units (JBT 2012).

There is no natural outlet for water in the coal seams (refer schematic cross sections, Figure 2), so groundwater movement within the coal seams could be expected to be minimal.

8.6.1.3 Tertiary basalts

The Tertiary Basalt aquifer is the most significant regional aquifer in the Clermont area as it is the main aquifer from which landholders in the region draw stock and domestic water supplies. The basalt is known to comprise a number of distinct flows, though these have not been mapped in a regional sense (JBT 2012).

Regionally, groundwater in the basalt has been observed to occur within discrete, isolated fractures, so that pumping from one fracture system can have little or no impact on water levels within adjacent fracture systems (JBT 2012). Basalt is encountered in the northern and eastern areas of the site, where basalt flows have infilled depressions in the pre-Tertiary land surface.

Seepage water from the basalt aquifer to the pits in the vicinity of Ramp 3 and Ramp 4 is understood to have provided reasonable supplies of non-potable water to the operation over the course of many years (JBT 2012). However, the average rate of seepage is unknown.

The basalt aquifer is the uppermost aquifer in the groundwater system, and receives recharge directly from rainfall. Regionally, the water level in the basalt aquifer rose in many bores after a succession of above average wet seasons from 2007/2008 to 2011 (JBT 2012).

Groundwater flow direction within the basalt aquifer is topographically controlled, with movement of water from topographically higher regions to topographically lower regions. Based on surface drainage, it is judged that the aquifer to the north of the site (within the Bath Creek catchment) will flow toward the mine, and that further north groundwater within the basalt aquifer will flow towards the north-east to either the Gowrie Creek or Miclere Creek catchments (JBT 2012).

8.6.1.4 Tertiary/Quaternary alluvium

Unconsolidated alluvial deposits occur along Bath Creek and Washpool Creek, which drain through the lease area from the north and north-east (Figure 2 – Appendix A). The creeks are ephemeral and groundwater occurrence within the alluvium is sporadic and related to rainfall recharge events when the streams briefly flow.

Following the 2010/2011 wet season rainfall the alluvium in the Ramp 1 mining area became sufficiently saturated that engineering measures were required to control the rate of groundwater inflow to the mining operation (JBT 2012). Therefore, potential exists for the alluvium to provide groundwater seepage to the final void particularly following above-average wet season rainfall, with the rate of seepage dependent on the degree of saturation of the alluvium, as well as the degree to which alluvial channels are hydraulically connected to the final void.

Groundwater recharge to the alluvium is via direct rainfall infiltration, with groundwater movement in the direction of surface drainage.

8.6.1.5 Tailings and spoil

The following section is taken from JBT (2012), in discussion of URS (2006) (which was not reviewed for this report):

> *The TSF is currently an artificial source of locally perched groundwater. The tailings are deposited as a slurry (about 40 - 60% solids). Seepage modelling undertaken by URS (2006) indicatively suggests (due to limited data) that most seepage from the TSF will be through the TSF embankments in the early and middle stages of construction and that seepage rates through the embankments will be minimal in the latter stages and moving into closure.*
>
> *The long-term prediction from the URS (2006) report is that most seepage (latter stages and post-closure) will be through the floor of the TSF into the underlying spoil, and thence into the sandstone/conglomerate Permian sediments. The flux (i.e. the rate of water movement) through the floor of the TSF is expected to decrease post-closure as the tailings dewater and the TSF cap reduces rainfall recharge (URS, 2006).*
>
> *As mentioned above, the fate of the basal conglomerate/sandstone aquifer on and immediately outside the site is difficult to predict.*
>
> *The elevation of the TSF is below the base of the basalt aquifer, and so does not influence the quality or elevation of groundwater within the basalt aquifer. This is expected to remain the case in the long term well after closure.*

The spoil comprises overburden and interburden that has been removed to access the coal seams, and progressively back-filled into pits as the coal is removed. The hydraulic properties of the spoil will therefore be dependent on the properties of the parent material, dumping method, degree to which the spoil has been consolidated by traffic, and degree to which the spoil as settled and consolidated over time.

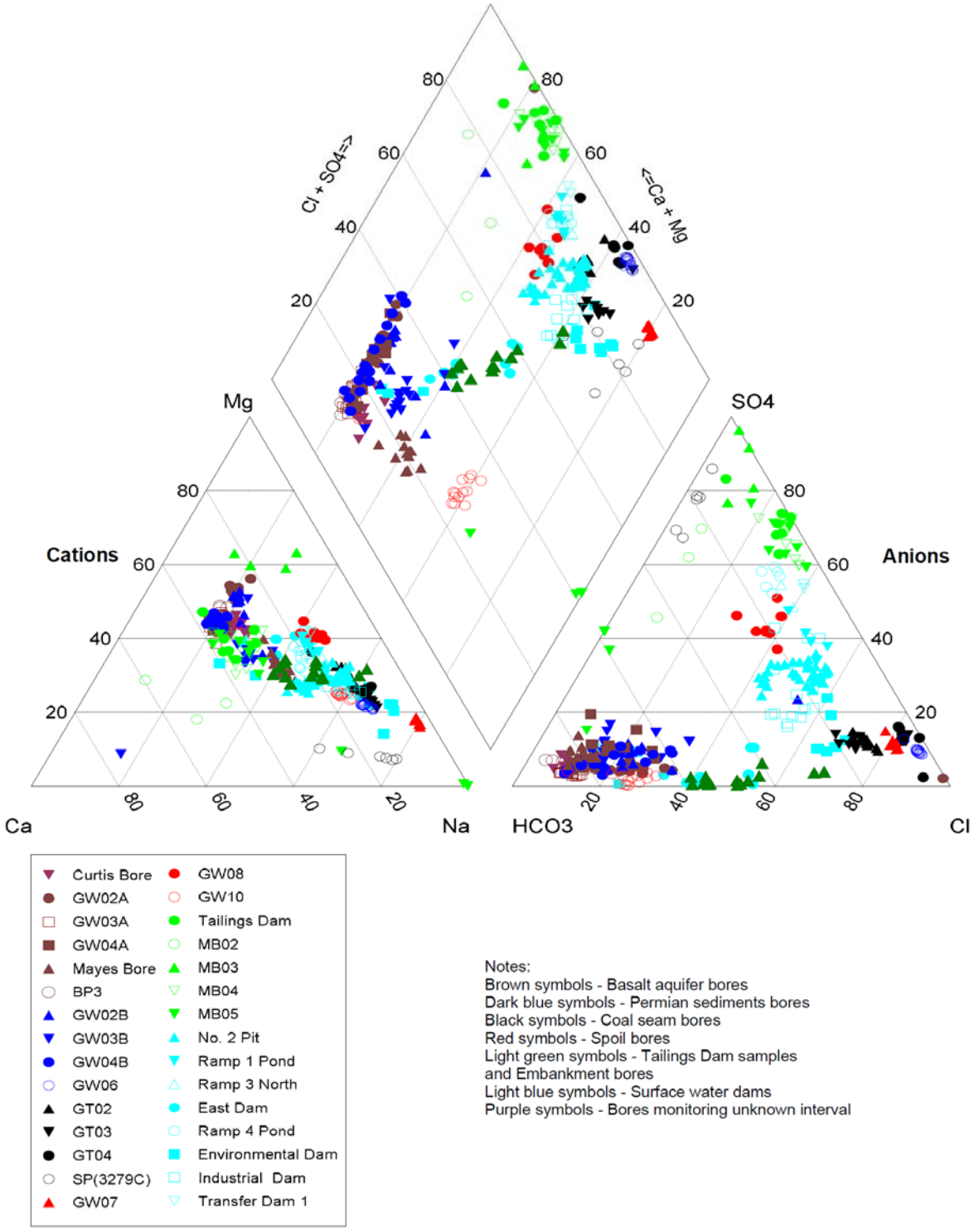
Recharge to the tailings and spoil is via direct rainfall recharge, and in the north of the lease area the spoil may receive recharge vial lateral flow from the basalt aquifer and minor inflow from the Permian sediments and alluvials (JBT 2012). Groundwater flow direction will be dependent on the degree to which a mounded water table develops in the spoil, and on the shape of the final landform relative to surrounding natural material.

8.6.2 Groundwater quality

Groundwater total dissolved solids (TDS) values reported in JBT (2012) ranged from 0 to 101,000 mg/L, indicating the variable groundwater chemistries in the area. The higher TDS values were associated with the TSF and mine spoil and are not representative of background groundwater quality. The mean TDS reported was 2,252 mg/L, while the median was 619 mg/L. Background water quality for the basalt aquifer (average of four samples collected in 2009 from Curtis Bore on Blair Athol Station) indicated concentrations of TDS at 405 mg/L, chloride at 20 mg/L, sodium at 40 mg/L, sulfate at 11.5 mg/L and a pH of 7.8 (Rio Tinto 2010).

Major-ion groundwater chemistry was presented in JBT (2012) based on BACM monitoring data collected from bores screened in the different hydrostratigraphic units at the site, including within placed mining spoil and the TSF embankment. The major ion analyses for each water source was plotted on a Piper diagram (Figure 3) to determine the water type in each hydrostratigraphic unit, as well as for surface water storages (discussed in Section 11). A piper diagram is a graphical

representation of the chemistry of a water sample which shows the relative concentrations of major ions (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, HCO_3^{-}+CO_3^{2-} and SO_4^{2-}). Piper diagrams are used to define water types and can be used to identify groundwater processes such as precipitation or solution, mixing and ion exchange.



Source: JBT 2012

Figure 3: Piper diagram — Blair Athol groundwater and surface water major ion chemistry

The major ion chemistry at site is summarised as:

- Basalt aquifer – basalt water samples are chemically characterised as Mg-Ca-HCO_3 type water, with the major cation composition related to the weathering products of basalt minerals (e.g. Na, Ca, Mg, K silicates). The bicarbonate is derived from interaction of recharge water with atmospheric CO_2 and plant root zone.
- Permian conglomerate – two distinct water types are present. Where Permian conglomerates are overlain by basalt groundwater is chemically classified as Mg-Ca-Na-HCO_3 type water. Together with groundwater level (higher water levels observed in basalt bores), water quality data indicates a potential for downward leakage of water from the basalt aquifer to the underlying Permian sediments. In areas where basalt is absent, groundwater is chemically classified as Na-Cl type.
- Spoil – Water from bores screening the spoil show varying water types from Na-Cl (GW07) to Na-Mg-SO_4-Cl (GW08) and Na-Mg-HCO_3 (GW10).
- Tailings Storage Facility – water samples are mixed cation (Ca, Mg and Na)-SO_4 type.

When plotted on the piper diagram, samples for the basalt aquifer, as well as the Permian sediments underlying basalt, display a dominance of calcium and magnesium over chloride and sulphate. All other sites are more dominated by a combination of chloride + sulphate, and less dominated by calcium + magnesium.

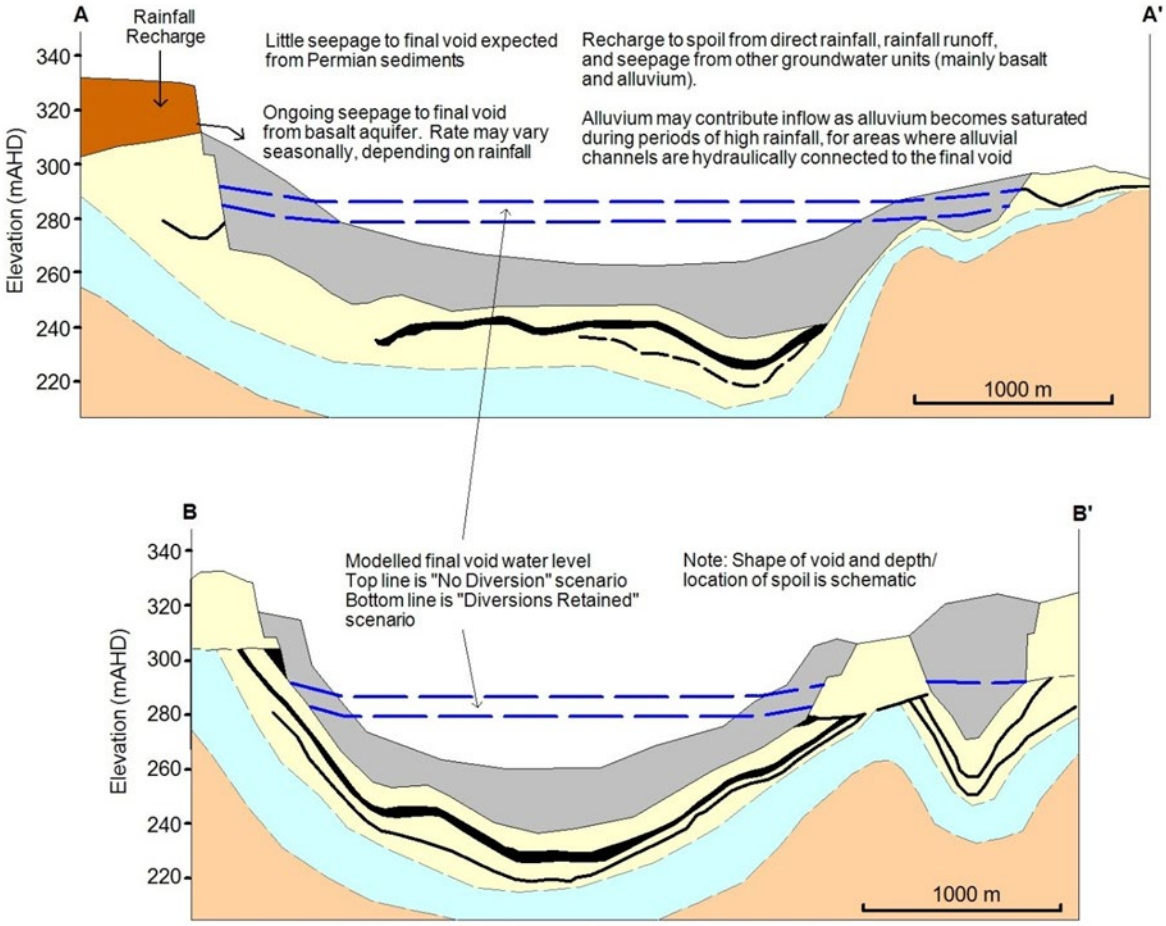
Groundwater quality appears to influence surface water geochemistry on site, with the early major ion chemistry of surface waters dominated by the geological environments within which the dams were developed. The major ion chemistry of surface waters then evolves over time to a mixed water type.

The beneficial use for groundwater in the Clermont region is stock watering. Groundwater within the Tertiary basalt aquifer is, in some instances, suitable for potable use based on TDS criteria alone; however, a number of other parameters (including pH, sodium, chloride, sulphate, arsenic, iron, cadmium, manganese and zinc) may make groundwater in the area unsuitable for potable consumption without treatment to a potable standard.

8.6.3 Groundwater inflow to final void

JBT (2012) presented estimates of the potential long-term post-closure yields of the groundwater units at BACM based on their conceptual groundwater model of the BACM at the end of the Rio Tinto mine plan (Figure 4). Changes to this mine plan have occurred since purchase of the site by TerraCom; however, it is considered that the general parameters used by JBT and the conclusions of their report remain valid as the changes to the hydrogeological conceptual model in the updated mine plan are minimal. It is recommended that the groundwater conceptual model be reviewed and a numerical groundwater model developed for BACM to provide certainty to the inflow volumes used in the final void water balance.

The potential inflow rates used in the JBT report (2012) were based on anecdotal information from site and professional judgement. Historical inflow rates to the mine were not quantified, and no groundwater modelling has been undertaken.



Source: JBT 2012

Figure 4: Post-closure hydrogeological model

Rates of groundwater inflow to the final void are likely to be highly dependent on climatic variation, as follows (JBT 2012):

- During periods of higher than average rainfall the water level in the basalt, alluvium, and spoil can be expected to rise, and the rate of inflow to the final void from these groundwater units will increase. It is noted that the more transmissive units of the coal measures (the coal seams) have been largely removed by mining. Therefore, it is judged that the Permian coal measures will not provide significant rates of inflow to the pit void; and
- During periods of lower than average rainfall the water level in groundwater units at site can be expected to decrease and the rate of inflow to the final void to decrease over time.

The indicative inflow rates to the final void for each hydrostratigraphic unit were predicted to be (JBT 2012):

- Permian coal measures: 0 L/s
- Permian basal conglomerate: 0-2 L/s
- Tertiary Basalt: 1-5 L/s
- Spoil: 1-5 L/s
- Tertiary/Quaternary Alluvium: 1-2 L/s

Based on these indicative inflow rates, the total groundwater contribution to the final void is predicted to be in the order of 3-5 L/s, though the actual rate will be dependent on factors such as seasonal rainfall, the overall shape and dimensions of the final landform, the hydraulic characteristics of groundwater units (such as spoil) that occur adjacent to or within the final void and the depth / extent of the residual pit lake.

Groundwater levels in the surrounding hydrostratigraphic units were reviewed by JBT (2012), and it was concluded that groundwater levels for the majority of water-bearing units at site are currently higher than the predicted maximum water level in the final landform (pit lake) (refer Section 11.1). Therefore, it is predicted that the final landform pit lake will act as a groundwater sink, (i.e. groundwater flow will be towards the residual void), which will limit the potential for off-site discharge of water from the final void via groundwater. The fact that the Permian sediments at BACM form a basin both geologically and hydrogeologically reinforces this conclusion.

9 LAND USE OPTIONS — RESIDUAL VOID

9.1 Land use options

TerraCom has revised the final land use objectives of each closure domain to be primarily biodiversity outcome focussed. The residual voids are expected to be classed as non-use management areas (NUMA) with the targeted objective of promoting biodiversity through the development of native, self-sustaining vegetation.

Water balance modelling suggests a pit lake(s) will be present in the residual void (Section 11). The water quality of the pit lake(s) is likely to be the limiting factor regarding use of any water bodies present in the residual void. The resulting pit lake(s) is likely to exhibit poor water quality over time and is unlikely to be suitable for use as a recreational area or for stock watering (BMT WBM 2012). The final salinity of the pit lake(s) is also likely to be too high to support freshwater fish species.

The presence of a pit lake with poor water quality in the residual void appears unavoidable and will be classed as non-use management areas; therefore, the land use management strategy is to minimise the area of the residual void and the pit lake where practicable.

9.2 Residual void area minimisation

A key factor towards meeting the final land use objective, promoting biodiversity, is to reduce the footprint of the existing residual pit lake and the footprint that will be created due to future mining. This will maximise spoil for revegetation in the areas of the void that will not be regularly inundated by the pit lake.

The recommencement of mining at BACM provides the opportunity to reduce the number and size of residual voids through a planned spoils and waste placement program which is aligned with the closure plan. The overburden, interburden, spoil, coal washery coarse rejects and tailings disposal plan (TerraCom 2018) details the strategies to be utilised by TerraCom to manage PAF material and waste/residual coal susceptible to spontaneous combustion. Specific strategies designed to minimise the residual void and pit lake are discussed below.

Compliance with EA condition F14 will be possible through this plan by the disposal of coal washery wastes and spoil with exchangeable sodium percentage (ESP) >30% into the void and by covering this waste with a minimum of one metre of benign material (i.e. with ESP <15%) prior to rehabilitation commencing.

It is unknown whether sufficient spoil will be generated by ongoing mining by TerraCom to substantially fill the remnant voids as the mining plan has not been finalised and the final spoil volumes are not available to undertake this calculation. Should excess mining spoil be available, sequential backfilling of the final pit with this spoil will be conducted to minimise the size of the final pit. However, due to the coal measures geometry, namely their shallow dip and basinal nature, it is unlikely that the amount of spoil generated by mining will be sufficient to completely backfill of all mining voids. As a consequence, the focus for rehabilitation of the final void will be the creation of a safe and stable landform post-closure (Section 11.2). Therefore, the strategy is to fill as much of the void as possible whilst developing pit walls with appropriate factors of safety.

10 HYDROLOGY AND WATER QUALITY

The following hydrological constraints are proposed for BACM at closure:

- Surface water diversions will remain in place to provide adequate water flows downstream of the site. Modelling has been conducted on scenarios with and without diversions, and the conclusions were that retaining the diversions resulted in the better environmental outcome (BMT WBM 2012; Section 11);
- Internal drainage of the final mining areas will be directed into residual voids, with current voids backfilled and re-sculptured where possible; and
- Existing dams will be rehabilitated into wetlands with no connection to the residual void.

10.1 Final void water levels

Water balance modelling by BMT WBM (2012) was undertaken using the then existing Rio Tinto final mine plan. Post-closure water levels for a period of fifty years were modelled for two scenarios; with the current stream diversions remaining in place post-closure, and with the diversions removed allowing the upstream catchments to enter the residual void post-closure. Under both scenarios the water level does not approach the crest height of the lake (assumed at 300 mAHD from the digital elevation model of the site) at any stage during the 50 year simulation, indicating that the mine void is unlikely to fill and overflow into the downstream environment during typical climatic conditions (BMT WBM 2012). The maximum water levels reached during the 'with diversions' scenario were approximately 280 mAHD, whereas the 'no diversions' scenario reached approximately 285 mAHD. This signifies that allowing the upstream catchment to flow into the residual void will have a relatively minimal effect on the residual pit lake water levels.

Although TerraCom has changed aspects of the final mine plan since purchasing the site, it is considered that the changes to the hydrology of the site are minimal and that the findings of the BMT WMB report (2012) remain valid. It is recommended that the final void water balance is remodelled using the updated mining plans to reduce uncertainty associated with residual void water volumes and quality. As recommended in Section 9.6.3, numerical groundwater modelling should also be undertaken using the updated mining plans to provide certainty to the groundwater inflow volumes to be adopted in the final void water balance.

10.1.1 Flood events

The water balance modelling by BMT WBM (2012) indicated that the residual void was unlikely to overtop during typical climatic conditions. However, it was considered possible that overflow may occur during extremely large rainfall events. Whilst likely to be a highly infrequent event, the likely poor water quality of the residual pit lake (see below) makes overtopping of the residual void undesirable. Engineering options such as using mine spoil to construct berms to increase the overtop height of the residual void are to be investigated as part of the mine closure process.

The water balance modelling conducted by BMT WBM (2012) used monthly means to generate climate inputs for the modelling based on a 50-year period of historical climate data. It is recommended that probabilistic water balance modelling, using a Monte Carlo approach, be undertaken to model a wide range of synthetic climate sequences. This will generate greater certainty of potential pit lake heights during extreme rainfall events, informing management and engineering options to minimise the risk of flood overtopping events. It is also recommended that the revised water balance modelling be extended for a longer simulation period (say 500 years) to confirm that the final void reaches an equilibrium water level over time. It is also recommended to estimate the probable maximum precipitation depth for the

final void catchment using ARR2016 methods to check if the simulated freeboard in the final void can cater for this event.

10.2 Final void water quality

BMT WBM (2012) conducted hydrodynamic modelling of the final pit void at BACM to model the salinity, temperature and density of the pit lake after closure. The modelling was conducted assuming both "with diversions" and "no diversions" scenarios.

The pit lake was found to likely become a self-contained system, with inflows from the upstream catchment and groundwater infiltration, and with evaporative flux as the only loss of volume. Results of modelling showed the system to become hyper-saline over time, as dissolved solids accumulate within the void, with salinities as high as 15,000 mg/L (Rio Tinto 2010), which has implications for long-term water quality at the site. A more saline water-body is likely to develop persistent haloclines and become stratified for periods up to several years, which has implications for long-term water quality at the site.

A closed, stratified system may also result in other undesirable water quality outcomes, such as algal blooms or potential toxic concentrations of pollutants as they accumulate over time. A coupled hydrodynamic and water quality model with the ability to simulate the interactions of phytoplankton, nutrients, oxygen and potentially toxic pollutants such as heavy metals, updated with the TerraCom mining plan, may be required to better understand the long-term residual void water quality if the site is to be open to the public, or if numerical groundwater modelling indicates possible interaction between the residual pit lake and groundwater.

An advantage of a closed system such as this, is that the downstream environment may be relatively unaffected by the closure of the mine, as all flows are contained within the void and do not flow downstream. This assumes that the existing creek diversions are kept in place, which will provide ephemeral flows to the downstream environment. If the diversions are removed, then these flows will likely be contained within the void, removing the flows from regions downstream.

Groundwater investigations (JBT 2012) concluded that the residual void is likely to act as a sink, with no significant groundwater outflow from the site. Therefore, the modelled poor water quality of the residual pit lake is considered unlikely to impact downgradient groundwater users or groundwater dependent ecosystems in the long-term. Numerical groundwater modelling as recommended in Section 9.6.3 should be conducted to confirm that the residual void is a sink and that there will not be any interaction between the residual pit lake and groundwater.

11 GEOTECHNICAL STABILITY OF THE VOID

11.1 EA requirements

In regards to the final landform, the EA states:

F4 - Rehabilitation landform criteria

All areas disturbed by mining activities must be rehabilitated in a manner that ensures it is:

a) safe for humans and wildlife;

b) stable;

c) able to sustain vegetation; and

d) non-polluting.

"stable" means geotechnical stability of the rehabilitated landform where instability related to the excessive settlement and subsidence caused by consolidation / settlement of the wastes deposited, and sliding / slumping instability has ceased.

In addition, the EA requirement F6 states *Rehabilitated landform slope angles are not to exceed 15 percent, with the exception of Ramp 3 cut through competent rock.* The Rio Tinto Mine Closure Plan (Rio Tinto 2010) proposed that areas cut from competent rock will be constructed to geotechnical specification (max 30%) to ensure long term safety where a maximum slope of 15% is not achievable." TerraCom intends to retain these design specifications to achieve a safe and stable landscape on closure.

A final geotechnical stability analysis of the BACM has not been conducted. It is recommended that this be done with respect to TerraCom's mining plans to confirm that the stability of the proposed final landform meets EA requirements.

11.2 Mining spoil

Geotechnical studies at BACM have identified several failures in the low wall spoil piles. These failures are attributed mainly to the spoil material having a very low strength and a high clay content (Rio Tinto 2012). Failure within the spoil piles typically occurred when the spoil pile:

- Slopes were greater than 35%
- Foundation dips at a relatively high angle of between 5 - 10° into the pit
- Comprised poor quality very low strength, fine grained material with low plasticity.

Failure of the spoil often occurred following rainfall events. The occurrence of past failures in the mining spoil at BACM reinforces the necessity for final slope, encompassing the spoil pile, to meet the 15% angle criteria.

The minimisation of slope lengths will be important to prevent erosion of rehabilitated landforms. Specific drainage designs such as large grassed drainage swales or conventional rock lined and graded drainage channels are options to control rainfall runoff in the areas of rehabilitated spoil. Ultimately, the creation of a well-vegetated final landform that promotes infiltration and evapotranspiration is the best method to control erosion on rehabilitated mine spoil.

11.3 Highwalls

Based on observations and geotechnical assessment and analyses at BACM during operations (Rio Tinto 2006) geotechnical hazards or failures are typically associated with movement along geological discontinuities such as joints and faults and weak bedding parallel features. This movement results in isolated rock falls or larger block falls. Failure predominantly occurred within the Permian white sandstone, the coal seams and Tertiary basalt.

The weak bedding parallel features such as shears or layers of soft clay are generally associated with the coal seams especially with the roof and floor of Seam 3 and Seam 4. Translational sliding along the weak seams has occurred previously in the highwall as mining progresses up dip.

Isolated rock or block falls typically occur when Tertiary basalt overlies the Permian white sandstone.

The Permian white sandstone in the lower part of the highwall is usually weathered and is regarded as extremely weak (has a very low strength). On exposure, the condition of the sandstone rapidly deteriorates and after a few days localised rockfalls can occur. The poor performance of the white sandstones compared to other sandstones at BACM is thought to be related to either blasting impacts, deep weathering or leaching effects from the overlying basalts.

To ensure geotechnical stability of the still exposed highwalls and end walls at the closure at BACM, a flattening of the existing pit slope angles is required. The maximum allowed angle in competent rock is 30% as per EA conditions. To achieve this, at mine cessation, the highwall treatment strategies discussed in the Australian Coal Association Research Program (ACARP) Rehabilitation of Highwalls Report (ACARP 2006) should be implemented. Closure options could comprise:

- Cast blast the Tertiary basalt and Permian white sandstone highwall into the pit and regrade the blast material and slopes to 30% or less if possible.
- Regrade the backfilled spoil to a 15% slope on the low wall.

Although the laying back of the highwalls and end walls may increase the void catchment over a steeper configuration; the improved safety provided by the flatter slope angle is considered more important than creating a slightly larger final residual void.

Rock units considered susceptible to erosion, such as the highly weathered white sandstone, are to be covered in rock mulch where possible to ensure erosion does not compromise the safety and stability of the final landform. The final goal for the residual void landform that is not inundated by the pit lake is a self-sustaining vegetated stable landform that will persist in the long-term.

12 VOID CAPABILITY TO SUPPORT FLORA AND FAUNA

The capability of the residual void to support flora and fauna is dependent on the application and success of the management strategies outlined in Section 10.2 to minimise the residual void area and residual pit lake.

12.1 Rehabilitated landform

Intensive treatment such as backfilling will yield a similar environment to the rehabilitated spoil areas. Revegetation domain goals and action plans detailed in the Rehabilitation Management Plan (WSP 2018) describe revegetation methods and actions to promote biodiversity in the residual void by the seeding of reworked spoil with a selected mix of native species. Successful revegetation will provide food and shelter to encourage colonisation of the rehabilitated areas by native fauna.

The landform design is intended to achieve a safe and stable landscape on closure (Section 8). The EA requirement F6 states *Rehabilitated landform slope angles are not to exceed 15 percent, with the exception of Ramp 3 cut through competent rock*. The Rio Tinto Mine Closure Plan (Rio Tinto 2010) proposed that areas cut from competent rock will be constructed to geotechnical specification (max 30%) to ensure long term safety where a maximum slope of 15% is not achievable." intends to retain these design specifications.

The flattening of steep highwalls/end walls to a slope of less than 30% greatly reduces the risk of native fauna coming to harm from falling from the pit walls. Where possible, the slopes in the vicinity of the pit lake will be flattened to prevent fauna from falling into the pit lake and allowing escape from the water body should any animals enter the water.

12.2 Residual pit lake

The ability of the residual pit lake to support significant life will depend on whether there is permanent water stored in the void and the water quality of the void water. Modelling undertaken by BMT WBM (2012) suggests that a pit lake will be present in the residual void and that the water quality is likely to become hypersaline with time (Section 11.2). In addition, thermoclines and haloclines are likely to develop, limiting oxygen levels in deeper sections of the lake and potentially leading to algal blooms.

The modelling suggested that removal of the current creek diversions allowing flow from the upstream catchments into the residual void would not make a significant difference to the pit lake water qualities. Therefore, retainment of the diversions was recommended to retain beneficial water flows to Bath Creek downstream of the mine. The impact on downstream surface water systems as a result of interception of surface flows by the final void was identified as a potentially significant social impact (Rio Tinto 2010).

13 FINAL RESIDUAL VOID REHABILITATION PERFORMANCE AND SUCCESS CRITERIA

13.1 Rehabilitated spoil

The success criteria and monitoring requirements for the rehabilitated spoil in the residual void are the same as the requirements for BACM as a whole and are detailed in the Rehabilitation Management Plan (WSP 2018). The EA stipulates performance criteria for the following:

- Slope >15% and unstable
- Slope <15%
- Gully erosion
- Mature vegetation
- Vegetation diversity
- Groundcover cover

Reference sites for each natural land system domain need to be established prior to assessing existing and future rehabilitation. Once reference sites have been established, ongoing progressive rehabilitation will need to be assessed in accordance with the performance criteria derived from the reference sites. The results of the reference site data will need to be analysed to determine performance criteria for the corresponding rehabilitation land system domains.

13.2 Residual highwalls and end walls

Performance criteria for highwalls and end walls are designated in Table F1 of the EA (Table 1).

13.3 Residual pit lake

The only specific performance criteria relating to the residual void in the EA is *Condition F13– Residual Void Outcome: Residual voids must not cause any serious environmental harm to land, surface waters or any recognised groundwater aquifer, other than the environmental harm constituted by the existence of the residual void itself and subject to any other condition within this environmental authority*.

Performance criteria have been developed with regard to *Condition F13* and the Rio Tinto Mine Closure Plan (2010) (Table 4).

Table 4: Performance criteria for successful rehabilitation of residual pit lake

Rehabilitation objective	Success criteria	Monitoring
Final pit water quality will not impact negatively on the surrounding environment	No overflows of pit lake into external water systems	Quarterly water level monitoring until relinquishment. If the water levels are found to be inconsistent with modelling predictions, the measured data will be used to re-calibrate the final void water model.

Rehabilitation objective	Success criteria	Monitoring
	Water quality to meet expected (modelled) conditions	Quarterly water quality monitoring until relinquishment of the final void to ensure that it is consistent with the results of final void modelling. Monitoring will consist of physical and chemical measurements. (including pH, EC, TDS, dissolved oxygen, major cations and anions, and trace elements (metals and nutrients)). If the water quality is found to be inconsistent with modelling predictions, the measured data will be used to re-calibrate the final void water model.
	No impact on surrounding groundwater from the residual pit lake	Quarterly monitoring of groundwater chemistry and levels in surrounding sentinel monitoring bores. Monitoring of groundwater levels, pH, EC, TDS, major cations and anions and trace elements (metals and nutrients). Monitoring of water levels at Curtis Windmill Bore to detect any potential groundwater level impacts.

13.4 Review and corrective actions

Review and update of the monitoring and rehabilitation programs will be undertaken to ensure that:

- The RVMP incorporates significant changes to the long-term mine plan resulting in material impacts to the projected final landform
- The program can be altered if new technologies and/or strategies are developed by industry, government or academia
- The rehabilitation program and monitoring is being conducted as per the RVMP and the EA
- Rehabilitation performance is trending towards final completion criteria and the required rehabilitation schedule is being met by management
- Adequate and suitable stockpiles of rock mulch, topsoil and seed banks are available for the rehabilitation; and
- Records of rehabilitation (spoil backfilling, topsoil placement, etc) are being kept and are current.

13.5 Recommendations

The following actions are recommended to further inform future RVMPs.

- Review of the existing groundwater conceptual model and development of a numerical groundwater model for BACM to provide certainty to the inflow volumes used in the final void water balance;
- Remodelling of the final void water balance using the updated mining plans to reduce uncertainty associated with residual void water volumes and quality.
- Probabilistic water balance modelling, using a Monte Carlo approach, be undertaken to model a wide range of synthetic climate sequences, including extension of the modelling for a longer simulation period (say 500 years) to confirm that the final void reaches an equilibrium water level over time
- Estimation of the probable maximum precipitation depth for the final void catchment using ARR2016 methods to check if the simulated freeboard in the final void can cater for this event.
- If numerical groundwater modelling indicates possible interaction between the residual pit lake and groundwater, development of a coupled hydrodynamic and water quality model with the ability to simulate the interactions of phytoplankton, nutrients, oxygen and potentially toxic pollutants such as heavy metals, updated with the TerraCom mining plan.
- A final geotechnical stability analysis of the BACM, including a geotechnical assessment and certification on closure.
- Monitoring as per EA.

14 REFERENCES

BMT-WBM (2012) BAC Final Landform Water Study. Report to Rio Tinto Coal Australia, November 2012.

Department of Environment and Heritage Protection (DEHP) (2018). Environmental Authority EPML00876713 – Blair Athol Coal Mine, January 11, 2018.

JBT Consulting, (2012). Blair Athol Mine Closure Groundwater Investigation, September 2012.

Queensland Government (1994) Environmental Protection Act.

Rio Tinto (2006). Geotechnical Characteristics, Blair Athol Coal Project.

Rio Tinto (2010). Blair Athol Coal Project Mine Closure Plan, December 2010.

Rio Tinto (2012). Blair Athol Mine. Ramp 1 South West Contingency 4 (R1SWC4). Geotechnical Review, 20 February 2012.

Rio Tinto (2016). Blair Athol Acid & Metalliferous Drainage Management. HSEQ MS – Guideline. BAM-10-GUI-EV-0029_1, 21 July 2016.

TerraCom (2018). Disposal Plan. Overburden, Interburden, Spoil, Coal Washery Coarse Rejects and Tailings. Blair Athol Mine, 21 May 2018.

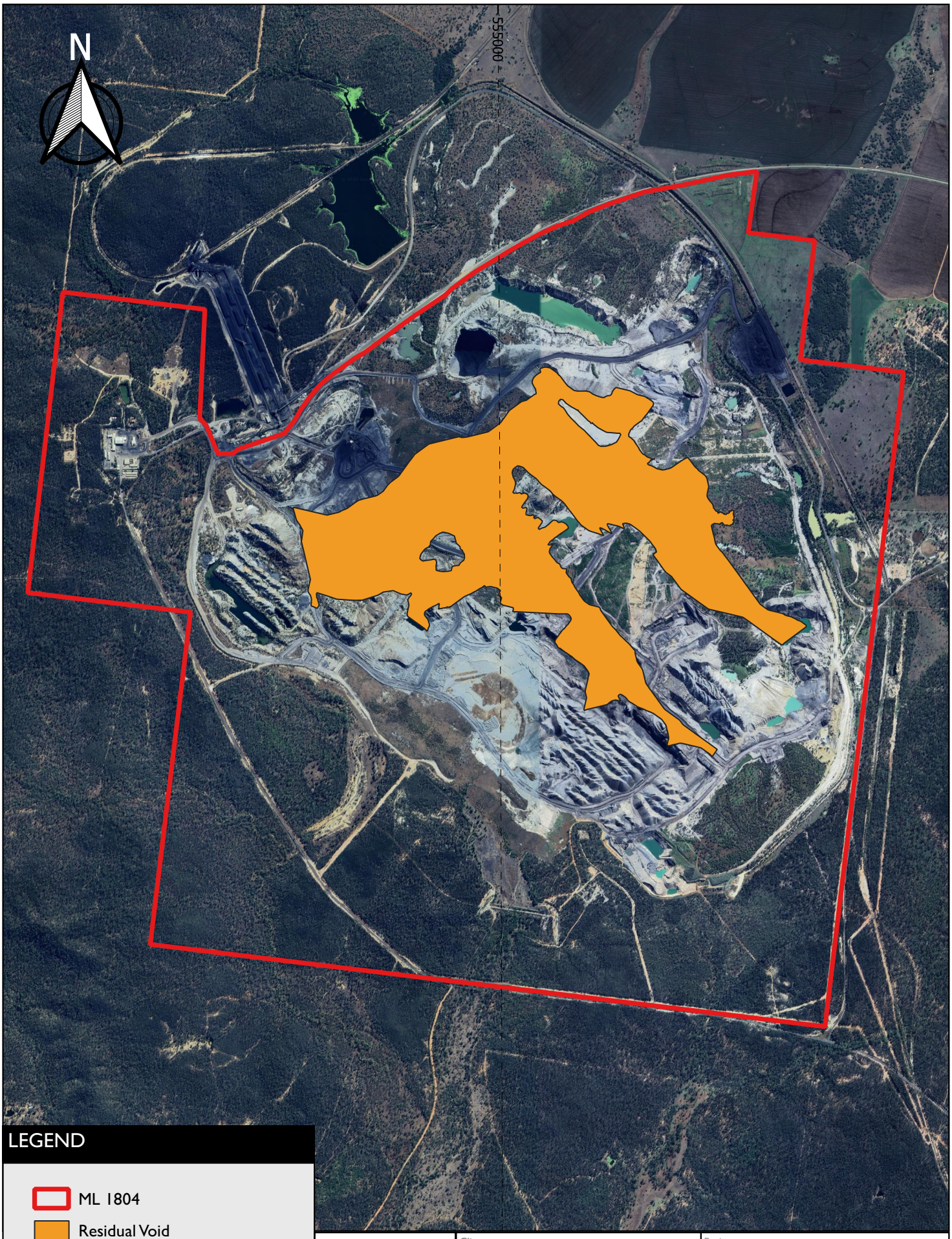
URS (2006) Assessment of water and sediment quality of Stockpile Dam and Environment Dam for EPA Hazardous Dam Classification. Letter report from URS to Blair Athol Coal Mine, Document No. 311006, 31 October 2006.

WSP (2018), Rehabilitation Management Plan Blair Athol Coal Mine Draft. June 2018.

Blair Athol Coal Mine – Environmental Management System

APPENDIX A — FIGURES





LEGEND

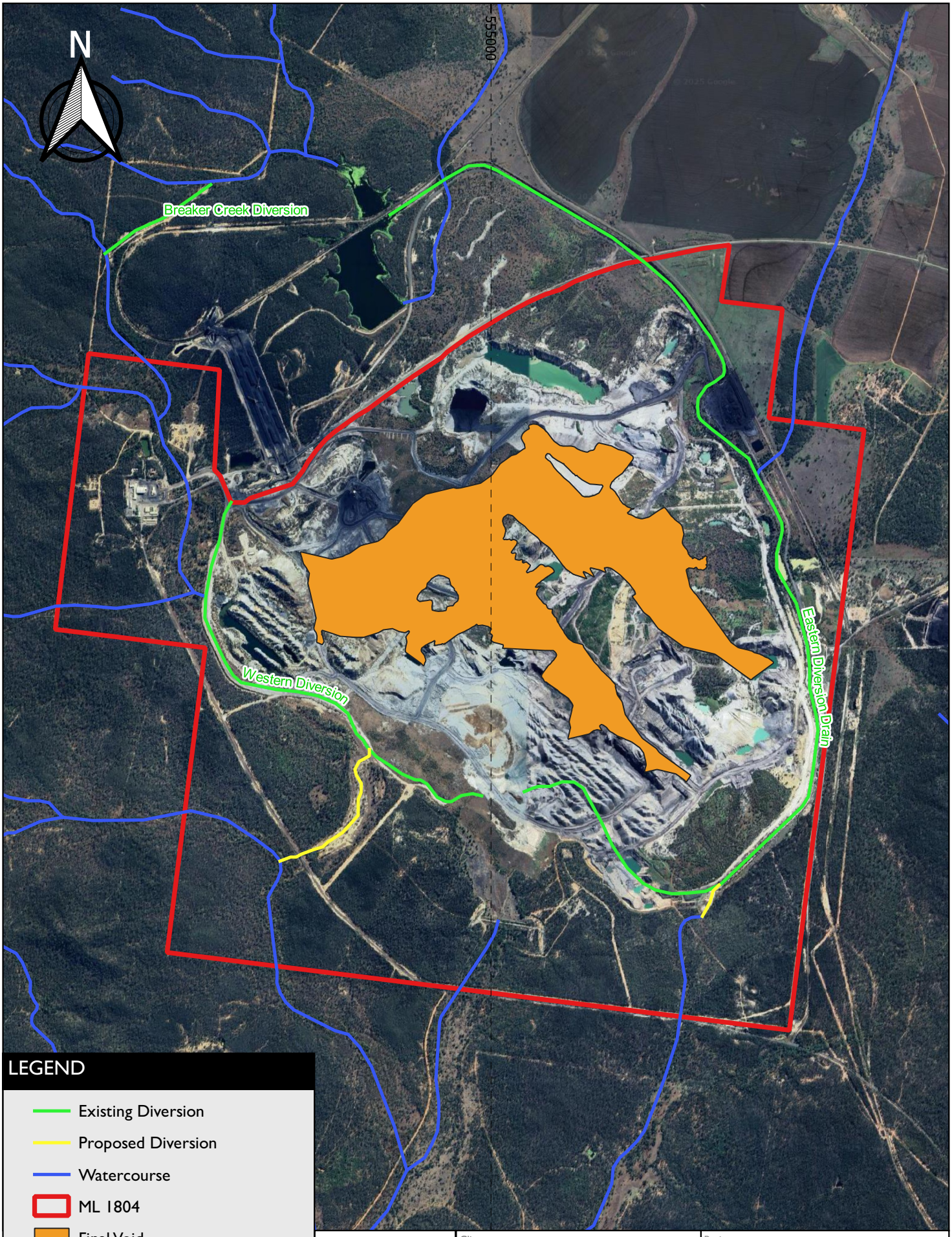
- ML 1804
- Residual Void

Scale 1 : 25 000

0 0.5 1 km

	Client: TerraCom Limited	Project: Residual Void Management Plan	
	Design: SGME Pty Limited 4.09.2025 Scale: 1 :25,000 CRS: GDA2020	Title: Final Void Extent	Figure: 1

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.



LEGEND

- Existing Diversion
- Proposed Diversion
- Watercourse
- ML 1804
- Final Void

Scale 1 : 25 000

0 0.5 1 km

SGME	Client: TerraCom Limited	Project: Residual Void Management Plan	
	Design: SGME Pty Limited 4.09.2025 Scale: 1 :25,000 CRS: GDA2020	Title: Site Hydrology	Figure: 2

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

Blair Athol Coal Mine – Environmental Management System

TerraCom

APPENDIX B — ENVIRONMENTAL AUTHORITY



Permit

Environmental Protection Act 1994

Environmental authority EPML00876713

This environmental authority is issued by the administering authority under Chapter 5 of the Environmental Protection Act 1994.

Environmental authority number: EPML00876713

Environmental authority takes effect on 11 June 2025.

Environmental authority holder(s)

Name(s)	Registered address
Orion Mining Pty Ltd	Blair Athol Mine Access Road, Clermont QLD 4721

Environmentally relevant activity and location details

Environmentally relevant activity/activities	Location(s)
Ancillary 08 - Chemical Storage 1: Storing a total of 50t or more of chemicals of dangerous goods class 1 or class 2, division 2.3 under subsection (1)(a)	ML1804
Ancillary 31 - Mineral processing 2: Processing, in a year, the following quantities of mineral products, other than coke (b) more than 100,000t	ML1804
Ancillary 63 - Sewage Treatment 1: Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of (b-i) more than 100 but not more than 1500EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme	ML1804
Schedule 3 13: Mining black coal	ML1804

Additional information for applicants

Environmentally relevant activities

The description of any environmentally relevant activity (ERA) for which an environmental authority (EA) is issued is a restatement of the ERA as defined by legislation at the time the EA is issued. Where there is any inconsistency between that description of an ERA and the conditions stated by an EA as to the scale, intensity or manner of carrying out an ERA, the conditions prevail to the extent of the inconsistency.

An EA authorises the carrying out of an ERA and does not authorise any environmental harm unless a condition stated by the EA specifically authorises environmental harm.

Queensland Government

A person carrying out an ERA must also be a registered suitable operator under the *Environmental Protection Act 1994* (EP Act).

Mobile and temporary activities

If you operate a mobile and temporary environmentally relevant activity (ERA), other than regulated waste transport, you are required to maintain a work diary. You must:

- use the approved form for a work diary (ESR/2015/1696);
- keep the work diary records for 2 years after the last entry;
- inform the administering authority within 7 days of the work diary being lost or stolen;
- record the information required in the work diary for each location within 1 day of leaving the location.

Contaminated land

It is a requirement of the EP Act that an owner or occupier of land give written notice to the administering authority if they become aware of the following:

- the presence of, or happening of an event involving, a hazardous contaminant on the land that is causing, or is reasonably likely to cause, serious or material environmental harm (notice must be given within 24 hours); or
- if the land is contaminated land – a change in the condition of the land that is causing, or is reasonably likely to cause, serious or material environmental harm (notice must be given within 24 hours); or
- a notifiable activity (as defined in Schedule 3) having been carried out, or is being carried out, on the land (notice must be given within 20 business days).

For further information, including the form for giving written notice, refer to the Queensland Government website www.qld.gov.au, using the search term 'duty to notify'.

Take effect

Please note that, in accordance with section 200 of the EP Act, an EA has effect:

a) if the authority is for a prescribed ERA and it states that it takes effect on the day nominated by the holder of the authority in a written notice given to the administering authority – on the nominated day; or

b) if the authority states a day or an event for it to take effect – on the stated day or when the stated event happens; or

c) otherwise – on the day the authority is issued.

However, if the EA is authorising an activity that requires an additional authorisation (a relevant tenure for a resource activity, a development permit under the *Planning Act 2016* or an SDA Approval under the *State Development and Public Works Organisation Act 1971*), this EA will not take effect until the additional authorisation has taken effect.

If this EA takes effect when the additional authorisation takes effect, you must provide the administering authority written notice within 5 business days of receiving notification of the related additional authorisation taking effect.

The anniversary day of this environmental authority is the same day each year as the effective date. The payment of the annual fee will be due each year on this day. An annual return will be due each year on 01 April.

If you have incorrectly claimed that an additional authorisation is not required, carrying out the ERA without the additional authorisation is not legal and could result in your prosecution for providing false or misleading

information or operating without a valid environmental authority.

	11 June 2025
Signature	Date

Alison Cummings
Department of the Environment, Tourism, Science and Innovation
Delegate of the administering authority
Environmental Protection Act 1994

Enquiries:
Business Centre (Coal)
Department of the Environment, Tourism, Science and Innovation
PO Box 3028
EMERALD QLD 4720
Phone: (07) 4987 9320
Email: CRMining@des.qld.gov.au

Obligations under the *Environmental Protection Act 1994*

In addition to the requirements found in the conditions of this environmental authority, the holder must also meet their obligations under the EP Act, and the regulations made under the EP Act. For example, the holder must comply with the following provisions of the Act:

- general environmental duty (section 319)
- duty to notify environmental harm (section 320-320G)
- offence of causing serious or material environmental harm (sections 437-439)
- offence of causing environmental nuisance (section 440)
- offence of depositing prescribed water contaminants in waters and related matters (section 440ZG)
- offence to place contaminant where environmental harm or nuisance may be caused (section 443)

Other permits required

This permit only provides an approval under the *Environmental Protection Act 1994*. In order to lawfully operate you may also require permits / approvals from your local government authority, other business units within the department and other State Government agencies prior to commencing any activity at the site. For example, this may include permits / approvals with your local Council (for planning approval), the Department of Transport and Main Roads (to access State controlled roads), the Department of Resources (to clear vegetation), and the Department of Agriculture and Fisheries (to clear marine plants or to obtain a quarry material allocation).

Obligations under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)

Matters of national environmental significance (MNES) are regulated under the Commonwealth EPBC Act rather than under state legislation. You may need to submit a referral if your project potentially impacts any matters protected under the EPBC Act. For more information on self-assessments, and referral and assessment processes please visit the Department of Climate Change, Energy, the Environment and Water webpage, https://www.dcceew.gov.au/environment/epbc/advice.

Obligations under the *Aboriginal Cultural Heritage Act 2003* and *Torres Strait Islander Cultural Heritage Act 2003* (the Cultural Heritage Acts)

The Cultural Heritage Acts require anyone who carries out a land-use activity to exercise a duty of care. This 'duty of care' means land users must take all reasonable and practicable measures to ensure their activity does not harm Aboriginal or Torres Strait Islander cultural heritage and applies to any activity where Aboriginal or Torres Strait Islander cultural heritage is located. For more information on your obligations under this legislation, please visit the Department of Women, Aboriginal and Torres Strait Islander Partnerships and Multiculturalism webpage at, https://www.tatsipca.qld.gov.au/.

Conditions of environmental authority

The environmentally relevant activities conducted at the locations as described above may be conducted in accordance with the following site-specific conditions of approval. This environmental Authority consists of the following Schedules:

- Schedule A – General
- Schedule B – Air
- Schedule C – Water
- Schedule D – Acoustic
- Schedule E – Waste
- Schedule F – Land
- Schedule G – Regulated Structures
- Schedule H – Sewage Treatment
- Schedule I – Groundwater
- Definitions
- Figures

Conditions of environmental authority

Schedule A: General	
Condition number	**Condition**
A1	Although this environmental authority authorises environmental harm to the extent stated in the conditions, all reasonable and practicable measures must be taken to prevent or minimise environmental harm caused by the activities.
A2	**Maintenance of measures, plant and equipment** All measures, plant and equipment necessary to comply with this authority must be: (a) installed in a proper and efficient condition; (b) maintained in a proper and efficient condition; (c) operated in a proper and efficient manner; and (d) properly calibrated.
A3	**Monitoring** The results and analysis of all monitoring and investigations required by this environmental authority must be: (a) kept for a period of at least **five years**; (b) be provided to the administering authority within a timeframe nominated by the administering authority; and (c) provided to the administering authority in the format requested.
A4	Any records kept or created in relation to this authority must be: (a) kept for a period of at least **five years**; and (b) provided to the administering authority on request.
A5	All monitoring and investigations required by this environmental authority must be undertaken by an appropriately qualified person.
A6	Upon request from the administering authority, copies of all records, plans and other documentation required by the conditions of this environmental authority must be made available and provided to the administering authority within: (a) **ten (10) business days**; or (b) an alternative timeframe agreed between the administering authority and the environmental authority holder.
A7	**Risk management** The holder of this environmental authority must develop and implement a risk management system for mining activities to the Standard for Risk Management (ISO31000:2009), or the latest edition of an Australian Standard for risk management, to the extent relevant to environmental management.
A8	Where a condition of this environmental authority requires compliance with a standard, policy or guideline published externally to this environmental authority and the standard is amended or changed subsequent to the issue of this environmental authority, the holder of this environmental authority must: (a) comply with the amended or changed standard, policy or guideline within two years of the amendment or change being made, unless a different period is specified in the amended standard or relevant legislation, or where the amendment or change relates specifically to regulated structures; and

	(b) until compliance with the amended or changed standard, policy or guideline is achieved, continue to remain in compliance with the corresponding provision that was current immediately prior to the relevant amendment or change.
A9	**Third-party Audits** The environmental authority must: (a) ensure that an appropriately qualified third party conducts and documents an audit of compliance with all conditions of the environmental authority by 15 December 2018; and (b) ensure that further audits in accordance with **condition A9(a)** are conducted at intervals not exceeding once every two years from completion of initial audit.
A10	**Notification of emergencies, incidents and exceptions** The holder of this environmental authority must notify the administering authority by written notification within **24 hours**, after becoming aware of any emergency or incident which results in the release of contaminants not in accordance, or reasonably expected to be not in accordance with, the conditions of this environmental authority.
A11	Within **10 business days** following the initial notification of an emergency or incident, or receipt of monitoring results, whichever is the latter, further written advice must be provided to the administering authority, including the following: (a) results and interpretation of any samples taken and analysed; (b) outcomes of actions taken at the time to prevent or minimise unlawful environmental harm; and (c) proposed actions to prevent a recurrence of the emergency or incident.
A12	**Complaints** A record must be kept in a single location of all complaints received about the activities.
A13	The record required by **condition A12** must include: (a) name, address and contact number for the complainant; (b) time and date of complaint; (c) investigations undertaken; (d) conclusions formed; (e) actions taken to resolve the complaint; (f) any abatement measures implemented; and (g) person responsible for resolving the complaint.
A14	The administering authority must be notified that a complaint has been made, within **48 hours** of receiving the complaint.
A15	When requested by the administering authority, monitoring must be undertaken to investigate any complaint arising from the activity: (a) in the manner requested by the administering authority; and (b) within a reasonable timeframe nominated by or agreed to by the administering authority.
A16	**Scope of activity** This environmental authority authorises the mining of no more than **11 million tonnes** of run of mine (ROM) coal per annum.
A17	The maximum area of disturbance that must not be exceeded in carrying out the mining activity is depicted in **Figure 1 – Blair Athol Mine authorised disturbance footprint**.

Schedule B: Air	
Condition number	**Condition**
B1	**Dust and particulate matter monitoring** The environmental authority holder must ensure that the dust and particulate matter emissions generated by the mining activities do not cause exceedances of the following levels when measured at any sensitive or commercial place: (a) Dust deposition of 120 milligrams per square metre per day, averaged over one month, when monitored in accordance with the most recent version of Australian Standard AS3580.10.1 Methods for sampling and analysis of ambient air-Determination of particulate matter-Deposited matter - Gravimetric method. (b) A concentration of particulate matter with an aerodynamic diameter of less than 10 micrometres (PM10) suspended in the atmosphere of 50 micrograms per cubic metre over a **24-hour** averaging time, when monitored in accordance with the most recent version of either: (i) Australian Standard AS3580.9.6 Methods for sampling and analysis of ambient air-Determination of suspended particulate matter-PM10 high volume sampler with size selective inlet - Gravimetric method; or (ii) Australian Standard AS3580.9.9 Methods for sampling and analysis of ambient air-Determination of suspended particulate matter-PM10 low volume sampler-Gravimetric method. (c) A concentration of particulate matter suspended in the atmosphere of 90 micrograms per cubic metre over a **1 year** averaging time, when monitored in accordance with the most recent version of AS/NZS3580.9.3:2003 Methods for sampling and analysis of ambient air- Determination of suspended particulate matter-Total suspended particulate matter (TSP)-High volume sampler gravimetric method.
B2	**Odour nuisance** The release of noxious or offensive odour or any other noxious or offensive airborne contaminants resulting from the mining activities must not cause an environmental nuisance at any sensitive or commercial place.
B3	When requested by the administering authority, odour monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive or commercial place, and the results must be notified within **14 days** to the administering authority following completion of monitoring.
B4	If the administering authority determines that **condition B2** is not being met, then the environmental authority holder must: (a) address the complaint including the use of appropriate dispute resolution if required; and (b) immediately implement odour abatement measures so that emissions of odour from the activity do not result in further environmental nuisance.

Schedule C: Surface Water	
Condition number	**Condition**
C1	**Contaminant release** Contaminants that will or have the potential to cause environmental harm must not be released directly or indirectly to any waters as a result of authorised activities, except as permitted under the conditions of this environmental authority.
C2	Unless otherwise permitted under the conditions of this environmental authority, the release of mine affected water to waters must only occur from the release points specified in **Table C1 (Mine affected release points, Sources and Receiving Waters)** and depicted in **Figure X** attached to this environmental authority.

Table C1 (Mine affected release points, sources and receiving waters) (1)					
Release Point (RP)	Latitude (GDA2020)	Longitude (GDA2020)	Mine affected water source and location	Monitoring Point	Receiving waters description
Note: (1) There is no current authorised release point for Blair Athol Mine on ML1804.					

C3	The release of mine affected water to internal water management infrastructure installed and operated in accordance with a water management plan that complies with **condition C24** is permitted.
C4	The release of mine affected water to waters in accordance with **condition C2** must not exceed the release limits stated in **Table C2 (Mine affected release limits)** when measured at the monitoring points specified in **Table C1 (Mine affected release points, sources and receiving waters)** for each quality characteristic.

Table C2 (Mine affected release limits)		
Quality Characteristic	Release limits	Monitoring frequency
Electrical conductivity (microsiemens per centimetre)	1000	Daily during release (the first sample must be taken within 2 hours of commencement of release)
pH (pH Unit)	6.5 (minimum), 9.0 (maximum)	Daily during release (the first sample must be taken within 2 hours of commencement of release)
Turbidity (NTU)	Current limit or limit derived from suspended solids limit and demonstrated correlation between turbidity to suspended solids historical monitoring data for dam water. To be provided to the administering authority following approval of a release point.	Daily during release (first sample within 2 hours of commencement of release)
Suspended Solids (mg/L)	1000	Daily during release (first sample within 2 hours of commencement of release)

Sulfate (mg/L)	500	Daily during release (first sample within 2 hours of commencement of release)

C5	The release of mine affected water to waters from the release points must be monitored at the locations specified in **Table C1 (Mine affected release points, sources and receiving waters)** for each quality characteristic and at the frequency specified in **Table C2 (Mine affected release limits)** and **Table C3 (Release contaminant trigger investigation levels)**.

Table C3 (Release contaminant trigger investigation levels)

Quality Characteristic (1), (2)	Trigger Levels (micrograms per litre)	Comment on Trigger level	Monitoring Frequency
Aluminium	55	For aquatic ecosystem protection, based on SMD guideline	Commencement of release and thereafter weekly during release
Arsenic	13	For aquatic ecosystem protection, based on SMD guideline	
Cadmium	0.2	For aquatic ecosystem protection, based on SMD guideline	
Chromium	1	For aquatic ecosystem protection, based on SMD guideline	
Copper	2	For aquatic ecosystem protection, based on LOR for ICPMS	
Iron	300	For aquatic ecosystem protection, based on low reliability guideline	
Lead	4	For aquatic ecosystem protection, based on SMD guideline	
Mercury	0.2	For aquatic ecosystem protection, based on LOR for CV FIMS	
Nickel	11	For aquatic ecosystem protection, based on SMD guideline	
Zinc	8	For aquatic ecosystem protection, based on SMD guideline	
Boron	370	For aquatic ecosystem protection, based on SMD guideline	
Cobalt	90	For aquatic ecosystem protection, based on low reliability guideline	
Manganese	1900	For aquatic ecosystem protection, based on SMD guideline	

Molybdenum	34	For aquatic ecosystem protection, based on low reliability guideline	
Selenium	10	For aquatic ecosystem protection, based on LOR for ICPMS	
Silver	1		
Uranium	1		
Vanadium	10		
Ammonia	900	For aquatic ecosystem protection, based on SMD guideline	
Nitrate	1100	For aquatic ecosystem protection, based on ambient Qld WQ Guidelines (2006) for TN	
Petroleum hydrocarbons (C6-C9)	20		
Petroleum hydrocarbons (C10-C36)	100		
Fluoride (total)	2000	Protection of livestock and short term irrigation guideline	
Sodium	Limit to be determined based on receiving water reference data and achievable best practice sedimentation control and treatment. To be provided to the administering authority following approval of a release point.		

Notes:
(1) All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal/metalloids apply if dissolved results exceed trigger.
(2) The quality characteristics required to be monitored as per **Table C3 (Release contaminant trigger investigation levels)** can be reviewed once the results of **two years** monitoring data is available, or if sufficient data is available to adequately demonstrate negligible environmental risk, and it may be determined that a reduced monitoring frequency is appropriate or that certain quality characteristics can be removed from **Table C3 (Release contaminant trigger investigation levels)** by amendment.
(3) SMD - slightly moderately disturbed level of protection, guideline refers ANZECC and ARMCANZ (2000).
(4) LOR - typical reporting for method stated. ICPMS/CV FIMS – analytical method required to achieve LOR.

C6	If quality characteristics of the release exceed any of the trigger levels specified in **Table C3 (Release contaminant trigger investigation levels)** during a release event, the environmental authority holder must compare the downstream results in the receiving waters to the trigger values specified in Table C3 and; (1) where the trigger values are not exceeded then no action is to be taken. (2) where the downstream results exceed the trigger values specified **Table C3 (Release contaminant trigger investigation levels)** for any quality characteristic, compare the results of the downstream site to the data from background monitoring sites; (a) if the result is less than the background monitoring site data, then no action is to be taken. (b) if the result is greater than the background monitoring site data, complete an investigation into the potential for environmental harm and provide a written report to the administering authority within **90 days** of receiving the result, outlining (i) details of the investigations carried out; and (ii) actions taken to prevent environmental harm.

	Note: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with **C6(2)(b)(ii)** of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.
C7	If an exceedance in accordance with condition **C6(2)(b)** is identified, the holder of the authority must notify the administering authority within **24 hours** of receiving the result.
C8	**Mine affected water release events** The holder must ensure a stream flow gauging station/s is installed, operated and maintained to determine and record stream flows at the locations and flow recording frequency specified in **Table C3 (Release contaminant trigger investigation levels)**.
C9	Notwithstanding any other condition of this environmental authority, the release of mine affected water to waters in accordance with **condition C2** must only take place during periods of natural flow in accordance with the receiving water flow criteria for discharge specified in **Table C4 (Mine affected water release during flow events)** for the release point(s) specified in **Table C1 (Mine affected release points, sources and receiving waters)**.

Table C4 (Mine affected water release during flow events)

Receiving water description	Release Point	Gauging station description	Latitude (GDA94)	Longitude (GDA94)	Minimum Flow in Receiving Water Required for a Release Event	Flow recording Frequency
Bath Creek	TBA	Gauging station 1	-22° 32' 16.8''	147° 32' 16.8''	3.6 cubic metres per second	Continuous (minimum daily)

C10	The release of mine affected water to waters in accordance with **condition C2** must not exceed the Maximum Release Rate for each receiving water flow criterion for discharges specified in **Table C4 (Mine affected water release during flow events)** when measured at the monitoring points specified in **Table C1 (Mine affected release points, sources and receiving waters)**.
C11	The daily quantity of mine affected water released from each release point must be measured and recorded at the monitoring points in **Table C1 (Mine affected release points, sources and receiving waters)**.
C12	Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters, or cause a material build-up of sediment in such waters.
C13	**Notification of release event** The authority holder must notify the administering authority as soon as practicable (no later than **6 hours** of having commenced releasing mine affected water to the receiving environment). Notification must include the submission of written verification to the administering authority of the following information (a) release commencement date/time (b) expected release cessation date/time (c) release point/s (d) release volume (estimated) (e) receiving water/s including the natural flow rate (f) any details (including available data) regarding likely impacts on the receiving water(s).

	Note: Notification to the administering authority must be via an email to WaTERS.
C14	The authority holder must notify the administering authority as soon as practicable (nominally within **24 hours** after cessation of a release) of the cessation of a release notified under **condition C13** and within **28 days** provide the following information in writing: (a) release cessation date/time (b) natural flow volume in receiving water (c) volume of water released (d) details regarding the compliance of the release with the conditions of Department Interest: Water of this environmental authority (i.e. contamination limits, natural flow, discharge volume) (e) all in-situ water quality monitoring results (f) any other matters pertinent to the water release event.
C15	**Notification of release event exceedance** If the release limits defined in **Table C2 (Mine affected release limits)** are exceeded, the holder of the environmental authority must notify the administering authority within **24 hours** of receiving the results.
C16	The authority holder must, within **28 days** of a release that exceeds the conditions of this authority, provide a report to the administering authority detailing: (a) the reason for the release (b) the location of the release (c) all water quality monitoring results (d) any general observations (e) all calculations (f) any other matters pertinent to the water release event.
C17	**Receiving Environment Monitoring and Contaminant Trigger Levels** The quality of the receiving waters must be monitored at the locations specified in **Table C8 (Receiving water upstream background sites and downstream monitoring points)** for each quality characteristic and at the monitoring frequency stated in **Table C7 (Receiving waters contaminant trigger levels)**.

Table C7 (Receiving waters contaminant trigger levels)

Quality Characteristic	Trigger Level	Monitoring Frequency
pH	6.5 - 8.0	Daily during the release
Electrical Conductivity (microsiemens per centimetre)	1000	
Suspended solids (mg/L)	1000	
Sulfate (mg/L)	250	

Table C8 (Receiving water upstream background sites and downstream monitoring points)

Monitoring point	Receiving Waters Location	Latitude	Longitude	Monitoring frequency
Upstream Background Monitoring Points				

Monitoring Point 1	Washpool Creek, 10,700m upstream of GS1	-22° 40’ 02.3’’	147° 31’ 52.7’’	Daily during release
Monitoring Point 2	Back Creek, 6,600m upstream of GS 1	-22° 41’ 17.5’’	147° 33’ 16’’	Daily during release
Monitoring Point 3	Breaker Creek	-22° 41’ 10.1’’	147° 30’ 40.7’’	Daily during release
Downstream Monitoring Points				
Monitoring Point 4	Breaker Creek Diversion	-22° 42’ 53’’	147° 31’ 17’’	Daily during release
Monitoring Point 5	Bath Creek East	-22° 43’ 27’’	147° 32’ 53’’	Daily during release
Monitoring Point 6	Bath Creek Down Stream	-22° 44’ 59’’	147° 32’ 13’’	Daily during release
Note: The data from background monitoring points must not be used where they are affected by releases from other mines.				

C18	If quality characteristics of the receiving water at the downstream monitoring points exceed any of the trigger levels specified in **Table C7 (Receiving waters contaminant trigger levels)** during a release event, the environmental authority holder must compare the downstream results to the upstream results in the receiving waters and: (1) where the downstream result is the same or a lower value than the upstream value for the quality characteristic then no action is to be taken. (2) where the downstream results exceed the upstream results, complete an investigation in accordance with the ANZECC and ARMCANZ 2000 methodology, into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining; (i) details of the investigations carried out; and (ii) actions taken to prevent environmental harm. [Note: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with **C18(2)(ii)** of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.]
C19	All determinations of water quality monitoring must be performed by an appropriately qualified person.
C20	**Receiving Environment Monitoring Program (REMP)** The environmental authority holder must implement a Receiving Environment Monitoring Program (REMP) to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity. This must include monitoring the effects of the mine on the receiving environment periodically (under natural flow conditions) and while mine affected water is being discharged from the site. For the purposes of the REMP, the receiving environment is the waters of the Bath Creek and connected or surrounding waterways within **12 kilometres** downstream of the release. The REMP should encompass any sensitive receiving waters or environmental values downstream of the authorised mining activity that will potentially be directly affected by an authorised release of mine affected water.
C21	A report outlining the findings of the REMP, including all monitoring results and

	interpretations must be prepared annually. This must include an assessment of background reference water quality, the condition of downstream water quality compared with water quality objectives, and the suitability of current discharge limits to protect downstream environment values.
C22	**Water reuse** Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this authority and deposited into artificial water storage structures, such as farm dams or tanks, or used directly at properties owned by the environmental authority holder or a third party (with the consent of the third party).
C23	The following information must be recorded in relation to all water monitoring required under the conditions of this environmental authority and submitted to the administering authority in the specified format with each annual return: (a) the date on which the sample was taken (b) the time at which the sample was taken (c) the monitoring point at which the sample was taken (d) the measured or estimated daily quantity of the contaminants released from all release points (e) the release flow rate at the time of sampling for each release point (f) the results of all monitoring and details of any exceedances with the conditions of this environmental authority (g) water quality monitoring data must be provided to the administering authority in the specified electronic format upon request.
C24	**Water Management Plan** A Water Management Plan developed by an appropriately qualified person must be implemented for all stages of the mining activity.
C25	**Stormwater and water sediment controls** An Erosion and Sediment Control Plan must be developed by an appropriately qualified person and implemented for all stages of the mining activities on the site to minimise erosion and the release of sediment to receiving waters and contamination of storm water.
C26	Stormwater, other than mine affected water, is permitted to be released to waters from: (a) Erosion and sediment control structures that are installed and operated in accordance with the Erosion and Sediment Control Plan required by **condition C25**. (b) Water management infrastructure that is installed and operated, in accordance with a Water Management Plan that complies with **condition C24**, for the purpose of ensuring water does not become mine-affected water.

Schedule D: Acoustic	
Condition number	**Condition**
D1	**Noise limits** The holder of this environmental authority must ensure that noise generated by the mining activities does not cause an environmental nuisance at any sensitive place or commercial place.
D2	When requested by the administering authority, noise monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive place, and the results must be notified within **14 business days** to the administering authority following completion of monitoring.
D3	If monitoring indicates exceedance of the noise limits in **Table D1 - Noise limits**, then the environmental authority holder must: (a) address the complaint including the use of appropriate dispute resolution if required; or (b) immediately implement noise abatement measures so that noise from the activity does not result in further environmental nuisance.
D4	If monitoring indicates that noise from the mining activity is causing an environmental nuisance, then the environmental authority holder must: (a) address the complaint including the use of appropriate dispute resolution if required (b) immediately implement noise abatement measures so that emissions of noise from the activity do not result in further environmental nuisance.
D5	**Airblast overpressure nuisance** The holder of this environmental authority must ensure that blasting does not cause the limits for peak particle velocity and air blast overpressure in **Table D2 - Blasting noise limits** to be exceeded at any sensitive place or commercial place.
D6	**Monitoring and reporting** Noise monitoring and recording must include the following descriptor characteristics and matters: (a) LAN,T (where N equals the statistical levels of 1, 10 and 90 and T = 15 mins) (b) background noise LA90 (c) the level and frequency of occurrence of impulsive or tonal noise and any adjustment and (d) penalties to statistical levels (e) atmospheric conditions including temperature, relative humidity and wind speed and directions (f) effects due to any extraneous factors such as traffic noise (g) location, date and time of monitoring (h) if the complaint concerns low frequency noise, Max LpLIN,T and one third octave band measurements in dB(LIN) for centre frequencies in the 10 - 200 Hz range.

Table D1 (Noise limits)						
Sensitive place						
Noise level dB(A) measured as:	Monday to Saturday			Sundays and public holidays		
	7am to 6pm	6pm to 10pm	10pm to 7am	9am to 6pm	6pm to 10pm	10pm to 9am
LAeq, adj, 15 mins	CV = 50 AV = 5	CV = 45 AV = 5	CV = 40 AV = 0	CV = 45 AV = 5	CV = 40 AV = 5	CV = 35 AV = 0
LA1, adj, 15mins	CV = 55 AV = 10	CV =50 AV = 10	CV = 45 AV= 5	CV = 50 AV = 10	CV = 45 AV = 10	CV = 40 AV = 5
Commercial place						
Noise level dB(A) measured as:	Monday to Saturday			Sundays and public holidays		
	7am to 6pm	6pm to 10pm	10pm to 7am	7am to 6pm	6pm to 10pm	10pm to 7am
LAeq, adj, 15 mins	CV = 55 AV = 10	CV = 50 AV = 10	CV = 45 AV = 5	CV = 50 AV = 10	CV = 45 AV = 10	CV = 40 AV = 5

Notes:

(1) CV = Critical Value
(2) AV = Adjustment Value
(3) To calculate noise limits in Table D1:
    a. If bg ≤ (CV - AV):
    b. Noise limit = bg + AV
    c. If (CV - AV) /-- LESS THAN --/ bg ≤ CV:
    d. Noise limit = CV If bg /-- GREATER THAN --/ CV:
    e. Noise limit = bg + 0
(4) In the event that measured bg (LA90, adj, 15 mins) is less than 30 dB(A), then 30 dB(A) can be substituted for the measured background level
(5) bg = background noise level (LA90, adj, 15 mins) measured over 3-5 days at the nearest sensitive receptor
(6) If the project is unable to meet the noise limits as calculated above alternative limits may be calculated using the processes outlined in the “Planning for Noise Control” guideline.

Table D2 (Blasting noise limits)		
Blasting noise limits	Sensitive or commercial place	
	7am to 6pm	6pm to 7am
Airblast overpressure	115 dB (Linear) Peak for 9 out of 10 consecutive blasts initiated and not greater than 120 dB (Linear) Peak at any time	No blasting
Ground vibration peak particle velocity	5mm/second peak particle velocity for 9 out of 10 consecutive blasts and not greater than 10 mm/second peak particle velocity at any time	No blasting

Schedule E: Waste	
Condition number	**Condition**
E1	All general and regulated waste must only be removed and transported from site by a person who has the authority to transport such wastes to a facility that is lawfully able to accept the waste under the *Environmental Protection Act 1994*.
E2	**Storage of tyres** Tyres stored awaiting disposal or transport for take-back and, recycling, or waste to- energy options, should be stockpiled in volumes less than 3 metres in height and 200 square metres in area and at least 10 metres from any other tyre storage area.
E3	All reasonable and practicable fire prevention measures must be implemented, including removal of grass and other materials within a **ten** (**10) metre** radius of the scrap tyre storage area.
E4	**Disposal of tyres and conveyor belts** Disposing of scrap tyres and conveyor belts resulting from the mining activities in spoil emplacements is acceptable, provided they are placed as deep in the spoil as reasonably practicable.
E5	Scrap tyres resulting from the mining activities disposed within the operational land must not impede saturated aquifers or compromise the stability of the consolidated landform.
E6	The location of tyre burial sites must be recorded.
E7	**Burning Waste** Unless otherwise permitted by the conditions of this environmental authority or with prior approval from the administering authority and in accordance with a relevant standard operating procedure, waste must not be burnt.
E8	The holder of this environmental authority may burn vegetation in accordance with the plan of operations, provided the activity does not cause environmental harm at any sensitive or commercial place.
E9	**Mine waste and rejects management** Waste products generated on or after the 30 August 2017 from the washing of coal must be disposed of within mining voids and covered with spoil to a depth of at least 5m.
E10	A Waste Rock, Spoil and Rejects Disposal Plan must be implemented and include, where relevant, at least: (a) effective characterisation of the waste rock, spoil and rejects to predict under the proposed placement and disposal strategy the quality of runoff and seepage generated concerning potentially environmentally significant effects including salinity, acidity, alkalinity and dissolved metals, metalloids and non-metallic inorganic substances; (b) a program of progressive sampling and characterisation to identify dispersive and non-dispersive spoil and the salinity, acid and alkali producing potential and metal concentrations of waste rock, spoil and rejects; (c) a materials balance and disposal plan demonstrating how potentially acid forming and acid forming waste rock, spoil and rejects will be selectively placed and/or encapsulated to minimise the potential generation of acid mine drainage; (d) where relevant, a sampling program to verify encapsulation and/or placement of potentially acid- forming and acid-forming waste rock, spoil and rejects; (e) how often the performance of the plan will be assessed; (f) the indicators or other criteria on which the performance of the plan will be assessed;

	(g) a rehabilitation strategy; and (h) monitoring or rehabilitation, research and/or trials to verify the requirements and methods for decommissioning and final rehabilitation of the placed materials, including the prevention and management of acid mine drainage, erosion minimisation and establishment of vegetation cover.
E11	The Waste Rock, Spoil and Rejects Disposal Plan developed by an appropriately qualified person must be implemented for all mining activities and reviewed and updated by 30 June every **two (2) years.**
E12	Tailings dewatering cells must be designed and constructed to ensure that any runoff or seepage is contained within the mine water management system.

Schedule F: Land	
Condition number	**Condition**
F1	**Cover Material** The topsoil requirements for rehabilitation of the mine and the availability of suitable topsoil on site must be detailed in a Rehabilitation Management Plan .
F2	Where a surrogate material (growth media) is proposed to be used for rehabilitation either in combination with, or instead of, topsoil, it must be demonstrated as being suitable for rehabilitation at the completion of rehabilitation trials.
F3	A description of the rehabilitation trials and monitoring results must be included in the Rehabilitation Management Plan .
F4	**Rehabilitation landform criteria** Unless otherwise permitted under the conditions of this environmental authority, all areas significantly disturbed by mining activities must be rehabilitated in accordance with **Table F1 - Rehabilitation Requirements** and as detailed in the Rehabilitation Management Plan described in **condition F10**. The final landform design is depicted in **Figure 2**.

Table F1 (Rehabilitation Requirements)					
Post Mining Land Use	**Mine domain**	**Goal**	**Objective**	**Indicator**	**Acceptance criteria**
Grazing	All areas disturbed by mining activities	Safe for humans and wildlife	Safety hazards in rehabilitation are not significantly different to surrounding unmined land subject to the same land use	Hazard assessment	No significant difference
		Stable	Rehabilitation is geotechnically stable	Factor of safety	≥1.5
			Rehabilitation is erosionally stable	Erosion	No gully erosion
				Slope gradient	Rehabilitated landform: <15%
					Ramp 3: <30%
				Groundcover	>50%
		Non-polluting	Rainfall runoff from rehabilitation achieves water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values

			Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: (a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines
		Able to sustain the agreed post-mining land use	Rehabilitation is suitable for sustainable light grazing	Land suitability assessment for light grazing	Land suitability class ≤3 or not different from pre-mining class if ≥4. *LSA Framework for Open-Cut Coal Mine Rehabilitation 2018 (A rule-set for land suitability assessment beef cattle grazing on land rehabilitated after open-cut coal mine in the Bowen Basin Queensland)* unless otherwise agreed in writing between the administering authority and the environmental authority holder.
Native ecosystem	Areas disturbed by mining activities that are located on State Forest Land	Safe for humans and wildlife	Construct landforms that do not pose unacceptable hazards to humans, stock and wildlife.	Safety hazards in rehabilitation are not significantly different to surrounding unmined land subject to the same land use	Hazard assessment
		Stable	Demonstrate geotechnical stability.	Factor of safety	≥1.5
				Erosion	No gully erosion

			Not exhibiting excessive erosion	Slope gradient	Rehabilitated landform: <15%
				Groundcover	>50%
		Able to sustain vegetation	Rehabilitation landform (including land cover and water) is suitable for providing native ecosystem	Vegetation assessment	A vegetation assessment is completed by an APQ using a methodology as outlined in the Queensland Mine Rehabilitation Commissioner technical paper 'Evaluating methods for assessing native ecosystem mine rehabilitation success' (March 2023).
			Achieve self-sustaining systems that doesn't require additional maintenance except that of surrounding areas (e.g., weed and fire control via grazing/pastoral management etc.).		>70% total cover across rehabilitation area, includes multilevel canopy, groundcover, and leaf litter. At least four native tree or shrub species across the rehabilitation area. Evidence of recruitment of native tree species over a representative climatic period.
		Non-polluting	Rainfall runoff from rehabilitation achieves water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
			Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: (a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or (b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines

Non-use Management Area (NUMA)	Final void	Safe for humans and wildlife, stable and non-polluting	Construct landforms that do not pose unacceptable hazards to humans, stock and wildlife	Highwall Criteria	(a) Maximum slope of 30% when measured from highwall toe to crest. (b) Buttressing at a minimum offset of 30m at the toe section of the highwall. (c) Fencing and warning signage posted at 50m intervals above the final void (d) Must be safe, stable and non-polluting.
				Low Wall Criteria	(a) Maximum slope of 15% slope. (b) Must be safe, stable, non-polluting.
			Demonstrate geotechnical stability Not exhibiting excessive erosion	Erosion	No gully erosion
			Maintain regional surface and groundwater quality	Maximum predicted water level (mAHD)	284.1
				Void maximum surface area	(a) Maximum NUMA extent no greater than 291.6 ha projected surface area. (b) Must be safe, stable and non-polluting
			Provide flood immunity.	Flood immunity	Upgrades of Eastern and Western Diversion Drains (EDD and WDD) and levees must provide flood

					immunity to NUMA up to PMF flood. There must be no ingress.

F5	Successfully rehabilitated land must have no active gully erosion. Erosion must be assessed by annual documented inspections. Gully dimensions must be quantitatively assessed for a minimum of **two years** both containing a minimum of two rainfall events of more than 25 millimetres in less than three hours.
F6	**Rehabilitation activities** Progressive rehabilitation of land disturbed by resource activities must be rehabilitated in accordance with **Table F1 – Rehabilitation Requirements** and must commence within **2 years** of when areas become available within the operational land.
F7	The environmental authority holder must provide written notification to the administering authority that details how the progressive rehabilitation has been completed with each annual return.
F8	**Rehabilitation Management Plan** A Rehabilitation Management Plan developed by an appropriately qualified person must be implemented for all mining activities and reviewed and updated by **30 June** every **two (2) years**.
F9	At a minimum, the Rehabilitation Management Plan must include: (a) map existing areas of rehabilitation including classification of stage (i.e. time since establishment) and quality; (b) a strategy for progressive rehabilitation; (c) detail the design objectives for rehabilitation of each domain to achieve rehabilitation success criteria and the identified post mining land uses; (d) specify spoil characteristics, soil analysis, soil separation for use on rehabilitation; (e) specify the topsoil requirements for the site and provide details of how topsoil will be managed for use in rehabilitation; (f) detail any topsoil deficit and how any deficit will be managed for successful rehabilitation, including, if applicable, the proposal of surrogate growth media; (g) detail rehabilitation methods applied to areas; (h) detail landform design including end of mine design; (i) detail how landform design will be consistent with surrounding topography; (j) identify and detail planned native vegetation rehabilitation areas and corridors; (k) identify at least a minimum of three (3) reference sites for use in rehabilitation monitoring; (l) describe rehabilitation indicators and how these will be monitored; (m) describe management actions to address unsuccessful rehabilitation or redesign; and (n) describe end of mine landform design planning and post mining land uses across the mine; and include a triple bottom line assessment (or a comparative alternative assessment method) of the proposed final landform design criteria and alternatives.
F10	**Exchange Sodium Percentage** Coal washery wastes and spoil with exchangeable sodium percentage (ESP) >30 percent must be covered with a minimum of one metre of benign material (i.e. with ESP <15 percent) prior to rehabilitation commencing.

F11	**Closure Management Plan** A Closure Management Plan developed by an appropriately qualified person must be implemented for all mining activities and reviewed and updated by **30 June** every **two (2) years**.
F12	At a minimum, the Closure Management Plan must include: (a) final landform design demonstrating rehabilitation requirements; (b) a schedule of rehabilitation that is integrated with the mine plan and identifies how rehabilitation will be completed progressively throughout the life of the mine; (c) the operation, monitoring and maintenance details of the following: (i) spontaneous combustion; (ii) wastewater collection and reticulation systems; (iii) wastewater treatment systems; (iv) groundwater quality monitoring network; (v) surface water quality; (vi) groundwater quality; (vii) seepage rates; (viii) erosion rates; (ix) integrity and stability of slopes, ramps and voids; and (x) the health and resilience of vegetation cover. (d) schematic representations of the proposed final landform including, landform type, slope, regional ecosystems, drainage designs and any post mining land or infrastructure use agreed with the landowner/holder and the administering authority; (e) details of the progressive rehabilitation program designed to demonstrate the trajectory of rehabilitated areas towards rehabilitation requirements; and (f) detail outlining potential residual risk with proposed strategies to reduce or manage these risks.
F13	**Residual void outcome** Residual voids must not cause any serious environmental harm to land, surface waters or any recognised groundwater aquifer, other than the environmental harm constituted by the existence of the residual void itself and subject to any other condition within this environmental authority.
F14	**Residual void design** Residual voids must comply with the design criteria specified in **Table F1 – Rehabilitation Requirements** and as detailed in the Residual Void Management Plan described in **condition F16**.
F15	**Residual Void Management Plan** A Residual Void Management Plan developed by an appropriately qualified person must be implemented for all mining activities and reviewed and updated by **30 June** every **two (2) years**.
F16	At a minimum, the Residual Void Management Plan must include: (a) options available for minimising final void area and volume; (b) design objectives for rehabilitation of final voids; (c) void hydrology, addressing the long-term water balance in the voids, connections to groundwater resources and water quality parameters in the long term; (d) pit wall stability, considering the effects of long-term erosion and weathering of the pit wall and the effects of significant hydrological events; (e) options available for minimising risk of flood interaction for all flood events up to and including the Probable Maximum Flood level; (f) void capability to support native flora and fauna; and

	(g) void rehabilitation success criteria and final void areas and volumes to meet the outcomes defined in the Rehabilitation Management Plan described in **condition F9.**
F17	**Acid rock drainage and leachate management** Subject to the release limits defined in **Table C2 - Mine affected release limits**, all reasonable and practicable measures must be implemented to prevent hazardous leachate being directly or indirectly released or likely to be released as a result of the activity to any groundwater or watercourse.

Schedule G: Regulated structures	
Condition number	**Condition**
G1	**Assessment of consequence category** The consequence category of any structure must be assessed by a suitably qualified and experienced person in accordance with the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933) at the following times: (a) prior to the design and construction of the structure, if it is not an existing structure; or (b) prior to any change in its purpose or the nature of its stored contents.
G2	A consequence assessment report and certification must be prepared for each structure assessed and the report may include a consequence assessment for more than one structure.
G3	Certification must be provided by the suitably qualified and experienced person who undertook the assessment, in the form set out in the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933).
G4	**Design and construction of a regulated structure** **Conditions G5** to **G9** inclusive do not apply to existing structures.
G5	All regulated structures must be designed by, and constructed under the supervision of, a suitably qualified and experienced person in accordance with the requirements of the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933).
G6	Construction of a regulated structure is prohibited unless: (a) the holder has submitted a consequence category assessment report and certification to the administering authority; and (b) certification for the design, design plan and the associated operating procedures has been certified by a suitably qualified and experienced person in compliance with the relevant condition of this authority.
G7	Certification must be provided by the suitably qualified and experienced person who oversees the preparation of the design plan in the form set out in the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933) and must be recorded in the Register of Regulated Structures.
G8	Regulated structures must: (a) be designed and constructed in compliance with the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933); (b) be designed and constructed with due consideration given to ensuring that the design integrity would not be compromised on account of: (i) floodwaters from entering the regulated dam from any watercourse or drainage line; and (ii) wall failure due to erosion by floodwaters arising from any watercourse or drainage line; and (c) have the floor and sides of the dam designed and constructed to prevent or minimise the passage of the wetting front and any entrained contaminants through either the floor or sides of the dam during the operational life of the dam and for any period of decommissioning and rehabilitation of the dam.
G9	Certification by the suitably qualified and experienced person who supervises the construction must be submitted to the administering authority on the completion of construction of the regulated structure, and state that:

	(a) the 'as constructed' drawings and specifications meet the original intent of the design plan for that regulated structure; and (b) construction of the regulated structure is in accordance with the design plan.
G10	**Notification of affected persons** All affected persons must be provided with a copy of the emergency action plan in place for each regulated structure: (a) for existing structures that are regulated structures, within **10 business days** of this condition taking effect; (b) prior to the operation of the new regulated structure; and (c) if the emergency action plan is amended, within **5 business days** of it being amended.
G11	**Operation of a regulated structure** Operation of a regulated structure, except for an existing structure, is prohibited unless the holder has submitted to the administering authority in respect of regulated structure, all of the following: (a) one paper copy and one electronic copy of the design plan and certification of the 'design plan' in accordance with **condition G6**; (b) a set of 'as constructed' drawings and specifications; (c) certification of the 'as constructed drawings and specifications' in accordance with **condition G9**; (d) where the regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, a copy of the certified system design plan; (e) the requirements of this authority relating to the construction of the regulated structure have been met; (f) the holder has entered the details required under this authority, into a Register of Regulated Structures; and (g) there is a current operational plan for the regulated structure.
G12	For existing structures that are regulated structures: (a) where the existing structure that is a regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, the holder must submit to the administering authority within **12 months** of the commencement of this condition a copy of the certified system design plan including that structure; and (b) there must be a current operational plan for the existing structures.
G13	Each regulated structure must be maintained and operated, for the duration of its operational life until decommissioned and rehabilitated, in compliance with the current operational plan and, if applicable, the current design plan and associated certified 'as constructed' drawings.
G14	**Mandatory reporting level** **Conditions G15** to **G16** inclusive only apply to Regulated Structures which have not been certified as low consequence category for 'failure to contain - overtopping'.
G15	The Mandatory Reporting Level (the MRL) must be marked on a regulated dam in such a way that during routine inspections of that dam, it is clearly observable.
G16	The holder must, as soon as practicable but within 48 hours of becoming aware, notify the administering authority when the level of the contents of a regulated dam reaches the MRL.
G17	The holder must, immediately on becoming aware that the MRL has been reached, act to prevent the occurrence of any unauthorised discharge from the regulated dam.
G18	The holder must record any changes to the MRL in the Register of Regulated Structures.

G19	The holder must assess the performance of each regulated dam or linked containment system over the preceding November to May period based on actual observations of the available storage in each regulated dam or linked containment system taken prior to **1 July** of each year.
G20	By **1 November** of each year, storage capacity must be available in each regulated dam (or network of linked containment systems with a shared DSA volume), to meet the Design Storage Allowance (DSA) volume for the dam (or network of linked containment systems).
G21	The holder must, as soon as practicable but within 48 hours of becoming aware that the regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on **1 November** of any year, notify the administering authority.
G22	The holder must, immediately on becoming aware that a regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on **1 November** of any year, act to prevent the occurrence of any unauthorised discharge from the regulated dam or linked containment systems.
G23	**Annual Inspection report** Each regulated structure must be inspected each calendar year by a suitably qualified and experienced person.
G24	At each annual inspection, the condition and adequacy of all components of the regulated structure must be assessed and a suitably qualified and experienced person must prepare an annual inspection report containing details of the assessment and include a recommendations section, with any recommended actions to ensure the integrity of the regulated structure or a positive statement that no recommendations are required.
G25	The suitably qualified and experienced person who prepared the annual inspection report must certify the report in accordance with the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933).
G26	The holder must within **20 business days** of receipt of the annual inspection report, provide to the administering authority: (a) The recommendations section of the annual inspection report; (b) If applicable, any actions being taken in response to those recommendations; and (c) If, following receipt of the recommendations and (if applicable) recommended actions, the administering authority requests a copy of the annual inspection report from the holder, provide this to the administering authority within **10 business days** of receipt of the request.
G27	**Transfer arrangements** The holder must provide a copy of any reports, documentation and certifications prepared under this authority, including but not limited to any Register of Regulated Structures, consequence assessment, design plan and other supporting documentation, to a new holder on transfer of this authority.
G28	**Register of Regulated Structures** A Register of Regulated Structures must be established and maintained by the holder for each regulated structure.
G29	The holder must provisionally enter the required information in the Register of Regulated Structures when a design plan for a regulated dam is submitted to the administering authority.
G30	The holder must make a final entry of the required information in the Register of Regulated Structures once compliance with **conditions G11** and **G12** has been achieved.
G31	The holder must ensure that the information contained in the Register of Regulated Structures is current and complete on any given day.
G32	All entries in the Register of Regulated Structures must be approved by the chief executive officer for the holder of this authority, or their delegate, as being accurate and correct.

G33	The holder must, at the same time as providing the annual return, supply to the administering authority a copy of the records contained in the Register of Regulated Structures, in the electronic format required by the administering authority.
G34	**Transitional arrangements** All existing structures that have not been assessed in accordance with either the Manual or the former Manual for Assessing Hazard Categories and Hydraulic Performance of Dams must be assessed and certified in accordance with the Manual within 6 months of amendment of the authority adopting this schedule.
G35	All existing structures must subsequently comply with the timetable for any further assessments in accordance with the Manual specified in **Table G1 (Transitional hydraulic performance requirements for existing structures)**, depending on the consequence category for each existing structure assessed in the most recent previous certification for that structure.
G36	**Table G1 (Transitional hydraulic performance requirements for existing structures)** ceases to apply for a structure once any of the following events has occurred: (a) it has been brought into compliance with the hydraulic performance criteria applicable to the structure under the Manual; or (b) it has been decommissioned; or (c) it has been certified as no longer being assessed as a regulated structure.
G37	Certification of the transitional assessment required by **G34** and **G35** (as applicable) must be provided to the administering authority within **6 months** of amendment of the authority adopting this schedule.

Table G1 (Transitional hydraulic performance requirements for existing structures)			
Transition period for existing structures to achieve the requirements of the Manual for Assessing Consequence Categories and Hydraulic Performance of Dams			
Compliance with criteria	High consequence	Significant consequence	Low consequence
>90 percent and a history of good compliance performance in last 5 years	No transition required	No transition required	No transitional conditions apply. Review consequence assessment every 7 years.
>70 percent - ≤90 percent	Within 7 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Within 10 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	No transitional conditions apply. Review consequence assessment every 7 years.
>50-≤70 percent	Within 5 years unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Within 7 years unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Review consequence assessment every 7 years.
≤50 percent	Within 5 years or as per compliance requirements (e.g. TEP timing)	Within 5 years or as per compliance requirements (e.g. TEP timing).	Review consequence assessment every 5 years.
Regulated levee designed to prevent the ingress of clean flood water <100 percent compliant	Within 5 years unless otherwise agreed with the administering authority		
Note: Levees designed for the diversion of contaminated waters or protection of the structural integrity of a dam is not to be considered as part of this provision. These levees are considered a key design element of the relevant dam and transitional periods should as such align to that relevant compliance criteria and consequence category.			

Schedule H: Sewage treatment	
Condition number	**Condition**
H1	All effluent released from the sewage treatment plant must be evaporated in an impervious pond.
H2	Dried sewage sludge must be buried within spoil emplacements, records of the disposal volumes and locations must be kept.
H3	The Sewage Treatment Management Plan must be implemented for all mining activities and reviewed and updated by **30 June** every **two (2) years**.

Schedule I: Groundwater	
Condition number	**Condition**
I1	The holder of this environmental authority must not release contaminants to groundwater.
I2	A groundwater monitoring program to monitor water quality and standing water level in any aquifers likely to be impacted by mining activities must be implemented for all mining activities and reviewed and updated by **30 June** every **two (2) years**.
I3	**Groundwater monitoring** Groundwater must be monitored: (a) at the locations and frequencies identified in **Table I1 (Groundwater monitoring locations and frequency)**; and (b) for the quality characteristics specified in **Table I2 (Groundwater quality trigger thresholds)** and (c) for the standing water levels stated in **Table I3 (Groundwater standing water level trigger thresholds)**.
I4	All groundwater sampling and monitoring methods must be in accordance with the latest version of the administering authority's '*Monitoring and Sampling Manual 2018: Environmental Protection (Water) Policy 2009*' unless otherwise approved by the administering authority.
I5	**Groundwater quality** Results of monitoring of groundwater quality from compliance bores identified in **Table I1 (Groundwater monitoring locations and frequency)** must not exceed any of the limits defined in **Table I2 (Groundwater quality trigger thresholds)** on more than **three (3)** consecutive monitoring occasions.
I9	**Bore construction, maintenance and decommissioning** The construction, maintenance and management of groundwater bores (including groundwater monitoring bores) must be undertaken in a manner that prevents or minimizes impacts to the environment and ensures the integrity of the bores to obtain accurate monitoring.
I10	**Transitional arrangements** By **30 June 2026**, the environmental authority holder must: (a) prepare a hydrogeological numerical groundwater model in accordance with the most recent version of the '*Australian Groundwater Modelling Guidelines*' (2012); and (b) submit a report to the administering authority proposing groundwater level trigger thresholds, derived from the results of the groundwater model, to populate **Table I3 (Groundwater standing water level trigger thresholds).**

Table I1 (Groundwater monitoring locations and frequency)					
Monitoring point	Location (GDA2020)		Hydrogeological Unit	Surface RL (mAHD)	Monitoring frequency
	Latitude	Longitude			
Reference bore-					
GW04B	-22.69090	147.55675	Permian conglomerate	314	Quarterly
Compliance bores					
BA Station (Mayes Bore)	-22.67855	147.55946	Tertiary Basalt	324	Quarterly
Curtis Windmill	-22.66615	147.56694	Tertiary Basalt	325	Quarterly

Notes:

[1] Monitoring is not required where a bore has been removed as a direct result of the mining activity.
[2] RL must be measured to the nearest 5cm from the top of the bore casing.
[3] Reference sites must:
(a) have a similar flow regime
(b) be from the same bio-geographic and climatic region
(c) have similar geology, soil types and topography
(d) not be so close to the test sites that any disturbance at the test site also results in a change at the reference site.

Table I2 (Groundwater quality trigger thresholds)				
Parameter	Units	Trigger value		Trigger type
		Curtis Windmill	BA Station	
EC	µS/cm	**883**	**631**	**Bore specific**
pH	pH units	6.5-8.5	6.5-8.5	WQO*
Sulfate	mg/L	**19**	**24**	**Bore specific**
Metals (dissolved)				
Aluminium	mg/L	0.055	0.055	ANZG
Arsenic	mg/L	0.013	**0.027**	ANZG and **bore specific**
Boron	mg/L	0.94	0.94	ANZG
Cadmium	mg/L	0.0002	0.0002	ANZG
Chromium	mg/L	0.001	0.001	ANZG
Copper	mg/L	**0.005**	**0.004**	**Bore specific**

Lead	mg/L	0.0034	0.0034	ANZG
Manganese	mg/L	1.9	1.9	ANZG
Mercury	mg/L	0.00006	0.00006	ANZG
Molybdenum	mg/L	0.034	0.034	ANZG
Nickel	mg/L	**0.012**	0.011	**Bore specific** and ANZG
Silver	mg/L	0.0005	0.0005	ANZG
Vanadium	mg/L	0.006	0.006	ANZG
Zinc	mg/L	**0.021**	**0.009**	**Bore specific**
Iron	mg/L	*Iron is monitored for interpretation purposes*		
Major ions	mg/L	*Calcium, Magnesium, Potassium, Sodium, Chloride, Bicarbonate and Carbonate are monitored for interpretation purposes*		

Table I3 (Groundwater standing water level trigger thresholds)			
Monitoring location	Hydrogeological Unit	Baseline water level (mAHD)	Standing water level trigger threshold (mAHD)
BA Station (Mayes Bore)	Tertiary Basalt	TBD	TBD
Curtis Windmill	Tertiary Basalt	TBD	TBD
GW04B	Permian Conglomerate	TBD	TBD

Definitions

Key terms and/or phrases used in this document are defined in this section. Where a term is not defined, the definition in the *Environmental Protection Act 1994*, its regulations or environmental protection policies must be used. If a word remains undefined it has its ordinary meaning.

"**20th percentile flow**" means the 20th percentile of all daily flow measurements (or estimations) of daily flow over a 10 year period for a particular site. The 20th percentile calculation should only include days where flow has been measured (or estimated), i.e. not dry weather days.

"**acid mine drainage**" means drainage that is characterised by low pH, elevated metal concentrations, high sulfate concentrations and high salinity.

"**acceptance criteria**" means the measures by which the actions implemented to rehabilitate the land are deemed to be complete. The acceptance criteria indicate the success of the rehabilitation outcome or remediation of areas which have been significantly disturbed by the mining activities. Acceptance criteria may include information regarding:

(a) vegetation establishment, survival and succession
(b) vegetation productivity, sustained growth and structure development
(c) fauna colonisation and habitat development
(d) ecosystem processes such as soil development and nutrient cycling, and the recolonisation of specific fauna groups such as collembola, mites and termites which are involved in these processes
(e) microbiological studies including recolonisation by mycorrhizal fungi, microbial biomass and respiration
(f) effects of various establishment treatments such as deep ripping, topsoil handling, seeding and fertiliser application on vegetation growth and development
(g) resilience of vegetation to disease, insect attack, drought and fire
(h) vegetation water use and effects on ground water levels and catchment yields.

"**administering authority**" means the Department of Environment and Heritage Protection or its successor.

"**affected person**" is someone whose drinking water can potentially be impacted as a result of discharges from a dam or their life or property can be put at risk due to dwellings or workplaces being in the path of a dam break flood.

"**airblast overpressure**" means energy transmitted from the blast site

within the atmosphere in the form of pressure waves. The maximum excess pressure in this wave, above ambient pressure is the peak airblast overpressure measured in decibels linear (dBL).

"**ambient (or total) noise**" at a place, means the level of noise at the place from all sources (near and far), measured as the Leq for an appropriate time interval.

"**annual exceedance probability or AEP**" the probability that at least one event in excess of a particular magnitude will occur in any given year.

"**annual inspection report**" means an assessment prepared by a suitably qualified and experienced person containing details of the assessment against the most recent consequence assessment report and design plan (or system design plan);

(a) against recommendations contained in previous annual inspections reports;
(b) against recognised dam safety deficiency indicators;
(c) for changes in circumstances potentially leading to a change in consequence category;
(d) for conformance with the conditions of this authority;

(e) for conformance with the 'as constructed' drawings;
(f) for the adequacy of the available storage in each regulated dam, based on an actual observation or observations taken after 31 May each year but prior to 1 November of that year, of accumulated sediment, state of the containment barrier and the level of liquids in the dam (or network of linked containment systems);
(g) for evidence of conformance with the current operational plan.

"**appropriately qualified person**" means a person who has professional qualifications, training, skills or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis on performance relative to the subject matter using the relevant protocols, standards, methods or literature.

"**assessed or assessment**" by a suitably qualified and experienced person in relation to a consequence assessment of a dam, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit of the assessment:

(a) exactly what has been assessed and the precise nature of that determination;
(b) the relevant legislative, regulatory and technical criteria on which the assessment has been based;
(c) the relevant data and facts on which the assessment has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and
(d) the reasoning on which the assessment has been based using the relevant data and facts, and the relevant criteria.

"**associated works**" in relation to a dam, means:

(a) operations of any kind and all things constructed, erected or installed for that dam;
(b) and any land used for those operations.

"**authority**" means an environmental authority or a development approval.

"**background**" with reference to the water schedule means the average of samples taken prior to the commencement of mining from the same waterway that the current sample has been taken.

"**blasting**" means the use of explosive materials to fracture:

(a) rock, coal and other minerals for later recovery or
(b) structural components or other items to facilitate removal from a site or for reuse.

"**certified**" with respect to watercourse diversions, means assessed and approved by a suitably qualified and experienced person. In relation to 'as constructed' drawings and specifications, the certification must be by the suitably qualified person who supervised the construction of the watercourse diversion, or re-establishment of the watercourse.

"**certification**" means assessment and approval must be undertaken by a suitably qualified and experienced person in relation to any assessment or documentation required by this Manual, including design plans, 'as constructed' drawings and specifications, construction, operation or an annual report regarding regulated structures, undertaken in accordance with the Board of Professional Engineers of Queensland Policy Certification by RPEQs (ID: 1.4 (2A)).

"**certifying, certify or certified**" have a corresponding meaning as 'certification'.

"**chemical**" means:

(a) an agricultural chemical product or veterinary chemical product within the meaning of the Agricultural and Veterinary Chemicals Code Act 1994 (Commonwealth), or

(b) a dangerous good under the Australian Code for the Transport of Dangerous Goods by Road and Rail approved by the Australian Transport Council, or
(c) a lead hazardous substance within the meaning of the Workplace Health and Safety Regulation 1997, or
(d) a drug or poison in the Standard for the Uniform Scheduling of Drugs and Poisons prepared by the Australian Health Ministers' Advisory Council and published by the Commonwealth, or
(e) any substance used as, or intended for use as:
(i) pesticide, insecticide, fungicide, herbicide, rodenticide, nematicide, miticide, fumigant or related product, or
(ii) a surface active agent, including, for example, soap or related detergent, or
(iii) a paint solvent, pigment, dye, printing ink, industrial polish, adhesive, sealant, food additive, bleach, sanitiser, disinfectant, or biocide, or
(iv) a fertiliser for agricultural, horticultural or garden use, or
(v) a substance used for, or intended for use for mineral processing or treatment of metal, pulp and paper, textile, timber, water or wastewater, or
(vi) manufacture of plastic or synthetic rubber.

"**competent person**" means a person with the demonstrated skill and knowledge required to carry out the task to a standard necessary for the reliance upon collected data or protection of the environment.

"**commercial place**" means a work place used as an office or for business or commercial purposes, which is not part of the mining activity and does not include employees accommodation or public roads.

"**compliance bore**" refers to a groundwater monitoring bore which is the subject of compliance requirements for groundwater quality and/or level.

"**construction or constructed**" in relation to a dam includes building a new dam and modifying or lifting an existing dam, but does not include investigations and testing necessary for the purpose of preparing a design plan.

"**consequence**" in relation to a structure as defined, means the potential for environmental harm resulting from the collapse or failure of the structure to perform its primary purpose of containing, diverting or controlling flowable substances.

"**consequence category**" means a category, either low, significant or high, into which a dam is assessed as a result of the application of tables and other criteria in the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933).

"**dam**" means a land-based structure or a void that contains, diverts or controls flowable substances, and includes any substances that are thereby contained, diverted or controlled by that land-based structure or void and associated works.

"**dam crest volume**" means the volume of material (liquids and/or solids) that could be within the walls of a dam at any time when the upper level of that material is at the crest level of that dam. That is, the instantaneous maximum volume within the walls, without regard to flows entering or leaving (for example, via spillway).

"**design plan**" is a document setting out how all identified consequence scenarios are addressed in the planned design and operation of a regulated structure.

"**design storage allowance or DSA**" means an available volume, estimated in accordance with the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933) published by the administering authority, must be provided in a dam as at 1 November each year in order to prevent a discharge from that dam to an annual exceedance probability (AEP) specified in that Manual.

"**designer**" for the purposes of a regulated dam, means the certifier of the design plan for the regulated dam.

"**development approval**" means a development approval under the Planning Act 2016 (or under the repealed Sustainable Planning Act 2009 or Integrated Planning Act 1997) in relation to a matter that involves an environmentally relevant activity under the Environmental Protection Act 1994.

"**disturbance**" of land includes:

(a) compacting, removing, covering, exposing or stockpiling of earth
(b) removal or destruction of vegetation or topsoil or both to an extent where the land has been made susceptible to erosion
(c) carrying out mining within a watercourse, waterway, wetland or lake
(d) the submersion of areas by tailings or hazardous contaminant storage and dam/structure walls
(e) temporary infrastructure, including any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc) which is to be removed after the mining activity has ceased
(f) releasing of contaminants into the soil, or underlying geological strata.

However, the following areas are not included when calculating areas of 'disturbance':

(a) areas off lease (e.g. roads or tracks which provide access to the mining lease)
(b) areas previously disturbed which have achieved the rehabilitation outcomes
(c) by agreement with the administering authority, areas previously disturbed which have not achieved the rehabilitation objective(s) due to circumstances beyond the control of the mine operator (such as climatic conditions)
(d) areas under permanent infrastructure. Permanent infrastructure includes any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc) which is to be left by agreement with the landowner
(e) disturbance that pre-existed the grant of the tenure.

"**EC**" means electrical conductivity.

"**effluent**" means treated waste water released from sewage treatment plants.

"**environmental offset**" has the meaning in section 7 of the Environmental Offsets Act 2014.

"**environmental authority**" means an environmental authority granted in relation to an environmentally relevant activity under the Environmental Protection Act 1994.

"**emergency action plan**" means documentation forming part of the operational plan held by the holder or a nominated responsible officer, that identifies emergency conditions that sets out procedures and actions that will be followed and taken by the dam owner and operating personnel in the event of an emergency. The actions are to minimise the risk and consequences of failure, and ensure timely warning to affected persons and the implementation of protection measures. The plan must require dam owners to annually review and update contact information where required.

"**environmental authority holder**" means the holder of this environmental authority.

"**equilibrium**" means a state where 'balance' is achieved despite changing variables.

"**existing structure**" means a structure that prior to 30 August 2017 meets any or both of the following, a structure:

(a) with a design that is in accordance with the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1934, Version 8.0, 05 JUL 2017) and that is considerably in progress;

(b) that is under considerable construction or that is constructed.

"**extreme storm storage**" - means a storm storage allowance determined in accordance with the criteria in the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933) published by the administering authority.

"**flare pit**" means containment area where any hydrocarbon that is discovered in an over-pressured reservoir during a drilling operation is diverted to, and combusted. The flare pit is only used during the drilling and work over process on a petroleum well.

"**flowable substance**" means matter or a mixture of materials which can flow under any conditions potentially affecting that substance. Constituents of a flowable substance can include water, other liquids fluids or solids, or a mixture that includes water and any other liquids fluids or solids either in solution or suspension.

"**foreseeable future**" is the period used for assessing the total risk of an event occurring. Permanent structures and ecological sustainability should be expected to still exist at the end of a 150 year foreseeable future with an acceptable risk of failure before that time.

"**infrastructure**" means water storage dams, roads and tracks, buildings and other structures built for the purpose of mining activities but does not include other facilities required for the long term management of mining impacts or the protection of potential resources. Such other facilities include dams containing hazardous waste, waste rock dumps, voids, or ore stockpiles and buildings as well as other structures whose ownership can be transferred and which have a residual beneficial use for the next owner of the operational land or the background land owner.

"**hazard category**" means a category, either low, significant or high, into which a dam is assessed as a result of the application of tables and other criteria in *Manual for Assessment Hazard Categories and Hydraulic Performance of Dams*.

"**hazardous waste**" means any substance, whether liquid, solid or gaseous, derived by or resulting from, the processing of minerals that tends to destroy life or impair or endanger health.

"**holder**" means:

(a) where this document is an environmental authority, any
(b) person who is the holder of, or is acting under, that
(c) environmental authority; or
(d) where this document is a development approval, any person who is the registered operator for that development approval.

"**hydraulic performance**" means the capacity of a regulated dam to contain or safely pass flowable substances based on the design criteria specified for the relevant consequence category in the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933).

"**hydrogeological unit**" is any soil or rock unit or zone that by virtue of its hydraulic properties has a distinct influence on the storage or movement of groundwater.

"**infrastructure**" means water storage dams, levees, roads and tracks, buildings and other structures built for the purpose of the mining activity.

"**interpretation bore**" means a monitoring bore located outside of any potential influence or impact by the mining activity, that is used for comparative and interpretative purposes and represents natural background quality and levels similar to the hydrogeological units of the compliance bores.

"**LA 10, adj, 10 mins**" means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 10% of any 10-minute measurement period, using Fast response.

"**LA 1, adj, 10 mins**" means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 1% of any 10-minute measurement period, using Fast response.

"**LA, max adj, T**" means the average maximum A-weighted sound pressure level, adjusted for noise character and measured over any 10 minute period, using Fast response.

"**land**" in the 'land schedule' of this document means land excluding waters and the atmosphere, that is, the term has a different meaning from the term as defined in the Environmental Protection Act 1994. For the purposes of the Acts Interpretation Act 1954, it is expressly noted that the term 'land' in this environmental authority relates to physical land and not to interests in land.

"**land capability**" as defined in the DME 1995 Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland.

"**land suitability**" as defined in the DME 1995 Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland.

"**land use**" term to describe the selected post mining use of the land, which is planned to occur after the cessation of mining operations.

"**leachate**" means a liquid that has passed through or emerged from, or is likely to have passed through or emerged from, a material stored, processed or disposed of at the operational land which contains soluble, suspended or miscible contaminants likely to have been derived from the said material.

"**levee**" means an embankment that only provides for the containment and diversion of stormwater or flood flows from a contributing catchment, or containment and diversion of flowable materials resulting from releases from other works, during the progress of those stormwater or flood flows or those releases; and does not store any significant volume of water or flowable substances at any other times.

"**low consequence dam**" means any dam that is not a high or significant consequence category as assessed using the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933).

"**mandatory reporting level or MRL**" means a warning and reporting level determined in accordance with the criteria in the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933) published by the administering authority.

"**manual**" means the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933) published by the administering authority, as amended from time to time.

"**mandatory reporting level**" means the volume below the spillway crest, equivalent to the lower of the AEP, 72 hour storm or the AEP wave allowance (AEP is the annual exceedance probability).

"**measures**" includes any measures to prevent or minimise environmental impacts of the mining activity such as bunds, silt fences, diversion drains, capping, and containment systems.

"**mine affected water**":

(a) means the following types of water:
(i) pit water, tailings dam water, processing plant water
(ii) water contaminated by a mining activity which would have been an environmentally relevant activity under Schedule 2 of the Environmental Protection Regulation 2008 if it had not formed part of the mining activity
(iii) rainfall runoff which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated, excluding rainfall runoff discharging through release points associated with erosion

and sediment control structures that have been installed in accordance with the standards and requirements of an Erosion and Sediment Control Plan to manage such runoff, provided that this water has not been mixed with pit water, tailings dam water, processing plant water or workshop water
(iv) groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated
(v) groundwater from the mine's dewatering activities
(vi) a mix of mine affected water (under any of paragraphs i)-v) and other water.

(b) does not include surface water runoff which, to the extent that it has been in contact with areas disturbed by mining activities that have not yet been completely rehabilitated, has only been in contact with:
(i) land that has been rehabilitated to a stable landform and either capped or revegetated in accordance with
the acceptance criteria set out in the environmental authority but only still awaiting maintenance and monitoring of the rehabilitation over a specified period of time to demonstrate rehabilitation success, or
(ii) land that has partially been rehabilitated and monitoring demonstrates the relevant part of the landform with which the water has been in contact does not cause environmental harm to waters or groundwater, for example:
    a. areas that are been capped and have monitoring data demonstrating hazardous material adequately contained with the site
    b. evidence provided through monitoring that the relevant surface water would have met the water quality parameters for mine affected water release limits in this environmental authority, if those parameters had been applicable to the surface water runoff, or
(iii) both.

"**minimise**" is to reduce to the smallest possible amount or degree.

"**mineral**" means a substance which normally occurs naturally as part of the earth's crust or is dissolved or suspended in water within or upon the earth's crust and includes a substance which may be extracted from such a substance, and includes-

(a) clay if mined for use for its ceramic properties, kaolin and bentonite
(b) foundry sand
(c) hydrocarbons and other substances or matter occurring in association with shale or coal and necessarily mined, extracted, produced or released by or in connection with mining for shale or coal or for the purpose of enhancing the safety of current or future mining operations for coal or the extraction or production of mineral oil there from
(d) limestone if mined for use for its chemical properties
(e) marble
(f) mineral oil or gas extracted or produced from shale or coal by in situ processes
(g) pea;
(h) salt including brine
(i) shale from which mineral oil may be extracted or produced
(j) silica, including silica sand, if mined for use for its chemical properties
(k) rock mined in block or slab form for building or monumental purposes
(l) but does not include-
(m) living matter
(n) petroleum within the meaning of the Petroleum Act 1923
(o) soil, sand, gravel or rock (other than rock mined in block or slab form for building or monumental purposes) to be used or to be supplied for use as such, whether intact or in broken form and
(p) water.

"**modification or modifying**" (see definition of 'construction')

"**monitoring bore**" means a groundwater bore that provides access to groundwater for measuring its quality and level; and allows groundwater samples to be withdrawn for laboratory analysis.

"**NATA**" means National Association of Testing Authorities, Australia.

"**natural flow**" means the flow of water through waters caused by nature.

"**non-polluting**" means having no adverse impacts upon the receiving environment.

"**noxious**" means harmful or injurious to health or physical wellbeing, other than trivial harm.

"**offensive**" means causing reasonable offence or displeasure; is disagreeable to the sense; disgusting, nauseous or repulsive, other than trivial harm.

"**operational plan**" includes:

(a) normal operating procedures and rules (including clear documentation and definition of process inputs in the DSA);
(b) contingency and emergency action plans including operating procedures designed to avoid and/or minimise environmental impacts including threats to human life resulting from any overtopping or loss of structural integrity of the regulated structure.

"**peak particle velocity (ppv)**" means a measure of ground vibration magnitude which is the maximum rate of change of ground displacement with time, usually measured in millimetres/second (mms- 1).

"**permanent watercourse diversion**" is as defined in Definitions, within the *Guideline: Works that interfere with water in a watercourse for a resource activity— watercourse diversions authorised under the Water Act 2000* or subsequent versions

"**pre-existing watercourse**" is the section of watercourse from which the flow of water will be diverted as a result of the construction and operation of a watercourse diversion.

"**protected area**" means - a protected area under the Nature Conservation Act 1992 or:

(a) a marine park under the Marine Parks Act 2004 or
(b) a World Heritage Area

"**progressive rehabilitation**" means rehabilitation (defined below) undertaken progressively or a staged approach to rehabilitation as mining operations are ongoing.

"**receiving waters**" means the waters into which this environmental authority authorises releases of mine affected water.

"**reference site**" (or analogue site) may reflect the original location, adjacent area or another area where rehabilitation success has been completed for a similar biodiversity. Details of the reference site may be as photographs, computer generated images and vegetation models etc.

"**register of Regulated Structures**" includes:

(a) Date of entry in the register;
(b) Name of the structure, its purpose and intended/actual contents;
(c) The consequence category of the dam as assessed using the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933);
(d) Dates, names, and reference for the design plan plus dates, names, and reference numbers of all document(s) lodged as part of a design plan for the dam;

(e) Name and qualifications of the suitably qualified and experienced person who certified the design plan and 'as constructed' drawings;
(f) For the regulated dam, other than in relation to any levees –
(i) The dimensions (metres) and surface area (hectares) of the dam measured at the footprint of the dam;
(ii) Coordinates (latitude and longitude in GDA94) within five metres at any point from the outside of the dam including its storage area
(iii) Dam crest volume (megalitres);
(iv) Spillway crest level (metres AHD).
(v) Maximum operating level (metres AHD);
(vi) Storage rating table of stored volume versus level (metres AHD);
(vii) Design storage allowance (megalitres) and associated level of the dam (metres AHD);
(viii) Mandatory reporting level (metres AHD);
(g) The design plan title and reference relevant to the dam;
(h) The date construction was certified as compliant with the design plan;
(i) The name and details of the suitably qualified and experienced person who certified that the constructed dam was compliant with the design plan;
(j) Details of the composition and construction of any liner;
(k) The system for the detection of any leakage through the floor and sides of the dam;
(l) Dates when the regulated dam underwent an annual inspection for structural and operational adequacy, and to ascertain the available storage volume for 1 November of any year;
(m) Dates when recommendations and actions arising from the annual inspection were provided to the administering authority;
(n) Dam water quality as obtained from any monitoring required under this authority as at 1 November of each year.

"**regulated structure**" means any structure in the significant or high consequence category as assessed using the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933) published by the administering authority. A regulated structure does not include:

- a fabricated or manufactured tank or container, designed and constructed to an Australian Standard that deals with strength and structural integrity of that tank or container;
- a sump or earthen pit used to store residual drilling material and drilling fluid only for the duration of drilling and well completion activities;
- a flare pit.

"**rehabilitation**" the process of reshaping and revegetating land to restore it to a stable landform and in accordance with the acceptance criteria set out in this environmental authority and, where relevant, includes remediation of contaminated land.

"**revegetation**" is the re-establishment of vegetation1 of a species and density of cover similar to surrounding undisturbed areas or the landform that existed before mining activities on soil surfaces associated with the construction or rehabilitation of a watercourse diversion.

"**RL**" means reduced level, relative to mean sea level as distinct from depths to water.

"**representative**" means a sample set which covers the variance in monitoring or other data either due to natural changes or operational phases of the mining activities.

"**residual drilling material**" means waste drilling materials including muds and cuttings or cement returns from well holes and which have been left behind after the drilling fluids are pumped out.

"**residual void**" means an open pit resulting from the removal of ore and/or waste rock which will remain following the cessation of all mining activities and completion of rehabilitation processes.

"**saline drainage**" The movement of waters, contaminated with salt(s), as a result of the mining activity.

"**self-sustaining**" means an area of land which has been rehabilitated and has maintained the required acceptance criteria without human intervention for a period nominated by the administering authority.

"**sensitive place**" means;

(a) a dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises or
(b) a motel, hotel or hostel or
(c) an educational institution or
(d) a medical centre or hospital or
(e) a protected area under the Nature Conservation Act 1992, the Marine Parks Act 1992 or a World Heritage Area or
(f) a public park or gardens.

Note: The definition of 'sensitive place' and 'commercial place' is based on Schedule 1 of EPP Noise. That is, a sensitive place is inside or outside on a dwelling, library and educational institution, childcare or kindergarten, school or playground, hospital, surgery or other medical institution, commercial and retail activity, protected area or an area identified under a conservation plan under Nature Conservation Act 1992 as a critical habitat or an area of major interest, marine park under Marine Parks Act 2004, park or garden that is outside of the mining lease and open to the public for the use other than for sport or organised entertainment. A commercial place is inside or outside a commercial or retail activity.

A mining camp (i.e., accommodation and ancillary facilities for mine employees or contractors, or both, associated with the mine the subject of the environmental authority) is not a sensitive place for that mine or= mining project, whether or not the mining camp is located within a mining tenement that is part of the mining project the subject of the environmental authority. For example, the mining camp might be located on neighbouring land owned or leased by the same company as one of the holders of the environmental authority for the mining project, or a related company. Accommodation for mine employees or contractors is a sensitive place if the land is held by a mining company or related company, and if occupation is restricted to the employees, contractors and their families for the particular mine or mines which are held by the same company or a related company.

For example, a township (occupied by the mine employees, contractors and their families for multiple mines that are held by different companies) would be a sensitive place, even if part or all of the township is constructed on land owned by one or more of the companies.

"**significant disturbance**" - includes land

(a) if it is contaminated land or
(b) it has been disturbed and human intervention is needed to rehabilitate it to a state required under the relevant environmental authority or
(c) if the environmental authority does not require the land to be rehabilitated to a particular state - to its state immediately before the disturbance.

Some examples of disturbed land include:

- areas where soil has been compacted, removed, covered, exposed or stockpiled
- areas where vegetation has been removed or destroyed to an extent where the land has been made susceptible to erosion; (vegetation and topsoil)

- areas where land use suitability or capability has been diminished
- areas within a watercourse, waterway, wetland or lake where mining activities occur
- areas submerged by tailings or hazardous contaminant storage and dam walls in all cases
- areas under temporary infrastructure. Temporary infrastructure includes any infrastructure (roads, tracks, bridges, culverts, dams, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc) which is to be removed after mining activities have ceased or
- areas where land has been contaminated and a suitability statement has not been issued

However, the following areas are not included:
- areas off lease (e.g. roads or tracks which provide access to the mining lease)
- areas previously significantly disturbed which have achieved the rehabilitation outcomes
- by agreement with the Department of Environment and Resource Management, areas previously significantly disturbed which have not achieved the rehabilitation objective(s) due to circumstances beyond the control of the mine operator (such as climatic conditions)
- areas under permanent infrastructure. Permanent infrastructure includes any infrastructure (roads, tracks, bridges, culverts, dams, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc) which is to be left by agreement with the landowner. The agreement to leave permanent infrastructure must be recorded in the Landowner Agreement and lodged with the Department of Environment and Resource Management
- disturbances that pre-existed the grant of the tenure unless those areas are disturbed during the term of the tenure.

"**spillway**" means a weir, channel, conduit, tunnel, gate or other structure designed to permit discharges form the dam, normally under flood conditions or in anticipation of flood conditions.

"**stable**" means geotechnical stability of the rehabilitated landform where instability related to the excessive settlement and subsidence caused by consolidation / settlement of the wastes deposited, and sliding / slumping instability has ceased.

"**structure**" means dam or levee.

"**suitably qualified and experienced person**" in relation to regulated structures means a person who is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the Professional Engineers Act 2002, and has demonstrated competency and relevant experience:

- for regulated dams, an RPEQ who is a civil engineer with the required qualifications in dam safety and dam design
- for regulated levees, an RPEQ who is a civil engineer with the required qualifications in the design of flood protection embankments.

Note: It is permissible that a suitably qualified and experienced person obtain subsidiary certification from an RPEQ who has demonstrated competence and relevant experience in either geomechanics, hydraulic design or engineering hydrology.

"**system design plan**" means a plan that manages an integrated containment system that shares the required DSA and/or ESS volume across the integrated containment system.

"**temporary watercourse diversion**" s as defined in Definitions, within the Guideline: Works that interfere with water in a watercourse for a resource activity— watercourse diversions authorised under the Water Act 2000 or subsequent versions.

"**the Act**" means the *Environmental Protection Act 1994*.

"**tolerable limits**" means that a range of values could be accepted to achieve an overall environmental management objective (e.g. a range of settlement of a tailing capping could still meet the objective of draining the cap quickly, preventing pondage and limiting infiltration and percolation).

"**trivial harm**" means environmental harm which is not material or serious environmental harm and will not cause actual or potential loss or damage to property of an amount of, or amounts totalling more than $5,000.

"**void**" means any constructed, open excavation in the ground.

"**watercourse**" has the same meaning given in the Water Act 2000.

"**waters**" includes all or any part of a river, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, unconfined water in natural or artificial watercourses, bed and banks of a watercourse, dams, nontidal or tidal waters (including the sea), stormwater channel, stormwater drain, roadside gutter, stormwater run-off, and groundwater.

"**water year**" means the 12-month period from 1 July to 30 June.

"**wet season**" means the time of year, covering one or more months, when most of the average annual rainfall in a region occurs. For the purposes of DSA determination this time of year is deemed to extend from 1 November in one year to 31 May in the following year inclusive.

Figure 1 – Blair Athol Mine authorised disturbance footprint

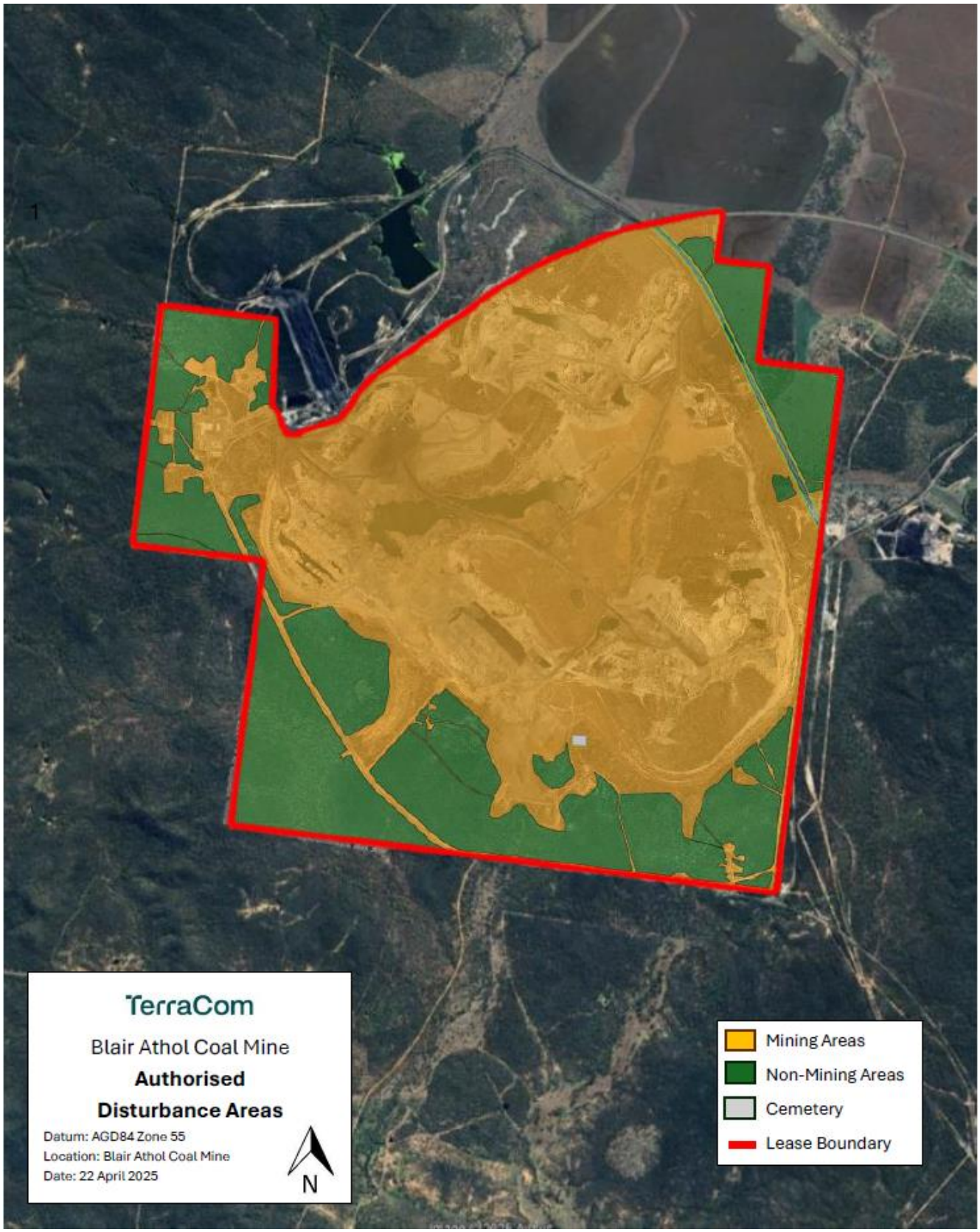
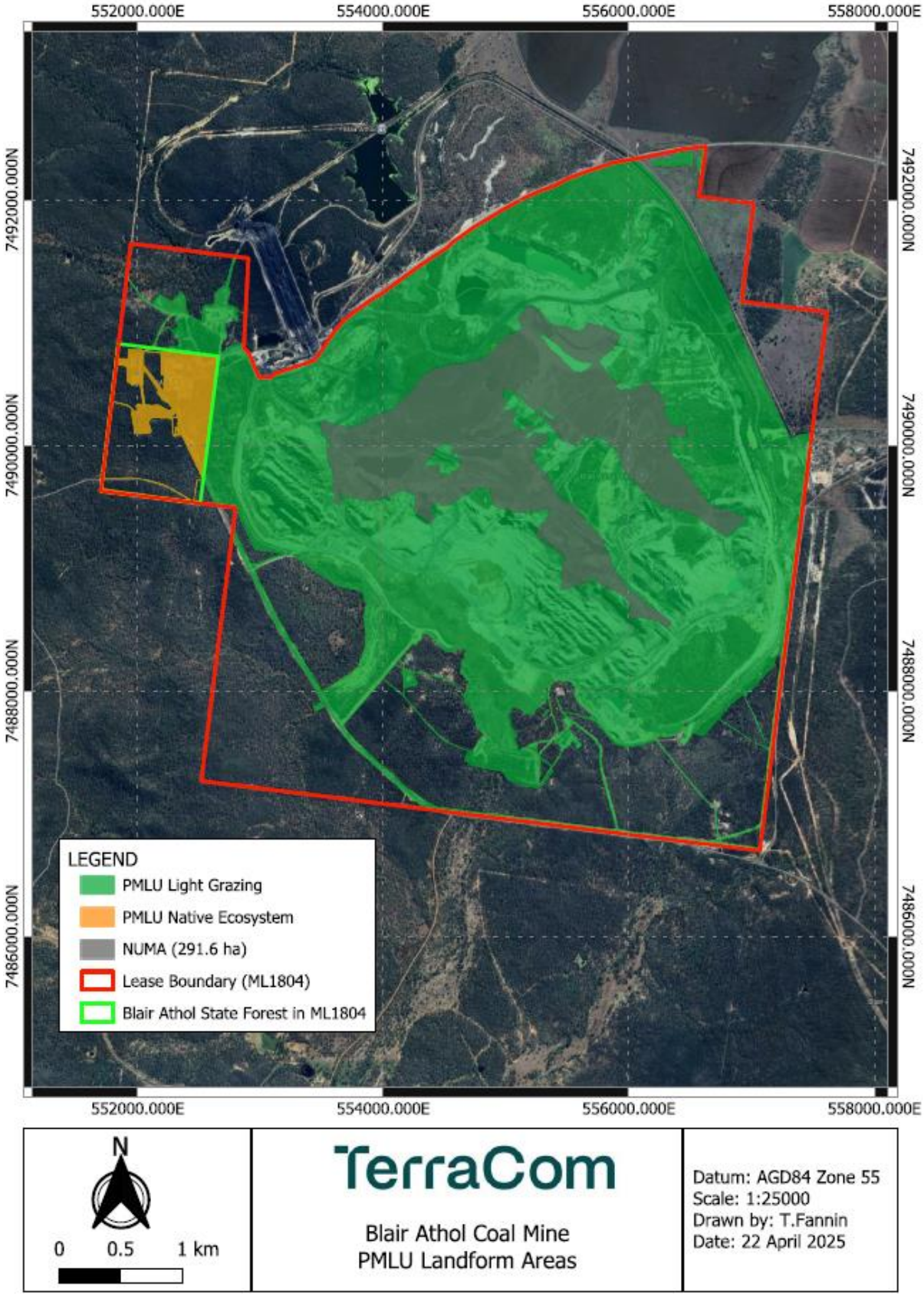


Figure 2 – Blair Athol Mine PMLU Landform Areas



END OF ENVIRONMENTAL AUTHORITY

Blair Athol Coal Mine – Environmental Management System

TerraCom

APPENDIX C — JBT 2012 GROUNDWATER INVESTIGATION



RIO TINTO COAL AUSTRALIA

BLAIR ATHOL MINE

BLAIR ATHOL MINE CLOSURE
GROUNDWATER INVESTIGATION

December 2012

JBT01-018-002

RECORD OF ISSUE

File Name	Description	Issued to:	Date Issued	Method of Delivery
JBT-018-002	Draft 1	S Diggles B Rickard	22/8/2012	email
JBT-018-002	Draft 2	S Diggles B Rickard	3/9/2012	email
JBT-018-002	Draft 3	S Diggles B Rickard	24/12/2012	email

DRAFT

TABLE OF CONTENTS

SECTION **PAGE**

1.0 INTRODUCTION 1
2.0 SCOPE OF WORK 2
3.0 HISTORY OF MINING 2
4.0 AVAILABLE DATA 3
4.1 Existing Reports 3
4.2 Bore Construction Records 5
4.3 Groundwater Level Data 6
4.4 Water Chemistry 6
4.5 Other Data 6
5.0 CLIMATIC DATA 6
5.1 Clermont Climatograph 6
5.2 Rainfall Analysis 7
6.0 GEOLOGY 9
6.1 Regional Geology 9
6.2 Site Geology 13
7.0 HYDROGEOLOGY 16
7.1 Introduction 16
7.2 Description of Hydrostratigraphic Units 16
7.2.1 Basement Rocks 16
7.2.2 Permian Sediments 16
7.2.3 Tertiary Basalt Aquifer 16
7.2.4 Tertiary/ Quaternary Alluvium 17
7.2.5 Tailings and Spoil 17
7.3 Groundwater Recharge and Flow Direction 17
7.3.1 Basement Rocks 17
7.3.2 Permian Sediments 18
7.3.3 Tertiary Basalt Aquifer 18
7.3.4 Tertiary/ Quaternary Alluvium 18
7.3.5 Tailings and Spoil 18
8.0 REVIEW OF MONITORING DATA 18
8.1 Groundwater Monitoring Bores 18
8.2 Groundwater Level Data 21
8.3 Water Chemistry 24
8.3.1 Major Ion Chemistry 24
8.3.2 Comparison of Site Water Quality with Australian Guidelines 30
9.0 FINAL VOID 32
9.1 Final Void (Pit Lake) Water Levels and Water Quality 32
9.2 Potential Groundwater Inflow Rates to Final Void 35
10.0 CONCEPTUAL GROUNDWATER MODEL 37
10.1 Pre-Mining Conceptual Groundwater Model 37
10.2 During Mining Conceptual Groundwater Model 39
10.3 Post-Closure Conceptual Groundwater Model 40
11.0 CONCLUSIONS 42
11.1 Hydrostratigraphy 42
11.2 Groundwater Levels 43
11.3 Water Chemistry 43
11.4 Final Void 45
11.4.1 Final Void Water Levels and Water Quality 45
11.4.2 Groundwater inflow to Final Void 45
11.5 Conceptual Groundwater Model 46
12.0 RECOMMENDATIONS 46
13.0 REFERENCES 47

DRAFT

LIST OF TABLES

Table 5-1: Clermont Rainfall (Clermont Post Office) 9
Table 8-2: Water Type Analysis 25
Table 9-1: Potential Groundwater Inflow Rates to Final Void 36

LIST OF FIGURES

Figure 1-1: Site Location 1
Figure 3-1: Blair Athol Mining Areas 3
Figure 5-1: Climatograph for Clermont (BOM Station No. 035019 – Clermont Post Office) 7
Figure 5-2: Clermont Monthly Rainfall and Residual Mass Curve 7
Figure 6-1: Location of Permian Basins in the Clermont Area 11
Figure 6-2: Pre-Tertiary Land Surface and Basement and Permian Outcrop Areas 11
Figure 6-3: Surface Geology 12
Figure 6-4: Mine Area Stratigraphy (Source: RTCA 2011) 14
Figure 6-5: Schematic Cross Sections Showing Coal Seams (Source: RTCA 2011) 15
Figure 8-1: Location of Bores and Surface Water Dams 20
Figure 8-2: Groundwater Hydrographs 23
Figure 8-3: Piper Diagram – Blair Athol Surface Water and Groundwater Samples 26
Figure 9-1: Modelled Water Level in Final Pit Lake (Source: WBM 2012) 33
Figure 9-2: Modelled Final Void Water Levels Compared to Current Groundwater Levels 34
Figure 10-1: Location of Conceptual Sections (modified from RTCA 2011) 37
Figure 10-2: Pre-Mining Conceptual Groundwater Model (Modified from RTCA 2011) 39
Figure 10-3: During-Mining Conceptual Groundwater Model 40
Figure 10-4: Post-Closure Conceptual Groundwater Model 42

LIST OF APPENDICES

Appendix A Groundwater Level Data

Appendix B Water Type Analysis

Appendix C Comparison of Site Water Quality to Australian Guidelines

DRAFT

1.0 INTRODUCTION

Rio Tinto Coal Australia (RTCA) operates the Blair Athol Mine (BA), which is located in central Queensland, approximately 20 km north-west of the town of Clermont (Figure 1-1).

RTCA are planning for closure of BA and are currently undertaking a number of mine closure studies. RTCA have commissioned JBT Consulting (JBT) to undertake groundwater studies to support the closure of BA.

The scope of work for undertaking the assessment is outlined in Section 2.

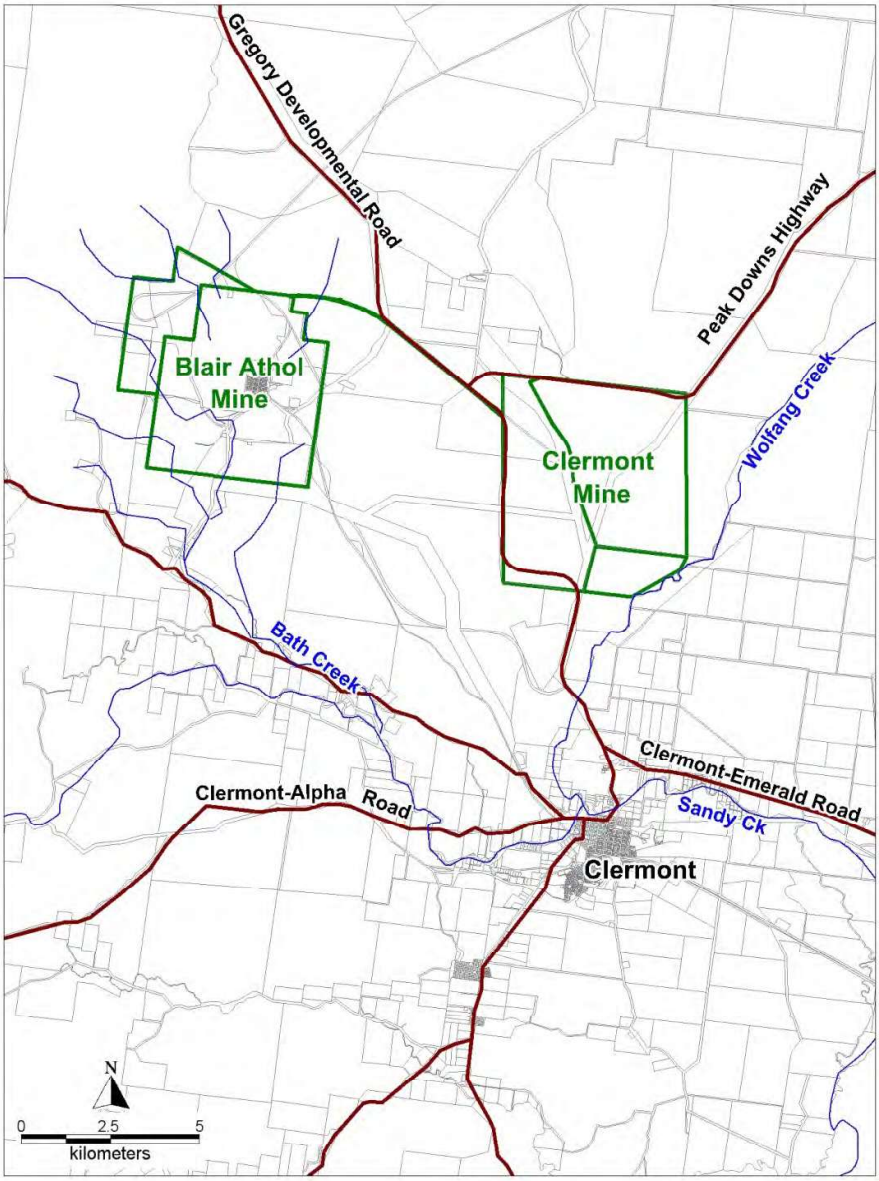


Figure 1-11 1: Site Location

2.0 SCOPE OF WORK

The scope of work for this groundwater study includes:

- Review groundwater data for the BA site, including previous reports, groundwater level data, surface water and groundwater quality data;
- Prepare an updated conceptual groundwater model for the site;
- Undertake a gap analysis with respect to the suitability of existing groundwater monitoring installations and monitoring/ sampling program for mine closure and post-closure;
- Make recommendations as appropriate for mine closure and post-closure groundwater monitoring/sampling, or other investigations if required; and,
- Prepare a report providing:
    - Detail of data available and reviewed for the study;
    - Presentation and discussion of groundwater level data
    - Presentation and discussion of water quality data from surface water and groundwater sources
    - An updated conceptual groundwater model for the site (pre-mining, during mining, and post-closure)
    - Data gap analysis; and,
    - Conclusions and Recommendations

3.0 HISTORY OF MINING

The Blair Athol Mine has been operating at large scale since 1984; prior to 1984 there was a history of small scale open cut and underground mining operations dating back to the 1890's.

There are four mining and rehabilitation areas at site, which are shown on Figure 3-1 and include:

- Ramp 1 (comprising Ramp 1 South Lower and Ramp 1 South East);
- Ramp 3 (comprising Ramp 3 North and Ramp 3 South);
- Ramp 4 (comprising Ramp 4 West and Ramp 4 East); and,
- Ramp 5 (comprising Ramp 5 North).

Since 1984 mining has focussed on Seam 3, which is up to 30 m thick, and the thinner (up to 5 m thick) Seam 4.

Mining has occurred at a typical production rate of 9-10 Mta (million tonnes per annum), with a maximum capacity of 12 Mta, and a recent production rate (for mining of Seam 4 reserves in the Ramp 1 area) of approximately 3.5 Mta.

Mining has been undertaken on site using the strip mining method, utilising a dragline for overburden removal, and truck and shovel operations for mining of coal and interburden. Mining areas have been progressively backfilled with spoil material (overburden and interburden material) leaving a final void at each mined-out area.

DRAFT

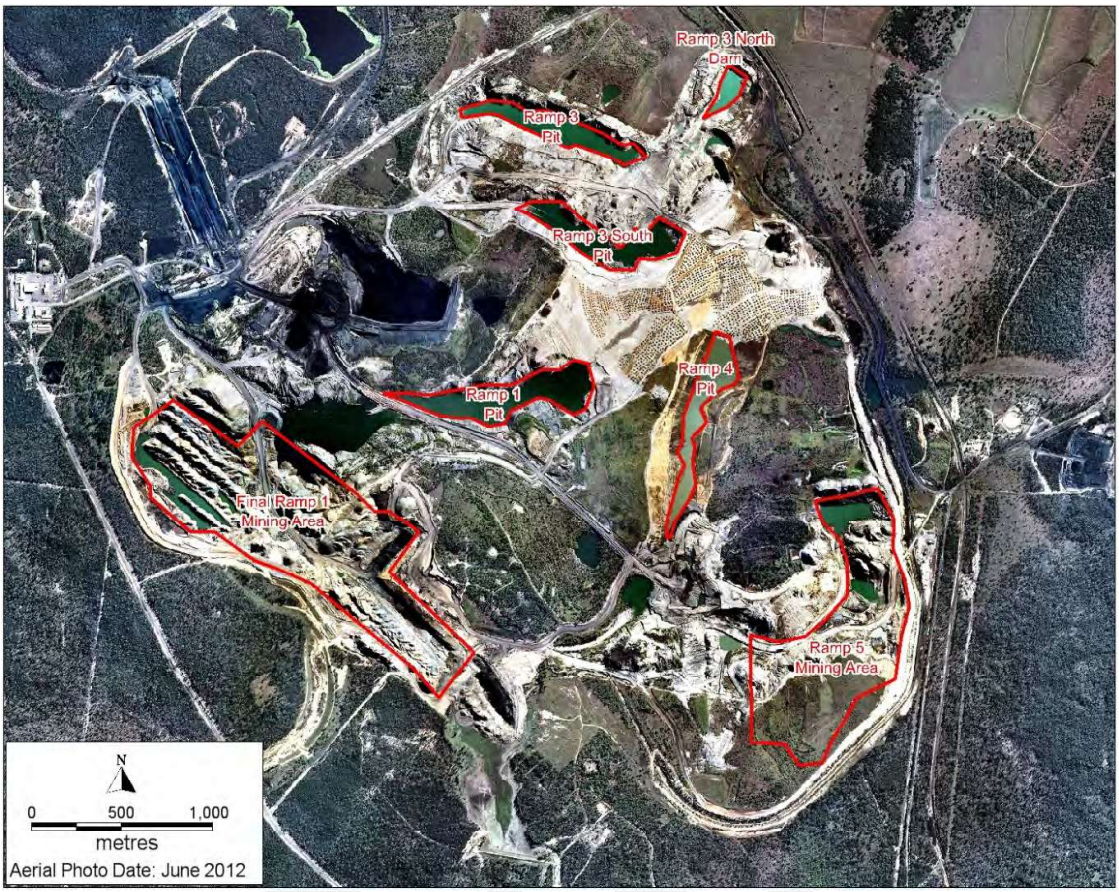


Figure 3-1~~3-1~~: Blair Athol Mining Areas

4.0 AVAILABLE DATA

4.1 Existing Reports

Reports made available for review include:

- BMT-WBM (2012) BAC Final Landform Water Study. Report to Rio Tinto by BMT WBM, November 2012

  Summary: The report presents a summary of water modelling of the pit lake within the final landform, and contains predictions of pit lake water level and salinity for two options: one where existing diversions around the operation are maintained, and another where the existing diversions are removed.

- Matrix+ (2007) *Groundwater Monitoring Bore Installation.* Report to Rio Tinto Coal Australia Blair Athol Coal Mine by Matrix + Consulting, July 2007.

  Summary: The report contains a brief overview of regional and site hydrogeology, followed by a description of the drilling and installation of a number of groundwater monitoring bores and geotechnical monitoring bores (GW-series and GT-series bores). Information in the report includes bore locations, construction information (summary table and bore construction logs), and recommendations that:

  - Monthly water level monitoring be undertaken at each groundwater and geotechnical bore; and,

- Quarterly water quality sampling be undertaken from each groundwater and geotechnical bore.

- RTCA (2011) *The Coal Resources and Coal Reserves of the Blair Athol Mine – 2010.* Report prepared to support 2010 year end statements by Rio Tinto Coal Australia (RTCA), February 2011.

  Summary: The report provides detail of:

  - Regional geology (structure and stratigraphy);
  - Local geology (structure, stratigraphy, description of coal seams, location of alluvium, influence of igneous activity at site (basalt flows and intrusive dykes);
  - Coal exploration status;
  - Current status of the geological database, geological model, and coal quality model;
  - Geotechnical characteristics of the site;
  - The status of coal resources;
  - Overview of the mining method, mining equipment, coal handling and processing, and site infrastructure;
  - Mine design (layout and constraints); and,
  - Economic information, including economic ranking, reserves statement, and stakeholder signoff.

- Terranus (2009) *Groundwater Review – Blair Athol Coal Mine.* Report to Blair Athol Coal Mine by Terranus Earth Sciences, May 2009.

  Summary: The report was prepared to provide a summary of the understanding of groundwater conditions at site, in response to the findings of an internal RTCA environmental audit that the current understanding of groundwater conditions could be improved upon. The report includes:

  - A summary of available reports and data;
  - Description of the geological environment
  - Description of the groundwater environment
  - Summary of groundwater bores at site
  - Review of data integrity (bore construction standards and monitoring data)
  - Review of groundwater chemistry data
  - Presentation of a conceptual hydrogeological model for the site;
  - Data gap analysis, including statements as to the adequacy of:
    - Data coverage (bore distribution
    - Data capture (water level and water quality data)
    - Data quality
    - Data assessment
  - Review of available site data in comparison to Rio Tinto environmental standards; and,
  - Recommended corrective actions, with recommendations that:
    - Water quality samples be collected from water bores every 4 months, but preferably quarterly;

  - Water quality and water level data be collected from key storage dams on site;
  - EDMS (site environmental database) be updated to improve water quality reporting (this recommendation was mainly related to recording of sample QA/QC documentation);
  - Two new monitoring bores be installed, with one adjacent to the wash plant and one to the north of the TSF; and,
  - A detailed groundwater assessment be undertaken, including generation of hydrogeological cross sections through the site.

- Water Solutions (1999) *Report to RTCA Clermont Mine/ Blair Athol Coal on Permanent Waterworks Options Overview Investigations.* Water Solutions Document No. WS990292.

  Summary: The report presents a review and hydrologic assessment of a number of options for controlling surface water runoff and diversion of surface water flow around the mined area as part of mine closure operations.

- Water Solutions (2012) *Report to RTCA Clermont Mine/ Blair Athol Coal on OPSIM Water Management Metered Data Review.* Water Solutions Document No. WS120175 (Draft) 3 May 2012.

  Summary: The report presents an update of the OPSIM model (site water balance model) for the Blair Athol and Clermont Mine sites. The report includes a summary of surface water storage volumes, catchment areas, site water demands, water inputs (rainfall, groundwater, other), and transfer of water between the two mine sites.

- URS (2006) Assessment of water and sediment quality of Stockpile Dam and Environment Dam for EPA Hazardous Dam Classification. Letter report from URS to Blair Athol Coal Mine, Document No. 311006, 31 October 2006.

  Summary: The report presents an assessment of water and sediment from the Environmental Dam, Stockpile Dam, and West Dam, in comparison to EPA acceptance criteria for hazardous dams.

- A number of other reports prepared for the nearby RTCA Clermont Mine, which provide information on the regional groundwater system, groundwater levels, and groundwater chemistry in the Clermont region. The reports include information on groundwater occurrence within the Clermont Mining lease boundary. The reports to not make reference to Blair Athol Mine, but are useful for placing the regional groundwater system into context. Relevant reports include:
  - JBT (2009) *Regional Groundwater Model Update.* Report by JBT Consulting to Rio Tinto Coal Australia, Clermont Mine Project. JBT report No. JBT01-001-008, June 2009
  - JBT (2012) Clermont Mine – 5th Annual Aquifer Performance Review - 2011/2012 Water Year. Report by JBT Consulting to Rio Tinto Coal Australia, Clermont Mine. JBT report No. JBT01-001-061, August 2012.

4.2 Bore Construction Records

Details of site monitoring bores, including bore name, location, elevation, depth, screened interval, formation monitored, operational status, were available from:

- A summary spreadsheet provided by BAC;
- Bore construction records contained in Matrix+ (2007);
- Additional bore location and elevation (GPS) data provided by 4T consultants.

A summary of bore data is provided in Table 8-1.

4.3 Groundwater Level Data

Groundwater Level data available in Excel spreadsheet format included:

- Data downloaded from the site EDMS database covering the period March 2008 to August 2011;
- Data provided by 4T Consultants (site environmental sampling consultants) that included groundwater level data collected by them between May 2011 and August 2012; and,
- Additional water level data from Curtis Bore between January 2007 and May 2009, provided by BA site personnel

4.4 Water Chemistry

Water chemistry data was provided in Excel spreadsheet format, and included:

- Data downloaded from the site EDMS database covering the period March 2008 to August 2011;
- Data provided by 4T Consultants that included water quality data collected by them between May 2011 and August 2012; and,
- Water quality data from monitoring of site surface water storage facilities between May 1985 and July 2012.

4.5 Other Data

Other data provided for review/ report preparation includes:

- A geo-registered aerial photograph of the site, current to June 2012; and,
- Data generated from the site geological model, including:
  - Cross sections through the mining area; and,
  - A dxf file showing the mined-out area at end of mining.

5.0 CLIMATIC DATA

5.1 Clermont Climatograph

This climatic description of the region in which the project site is located has been compiled using data from the Bureau of Meteorology (BOM) weather station at Clermont Post Office (Station No. 035019) from August 2012.

Figure 5-1 presents a climatograph for the region. Annual average rainfall for Clermont is 666.7 mm, with the dry season peaking between July and September, and the wet season peaking from December through to March.

The coldest mean daily temperatures occur in July, with a mean minimum of 6.7ºC and a mean maximum of 23ºC. The hottest months occur in December (mean minimum of 20.8ºC and a mean maximum of 34.9ºC) and January (mean minimum of 21.6ºC and a mean maximum of 34.3ºC), with January also the highest rainfall month (average rainfall 117.9 mm).

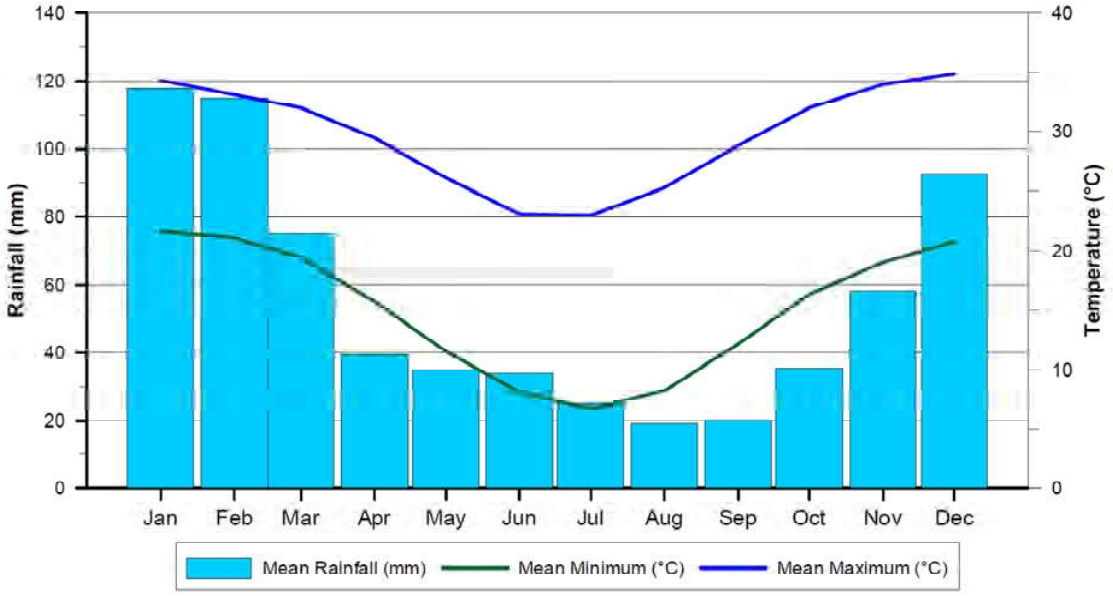


Figure 5-15-1: Climatograph for Clermont (BOM Station No. 035019 – Clermont Post Office)

5.2 Rainfall Analysis

Monthly rainfall for the period January 2002 to June 2012 is shown in Figure 5-2 (data recorded from the Bureau of Meteorology (BOM) Clermont Post Office weather station no. 035019).

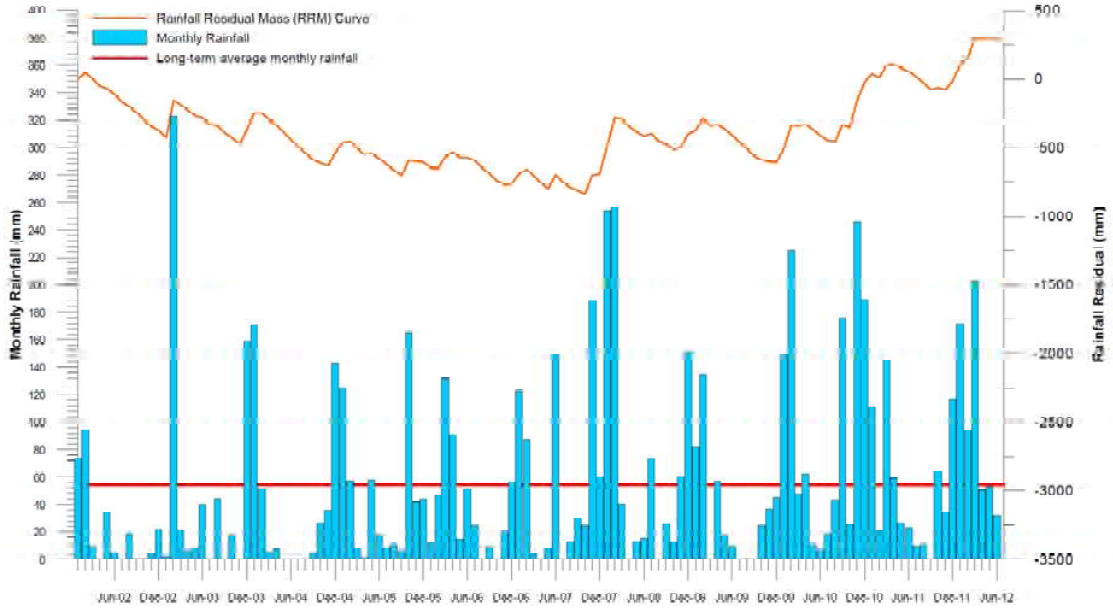


Figure 5-25-2: Clermont Monthly Rainfall and Residual Mass Curve

Table 5-1 shows monthly data for the Clermont Post Office weather station for each water year from 2007/2008 to 2011/2012. The long-term average data shown in Table 5-1 is for the full period of record from the Clermont Post Office weather station (1871 to present).

The wet season total (November to March) for each year is also shown on Table 5-1. The following observations are made with respect to rainfall data:

- The 2007/2008 wet season was one of the wettest on record. A total of 799.4 mm of rainfall was recorded between November 2007 and March 2008, out of a total of 894.4 mm for the entire 2007/2008 water year. The 2007/2008 wet season rainfall had a significant effect on groundwater levels in the Clermont region (JBT 2012). This effect is observed in the water level record for Curtis bore (landholder bore used for water level monitoring – discussed further in Section 8.2);
- The 2008/2009 wet season was slightly below average, however the following three wet seasons were all above average;
- The 2010/2011 year was also significant in terms of groundwater recharge. The wet season (November to March) rainfall of 695.2 mm was above average, but most significantly the wet season started early, with an additional 175.8 mm of rainfall recorded in September (compared to a September average of 19.3 mm). This meant that the above average wet season rainfall occurred when the ground was already saturated, providing enhanced conditions for groundwater recharge; and
- The 2011/2012 wet season was also above average, due mainly to high rainfall recorded during January and March 2012.

Figure 5-2 also shows the Rainfall Residual Mass (RRM) curve for the period of data between January 2002 and December 2011.

The RRM is calculated by subtracting the long-term average monthly rainfall from the actual monthly rainfall, to provide a monthly "departure" from average conditions. If the monthly rainfall is above average the resulting rainfall departure number is positive, whereas if rainfall is below average, the number is negative. The monthly rainfall departures are summed cumulatively to provide the RRM. A number of below-average rainfall months will result in a falling RRM curve, while a number of above average rainfall months will result in a rising RRM curve. The RRM curve is used extensively in groundwater investigations due to the strong correlation in many locations between the RRM and groundwater level trends, especially for shallow aquifers. This relationship is discussed further in Section 8.2.

The overall trend from early 2002 to mid-2007 has been a reducing RRM curve, followed by a rising RRM curve from mid-2007 to present. The 2007/2008 wet season is especially significant in that it marked a reversal from a trend for static or reducing groundwater levels, to a trend towards rising groundwater levels following wet season rainfall. In the Clermont region this trend has been especially evident in the basalt aquifer and other shallow aquifers including alluvium, Permian sediments where they occur close to surface, and areas of bedrock outcrop (JBT, 2012).

Table 5-1: Clermont Rainfall (Clermont Post Office)

Rainfall (mm)	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
2007-2008	0	13	29.6	24.4	188.4	60	254.2	256.4	40.4	0	12.8	15.2	894.4
					Total Nov to Mar - 799.4 mm								
2008-2009	73.4	0	26.4	12.2	60.4	150.8	82.1	134.8	0	57.2	17	9.6	623.9
					Total Nov to Mar - 428.6 mm								
2009-2010	0	0	0.4	24.2	36.8	45	148.2	231.8	47.6	63.4	12.4	6.6	616.4
					Total Nov to Mar - 509.4 mm								
2010-2011	18.5	43.4	175.8	25	225.6	192.6	111	20.6	145.4	79.6	26.8	22.7	1087.0
					Total Nov to Mar - 695.2								
2011-2012	9.5	10.9	0	63.8	34.2	99.4	165.8	77	193.2	49.4	51	32.4	786.6
					Total Nov to Mar - 569.6 mm								
Long-term average	24.8	19.1	20.2	35.5	58.1	92.5	117.5	115.1	74.2	39.1	34.8	34	663.5
					Total Nov to Mar – 457.4 mm								

* The table has been divided to provide a summary of rainfall over the wet season months (November to March).

6.0 GEOLOGY

6.1 Regional Geology

The Blair Athol Mine is located in the Blair Athol Basin, an isolated Permian basin near the western edge of the northern Bowen Basin, on the northern extension of the Dennison Trough.

The Denison Trough formed in the early Permian as an elongate depositional downwarp that developed as a half-graben (RTCA 2011). The Blair Athol Basin is an early Permian half graben lying unconformably on rocks of the Proterozoic to Cambrian Anakie Metamorphic Group (RTCA 2011).

The Permian coal basins in the Clermont area (including the Blair Athol Basin, which hosts the Blair Athol Mine, and the Wolfang Basin which hosts the Clermont Coal – refer Figure 6-1) contain Lower Permian Blair Athol Coal Measures, which overly the Proterozoic/ Cambrian Anakie Metamorphic Group (tightly folded mica, quartz-mica and quartz-chlorite schist, with phyllite, slate and quartzite.

The Permian sequence comprises a lower basal conglomerate, which is a quartzose and lithic pebble to cobble conglomerate, thought to be of glacial origin[1]. The basal conglomerate is overlain by the Permian coal-bearing sequence, which includes laminated sandstone and siltstone, coal seams, carbonaceous siltstone and mudstone, and minor conglomerate (refer stratigraphic section, Figure 6-4).

Vertical movement along faults has brought the basal conglomerates to the surface at various locations, so that the deposits occur at or near surface (with the overlying coal measures eroded away at these locations). This has occurred in the western area of the Clermont Mine, as well as in the vicinity of the Cement Hill and Black Ridge gold mines which are developed within Permian conglomerate (refer Figure 6-3).

The location of Permian coal basins within, and to the north and south of the lease area, can be seen in Figure 6-1, which shows the thickness of sediment within Permian basins in the Clermont area

[1] Herbert, H.K. (1989) Geology and Gold Potential, Black Ridge Area, Clermont Qld. Report to Southern Aurora Joint Venture, June 1989.

(including the Blair Athol Basin in which the BA Mine is developed, and the Wolfang Basin in which the Clermont Mine is developed).

The top of Permian (pre-Tertiary) surface is shown in Figure 6-2. From this figure it can be seen that pre-Tertiary drainage in the northern part of the BA lease area was to the north-east and east, via a channel system incised into the pre-Tertiary surface. The area of Permian outcrop to the north of this valley (Figure 6-2) contains the host rocks for the Cement Hill and Black Ridge gold mines. The location of these mining areas is shown on Figure 6-3.

During the Tertiary (Late Eocene to Middle Oligocene) basalt filled the area from east to west, with initial deposition focused on a deep paleochannel that can be seen to the east of Figure 6-2. The basalt is derived from nearby volcanoes, the remnants of which are still visible today as andesitic plugs including Mt Oscar and Wolfang Peak.

As deposition of basalt continued, the flows progressed further west and eventually infilled the pre-Tertiary channel that can be seen to the north of the BA and Clermont leases on Figure 6-2. The extent of basalt can be seen on the surface geology map shown as Figure 6-3.

Therefore the basalt encountered in the north and north east of the site (Figure 6-3) represents the marginal extent of basalt. Basalt thickens to the north and north-east of the site, with the greatest thickness (locally) within the pre-Tertiary channel shown on Figure 6-2. The basalt progressively thickens to the east of BA; at Clermont Mine the basalt maximum thickness of basalt is in the order of 70-80 m, and in the deepest part of the paleochannel (to the east of the extent shown on Figure 6-2) the basalt thickness exceeds 170 m (JBT 2009).

DRAFT

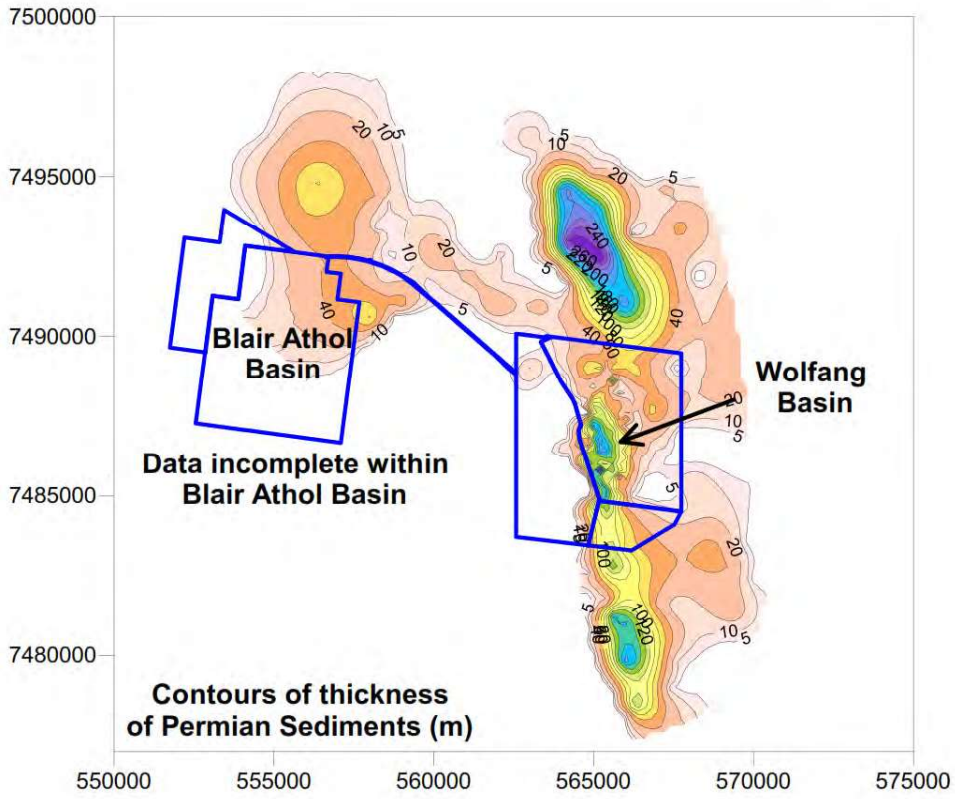


Figure 6-16-1: Location of Permian Basins in the Clermont Area

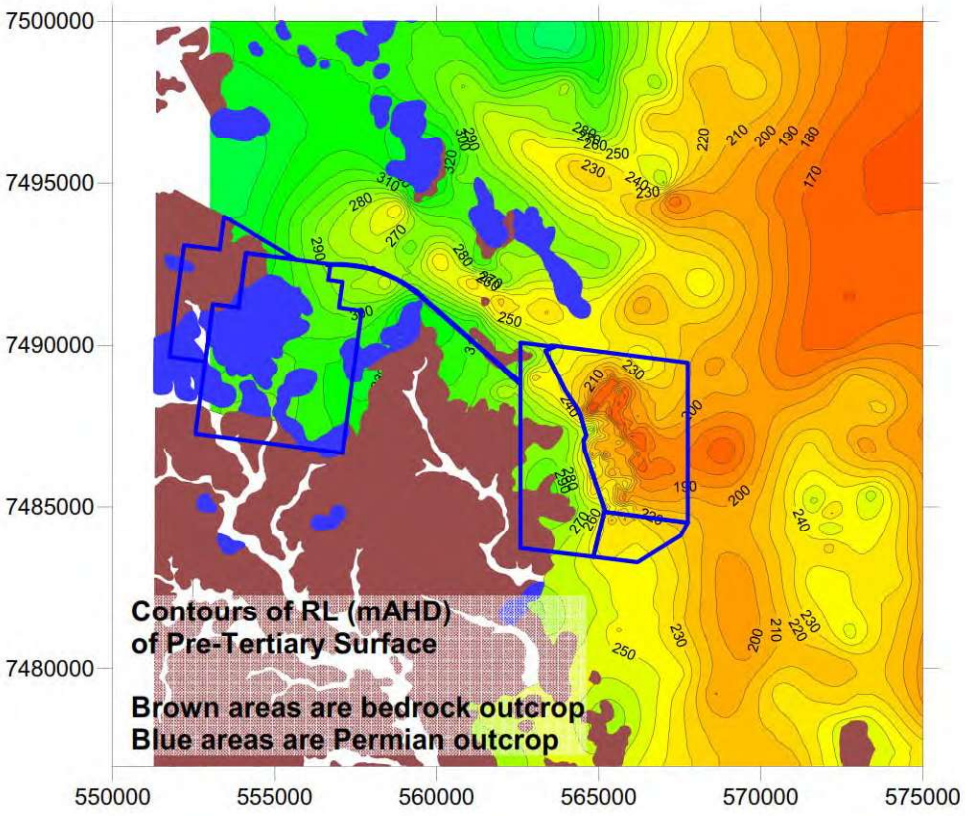


Figure 6-26-2: Pre-Tertiary Land Surface and Basement and Permian Outcrop Areas

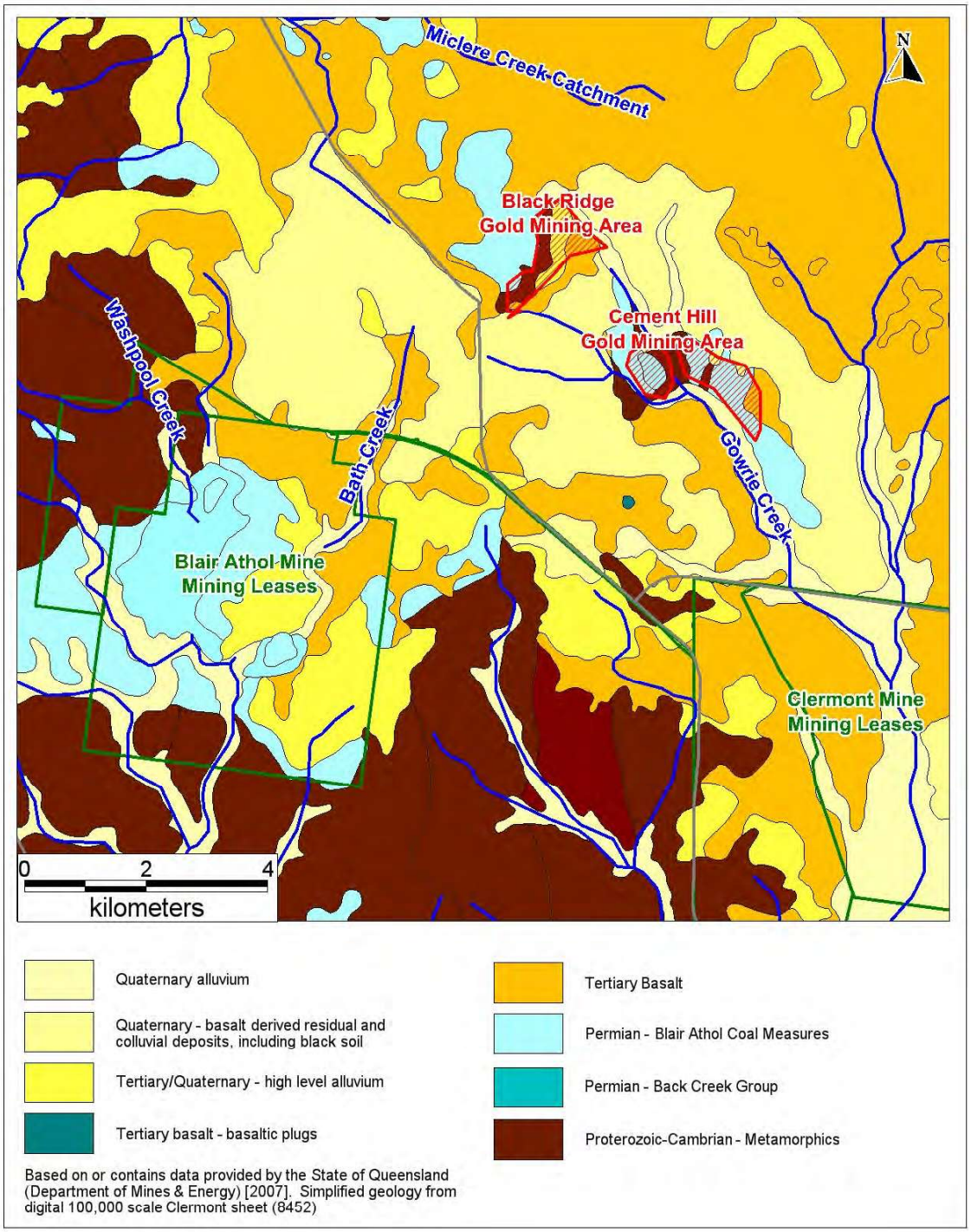


Figure 6-~~3~~6-~~3~~: Surface Geology

6.2 Site Geology

The stratigraphic sequence in the Blair Athol Basin comprises five lithological units (RTCA 2011). These are, from stratigraphically lowest to highest:

- Proterozoic/ Cambrian Anakie Metamorphic Group, comprising schist, phyllite, metabasalt;
- Early to Middle Devonian arenites, occupying a small basement trough in the southern part of the basin;
- Permian-age Blair Athol Coal Measures, comprising:
    - The lower Coal Measures, which include basal conglomerate, sandstone, siltstone, and mudstone with an estimated maximum thickness of 130-150 m; and,
    - The upper Coal Measures, which include sandstone, siltstone, mudstone, conglomerate, as well as the four main coal seams of the basin (Seams 1, 2, 3, and 4)
- Tertiary basalt, which only occurs in the north and east of the lease area (Figure 6-3), with an average thickness within the lease area of 18-22 m; and,
- Tertiary and Quaternary (recent) alluvial deposits developed within the ephemeral streams that drain the site, including Bath Creek and Washpool Creek.

The stratigraphy outlined above is shown as a stratigraphic section in Figure 6-4.

Schematic sections through the basin, showing the general basin geometry and the relationship of the coal seams, are shown as Figure 6-5.

DRAFT

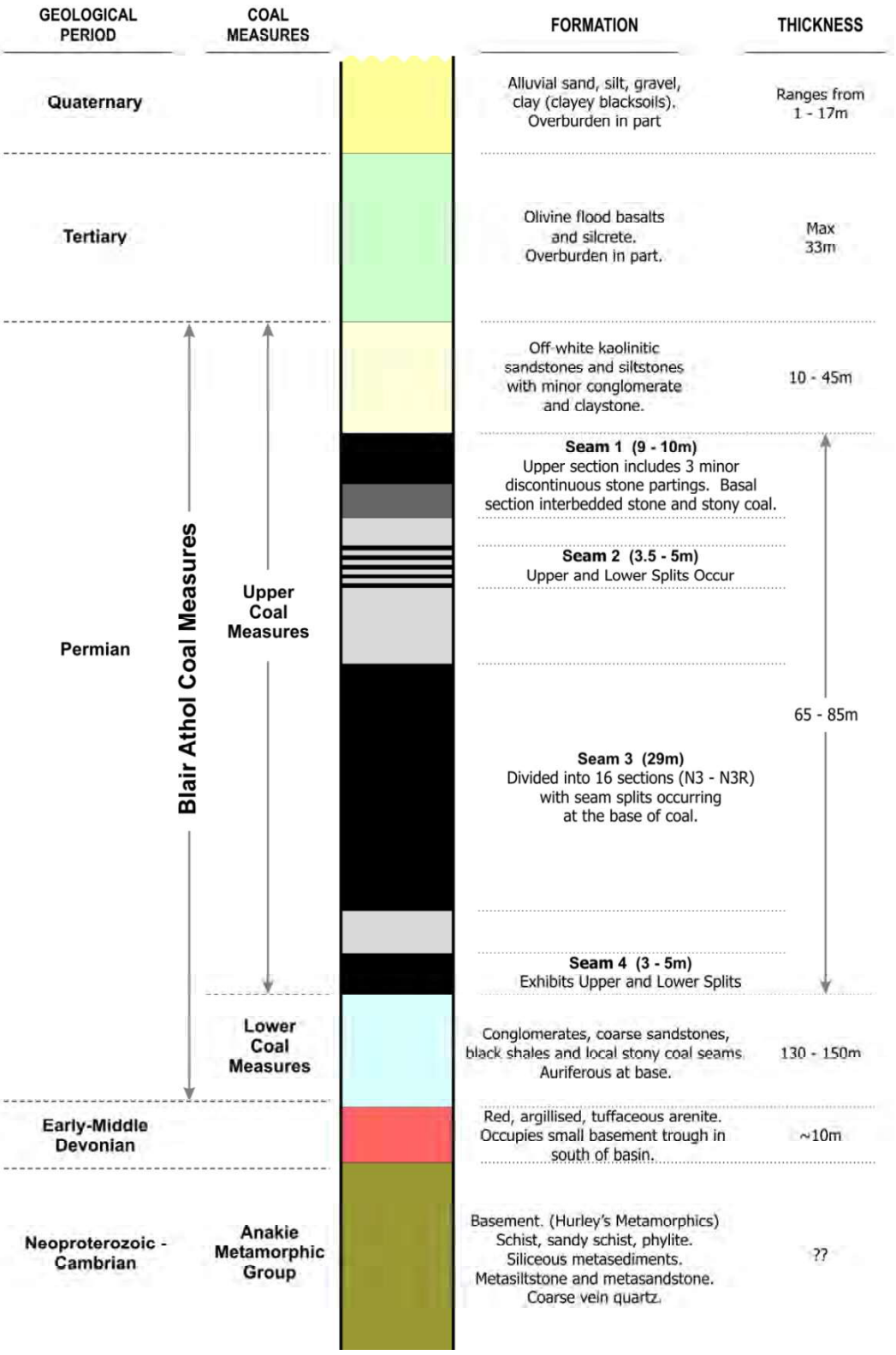


Figure 6-~~4~~6-~~4~~: Mine Area Stratigraphy (Source: RTCA 2011)

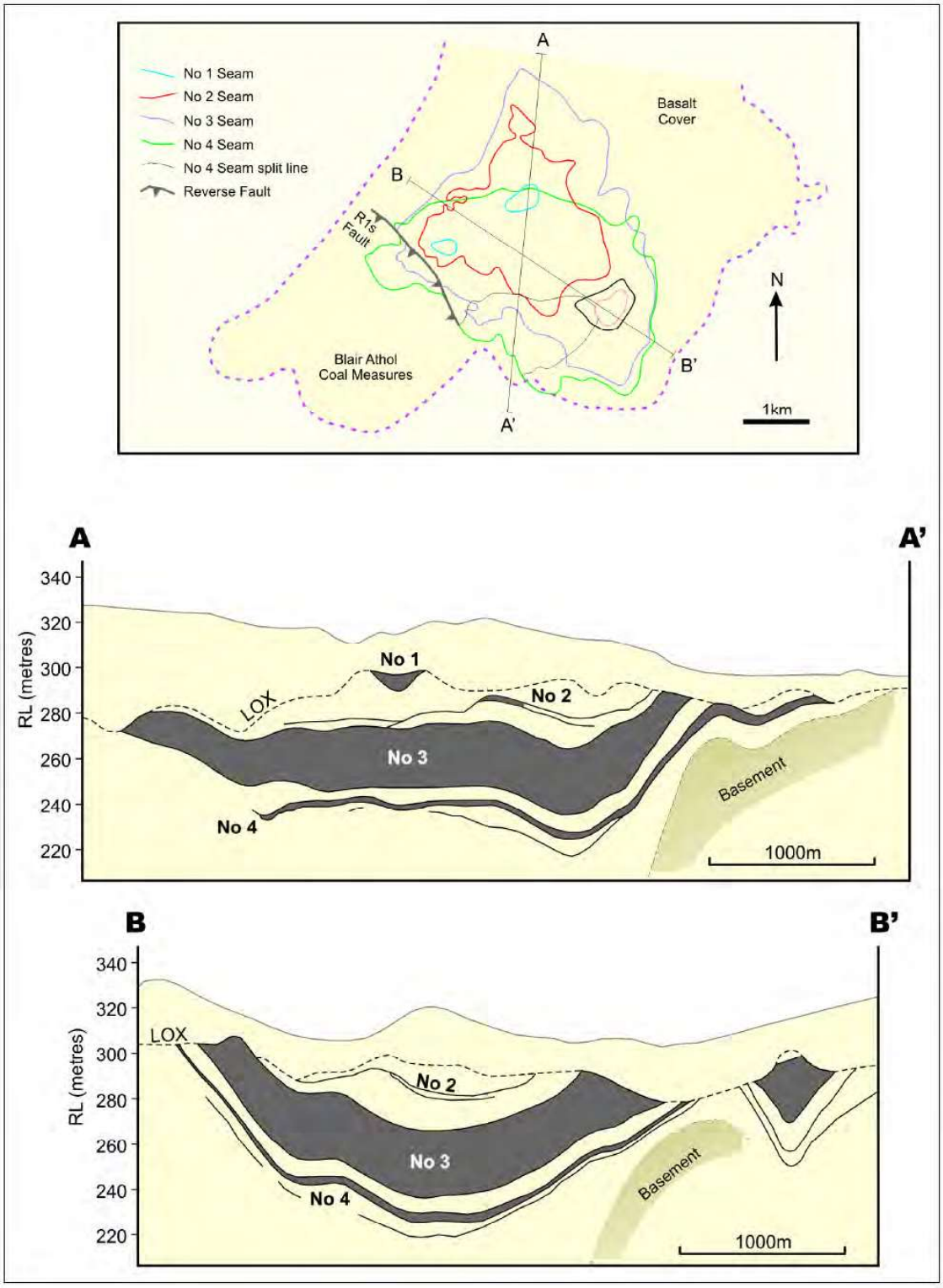


Figure 6-56-5: Schematic Cross Sections Showing Coal Seams (Source: RTCA 2011)

7.0 HYDROGEOLOGY

7.1 Introduction

Complex subsurface geology is generally simplified for groundwater studies by defining distinct hydrostratigraphic units. Hydrostratigraphic units comprise geological units grouped together on the basis of similar hydraulic properties, generally hydraulic conductivity (Fetter, 1994). Hydrostratigraphic units may incorporate a number of separate geological units if the hydraulic properties of those units are similar (e.g. a number of different rock types may be treated as one hydrostratigraphic unit if the rocks are similarly fractured, and store and transmit groundwater in the same way). In the Clermont area the distinct geological units are also distinct hydrostratigraphic units (JBT 2009), as discussed further below.

7.2 Description of Hydrostratigraphic Units

7.2.1 Basement Rocks

Proterozoic-Cambrian metamorphics occur at surface or close to surface at a number of locations in the Clermont area, including the western and southern portions of the Blair Athol Mining Lease, and to the east between the BA and Clermont Mining Lease areas (refer Figure 6-3).

A number of regional groundwater monitoring bores are screened within basement metamorphics at shallow depth (for a detailed discussion of regional water level data, refer JBT 2012). In these bores, the weathered metamorphics show a response to rainfall recharge that is similar to other watertable bores. However the bore yields within the metamorphics are low and the unit is not regarded as an aquifer. The Proterozoic-Cambrian metamorphics are regarded as the hydraulic basement to other groundwater units in the region (JBT 2009).

7.2.2 Permian Sediments

Groundwater has been encountered in all coal seams during exploration drilling, but groundwater occurrence is more pervasive in Seams 3 and 4 (Terranus 2009).

The coal seams are water-bearing units but are not aquifers as the yields are too low and too short-lived (generally hours, based on air-lift data (Terranus 2009)).

The coal seams have not been observed to provide significant rates of seepage to the open pits during mining, and generally the seepage rates encountered were insufficient to provide a reliable water supply to the mining operation (Terranus 2009).

7.2.3 Tertiary Basalt Aquifer

The Tertiary Basalt aquifer is the most significant regional aquifer in the Clermont area as it is the main aquifer from which landholders in the region draw stock and domestic water supplies. The basalt is known to comprise a number of distinct flows, though these have not been mapped in a regional sense.

Regionally, groundwater in the basalt has been observed to occur within discrete, isolated fractures, so that pumping from one fracture system can have little or no impact on water levels within adjacent fracture systems (JBT 2009).

Basalt is encountered in the northern and eastern areas of the site, where basalt flows have infilled depressions in the pre-Tertiary land surface (as described in Section 6.1).

Seepage water from the basalt aquifer to the pits in the vicinity of Ramp 3 and Ramp 4 is understood to have provided reasonable supplies of non-potable water to the operation over the course of many years (Terranus 2009). However, the average rate of seepage is unknown.

7.2.4 Tertiary/ Quaternary Alluvium

Unconsolidated alluvial deposits occur along Bath Creek and Washpool Creek, which drain through the lease area from the north and north-east (Figure 6-3). The creeks are ephemeral and groundwater occurrence within the alluvium is sporadic and related to rainfall recharge events when the streams briefly flow.

Following 2010/2011 wet season rainfall the alluvium in the Ramp 1 mining area became sufficiently saturated that engineering measures were required to control the rate of groundwater inflow to the mining operation. Therefore, potential exists for the alluvium to provide groundwater seepage to the final void particularly following above-average wet season rainfall, with the rate of seepage is dependent on the degree of saturation of the alluvium, as well as the degree to which alluvial channels are hydraulically connected to the final void.

7.2.5 Tailings and Spoil

The following section is taken from Terranus (2009), in discussion of URS (2008) (which was not reviewed for this report)

> *The TSF is currently an artificial source of locally perched groundwater. The tailings are deposited as a slurry (about 40 - 60% solids). Seepage modelling undertaken by URS (2008a) indicatively suggests (due to limited data) that most seepage from the TSF will be through the TSF embankments in the early and middle stages of construction and that seepage rates through the embankments will be minimal in the latter stages and moving into closure.*
>
> *The long-term prediction from the URS (2008a) report is that most seepage (latter stages and post-closure) will be through the floor of the TSF into the underlying spoil, and thence into the sandstone/conglomerate aquifer. The flux (i.e. the rate of water movement) through the floor of the TSF is expected to decrease post-closure as the tailings dewater and the TSF cap reduces rainfall recharge (URS, 2008a).*
>
> *As mentioned above, the fate of the basal conglomerate/sandstone aquifer on and immediately outside the site is difficult to predict.*
>
> *The elevation of the TSF is below the base of the basalt aquifer, and so does not influence the quality or elevation of groundwater within the basalt aquifer. This is expected to remain the case in the long term well after closure.*

The spoil comprises overburden and interburden that has been removed to access the coal seams, and progressively back-filled into pits as the coal is removed. The hydraulic properties of the spoil will therefore be dependent on the properties of the parent material, dumping method, degree to which the spoil has been consolidated by traffic, and degree to which the spoil as settled and consolidated over time.

The final landform should be shaped to control runoff and prevent ponding (i.e. to prevent conditions which could lead to enhanced recharge of the spoil).

7.3 Groundwater Recharge and Flow Direction

7.3.1 Basement Rocks

Water level response in regional basement monitoring bores indicates that the basement rocks, especially where they occur at surface, are recharged via direct rainfall infiltration. However, the storage of the rocks is low relative to other groundwater units in the area, so much rainfall in basement outcrop areas will report as runoff (i.e. rejected recharge) to surface drainage systems.

7.3.2 Permian Sediments

The Blair Athol Basin is a relatively isolated groundwater system, at least in the sense of groundwater within the coal seams. Recharge mechanisms are unknown, however based on recharge mechanisms observed at other Bowen Basin coal mines it is speculated that recharge to the coal seams occurs in marginal areas of the basin where the coal seams subcrop, or via downward drainage from overlying groundwater units.

There is no natural outlet for water in the coal seams (refer schematic cross sections, Figure 6-5), so groundwater movement within the coal seams could be expected to be minimal.

7.3.3 Tertiary Basalt Aquifer

The basalt aquifer is the uppermost aquifer in the groundwater system, and receives recharge directly from rainfall. Regionally, the water level in the basalt aquifer has risen in many bores due to a succession of above average wet seasons since 2007/2008. Therefore water levels in the basalt aquifer are currently elevated relative to historic levels.

Groundwater flow direction within the basalt aquifer is topographically controlled, with movement of water from topographically higher regions to topographically lower regions. Based on surface drainage evident from Figure 6-3, it is judged that the aquifer to the north of the site (within the Bath Creek catchment) will flow toward the mine, and that further north groundwater within the basalt aquifer will flow towards either the Gowrie Creek or Miclere Creek catchments..

7.3.4 Tertiary/ Quaternary Alluvium

Groundwater recharge to the alluvium is via direct rainfall infiltration, with groundwater movement in the direction of surface drainage.

7.3.5 Tailings and Spoil

Recharge to the tailings and spoil is via direct rainfall recharge, and in the north of the lease area the spoil may receive recharge vial lateral flow from the basalt aquifer.

Groundwater flow direction will be dependent on the degree to which a mounded water table develops in the spoil, and on the shape of the final landform relative to surrounding natural material.

The degree of recharge and the water table height (and hence groundwater flow direction) is difficult to predict at this stage, though it is considered likely (based on surrounding topography) that flow direction will continue to be a reflection of topography, and that the ultimate flow direction will be to the south in the direction of Bath Creek drainage.

8.0 REVIEW OF MONITORING DATA

8.1 Groundwater Monitoring Bores

Groundwater monitoring is currently undertaken on 24 bores at 20 sites. Details of the monitoring bores are provided in Table 8-1, and the bore locations are shown on Figure 8-1. The information contained in Table 8-1 is based on information provided from site, as well as review of previous reports (Matrix+ (2007) and Terranus (2009)).

Table 8-1: Groundwater Monitoring Bore Summary Data

Bore Name	Easting (AGD84)	Northing (AGD84)	RL (mAHD)	Total Depth (m)	Casing Diameter (mm)	Screen From (mbgl)	Screen To (mbgl)	Lithology Monitored	Comment
BP3	556021	7492053	327					Tertiary Basalt	Located at same site as GW01
Curtis Bore	557350	7491750	325					Tertiary Basalt	Landholder bore on Blair Athol Station
GT01A	556584	7491258	318	54	50	36	39	Coal - Seam 3	Dry when drilled – bores no longer monitored. Site comprises two 50 mm standpipes within one borehole
GT01B	556584	7491258	318	54	50	44	46	Coal - Seam 4	
GT02	555631	7488834	318	24	50			Coal - Seam 4	
GT03	554768	7489108	318		50			Coal - Seam 4	
GT04	556584	7491258	314	72	50	41	44	Coal - Seam 4	
GW01B	556026	7492049	327	57	50	33	39	Permian Conglomerate	
GW02A	555293	7492702	329	60	50	21	27	Tertiary Basalt	
GW02B	555287	7492696	329	60.3	50	53	59	Permian Conglomerate	
GW03A	556581	7491265	318	17	50	11	14	Tertiary Basalt	
GW03B	556581	7491265	318	54.9	50	43	46	Permian Conglomerate	
GW04A	557071	7490417	314	16	50	11	14	Tertiary Basalt	
GW04B	557073	7490412	314	48	50	39	45	Permian Conglomerate	
GW05	557330	7489460	318	40.1	50	25	28	Permian Conglomerate	Dry when drilled – bore no longer monitored
GW06	553976	7491409	318	36	50	28	34	Permian Conglomerate	
GW07	554172	7490244	310		50			Spoil	
GW08	554834	7490684	307		50			Spoil	
GW10	555711	7489930	328	72	100			Spoil	
Mayes Bore	558120	7493142	324					Tertiary Basalt	Landholder bore on Blair Athol Station
MB02	554215	7490409	313		50	Screened for entire length of bore		TSF Embankment	Construction details for individual bores unknown, but bore depths are understood to be between 7.88 and 17.60 m (Terranus 2009).
MB03	554254	7490402	312		50			TSF Embankment	
MB04	554672	7490544	308		50			TSF Embankment	
MB05	554657	7490493	307		50			TSF Embankment	
SP(3279C)	555431	7488557	310	40	50	30?	?	Coal - Seam 4	Comprises 2 x 50 mm standpipes within one borehole. Upper piezo (20 m depth in sandstone) is dry

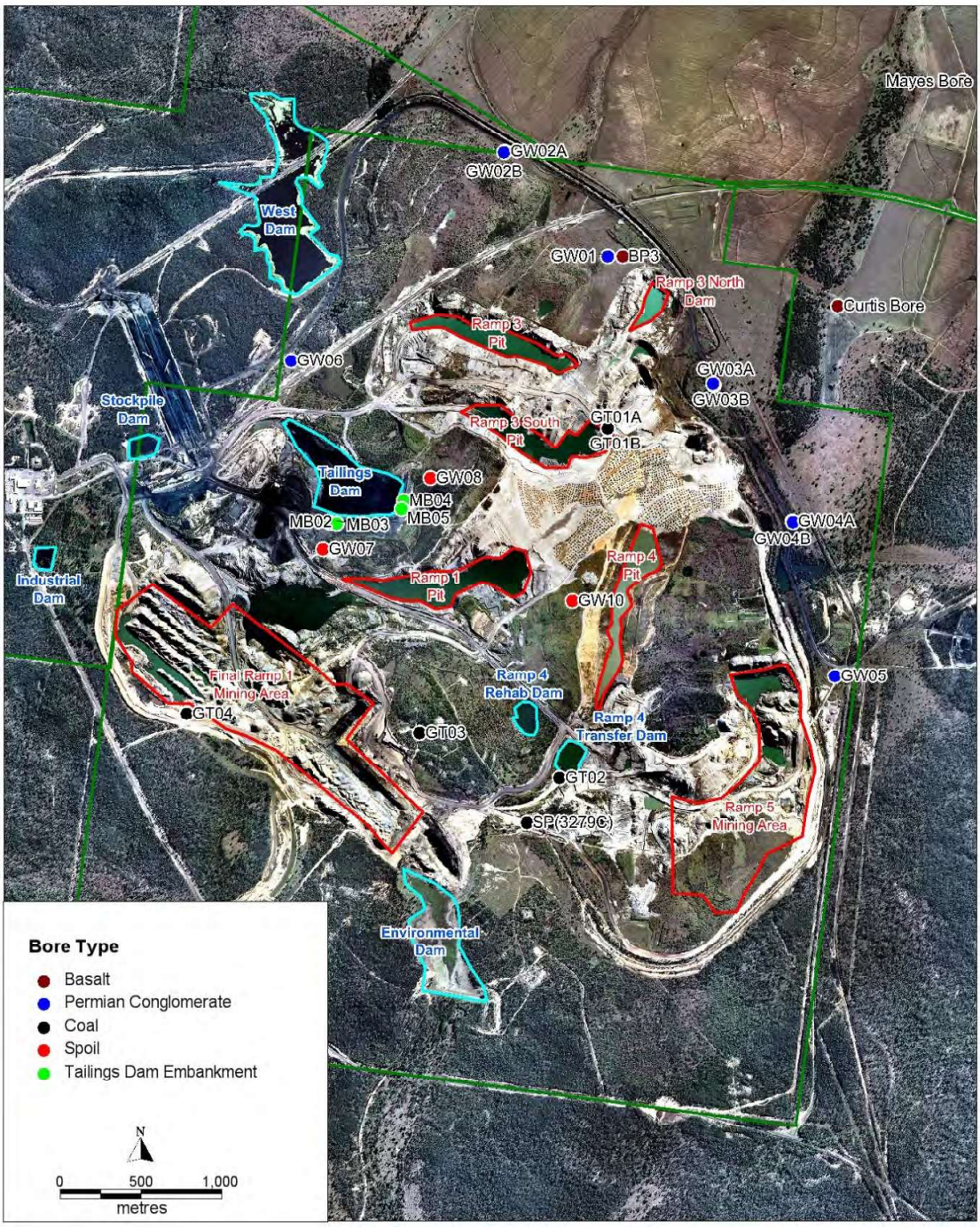


Figure 8-~~1~~18 ~~1~~: Location of Bores and Surface Water Dams

8.2 Groundwater Level Data

Groundwater level data (as water level below top of casing (TOC)) is shown in Appendix A. The data has been converted to reduced water level (relative to Australian Height Datum, AHD) with the resultant hydrographs shown as Figure 8-2. Observations from review of the hydrographs include:

Tertiary Basalt Aquifer

- Only one bore (Curtis Bore) has water level readings that date prior to January 2008 (prior to the 2007/2008 wet season). The impact of 2007/2008 wet season rainfall is evident at this site, where the water level rise in the bore matches the rise in the residual rainfall mass (RRM) curve. In response to 2007/2008 wet season rainfall the water level in the bore rose from 10.16 m below top of casing (mTOC) (November 2007) to 4.55 mTOC (March 2008). The water level has continued to rise in this bore, and in August 2012 the water level was above ground level (i.e. the bore is flowing).
- Other basalt bores display a relatively steady water level trend, with a slight overall rise in water level evident between March 2008 and August 2012 (refer also Appendix A).

Coal Seam

- Monitoring bores at site are screened in either Seam 3 or Seam 4 (lower coal seams) as the seams above (Seam 1 and Seam 2) tend to be dry when drilled;
- Bore GT01 is located adjacent to the Ramp 3 South pit (Figure 8-1). Both GT01A (Seam 3) and GT01B (Seam 4) are dry, indicating that water within the coal seams has drained to the pit at this location;
- The impact of mining on water levels in the coal seam can be seen from the hydrograph for bore GT03 (Seam 4). The bore is located adjacent to the Ramp 1 mining area, and the water level has reduced significantly at this site between May 2011 and May 2012 (7.38 m water level reduction) compared to a water level reduction of 0.11 m between March 2009 and May 2011. It is assumed that the water level reduction is related to mining in the adjacent Ramp 1 area.

Permian Conglomerate

- Water levels in bores monitoring the Permian conglomerate have tended to increase in response to rainfall recharge, i.e. water levels tend to conform to the overall trend of the RRM curve, which has displayed a rising trend since December 2007. Between May 2008 and May 2012 the water level has increased by 6.01 m in GW03B, 9.98 m in GW04B, and 1.36 m in GW06 (i.e. the greatest rate of water level increase has been in bores that are overlain by Tertiary basalt);
- At sites where the conglomerate is overlain by basalt (GW02B, GW03B, GW04B) the water level in the basalt aquifer is higher than the water level in the conglomerate, indicating a potential for the basalt aquifer to recharge the underlying Permian sediments. Recharge from the basalt aquifer to the underlying Permian sediments is noted from water quality data, as discussed in Section 8.3;
- At the site of GW04B the water level trend matches the trend displayed in adjacent basalt aquifer bore GW04A, though the rate of water level increase in GW04B is greater than observed in the basalt bore. The hydrographs have now almost converged (i.e. the hydrographs are almost reading the same water level) indicating a high degree of hydraulic connection, and a strong recharge potential, between the Tertiary basalt and the underlying Permian sediments.

Spoil

- Bores screened in spoil (GW08, GW10) show a rise in water level between July 2008 and August 2012 of between 8.06 m (GW10) and 12.32 m (GW08). This matches the overall rise in the RRM curve, indicating that groundwater levels within the spoil are directly impacted by rainfall recharge events.

Tailings Storage Facility (TSF)

- Bores screened within the TSF embankment (MB02, MB03, MB04, MB05) display relatively consistent water levels, suggesting that water levels in the bores are dominated by the water level within the TSF rather than by rainfall recharge (as is the case with bores in the surrounding spoil);
- Site sampling records indicate that all of the TSF bores are difficult to sample as the water level in all bores is just above the base of screens, and the water that is able to be bailed from the bores is generally turbid and often black in colour (reported as coal fines within the samples).

DRAFT

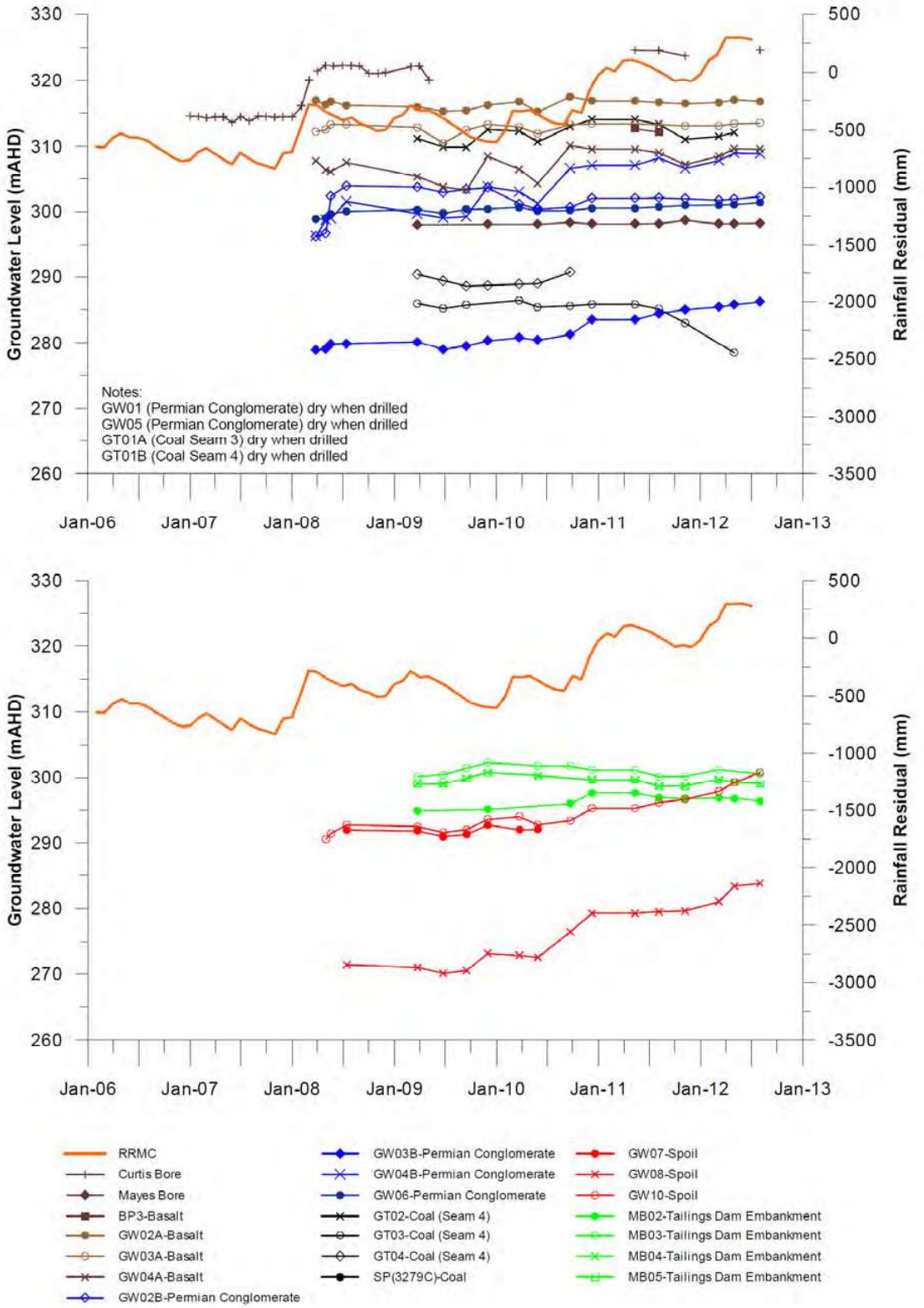


Figure 8-2~~8~~ ~~2~~: Groundwater Hydrographs

8.3 Water Chemistry

The following section presents an analysis of chemistry data from groundwater bores as well as site water storages.

Section 8.3.1 presents an analysis of major ion chemistry, which is used to differentiate water types at the site, and to describe the evolution of water at site from one water type to another (which is evident at a number of surface water storages).

Section 8.3.2 presents a comparison of historic and current site water quality data for major and minor ions, as well as for a number of metals/metalloids, against a range of Australian guidelines.

8.3.1 Major Ion Chemistry

8.3.1.1 Data Analysis

Major ion chemistry includes concentration data for cations (sodium (Na), potassium (K), magnesium (Mg), calcium (Ca)) and anions (chloride (Cl), carbonate (CO_3), bicarbonate (HCO_3), and sulphate (SO_4)). These data have been analysed to determine the water type at each groundwater bore location, as well as for surface water storages.

To undertake a water type analysis the relative concentration of each parameter (converted to milliequivalents per litre) is determined, so that the relative percentage of each anion adds up to 100%, and the relative percentage of each anion adds up to 100%.

Water type is then determined based on the dominant cation and anion in water samples from each site. For example, water classified as a sodium-chloride (Na-Cl) type water contains more than 50 percent of the total cation milliequivalents as sodium and more than 50 percent of the total anion milliequivalents as chloride. If no cation or anion is dominant (i.e. more than 50%) then the water is a mixed type and the most common cations and ions, in decreasing order of abundance, are used to describe the water type.

The water type for each site is presented in Table 8-2.

The major ion analyses for each water source has also been plotted on a Piper diagram (Figure 8-3). Piper diagrams are a useful visual indicator of the range of water types present in a particular area. Piper diagrams plot the percentage concentration of three cation types (i.e. the concentrations of Ca, Mg, and the sum of Na+K are expressed as a percentage, so that the sum of the cations is 100%) and three anion types (Cl, SO_4, and the sum of CO_3+HCO_3) on separate ternary diagrams. The data points for the top diamond plot are derived as the intersection point of lines drawn from the cation and anion plots.

Water that is dominated by Na and Cl ions will plot in the bottom right corner of the cation and anion plots, while water that is dominated by Ca and CO_3+HCO_3 will plot in the bottom left corner of the cation/anion plots. As water from one source mixes with water from another source (e.g. with further distance along a groundwater flow line) this can be seen as the plot symbols for different dates move from one part of the graph to another.

Raw data used as the basis for the analysis presented in this section (i.e. major ion concentration converted from mg/L to meq/L, in preparation for plotting on a Piper diagram, and for performing water-type analysis) is presented in Appendix B.

Table 8-2: Water Type Analysis

Sample Point	Type	Water Source	Water Type
BP3	Groundwater bore	Tertiary Basalt	Mg-Ca-HCO_3
Curtis Bore	Groundwater bore	Tertiary Basalt	Mg-HCO_3
GW02A	Groundwater bore	Tertiary Basalt	Mg-Ca-HCO_3
GW03A	Groundwater bore	Tertiary Basalt	Mg-Ca-HCO_3
GW04A	Groundwater bore	Tertiary Basalt	Mg-Ca-HCO_3
Mayes Bore	Groundwater bore	Tertiary Basalt	Na-Ca-HCO_3
GW01	Groundwater bore	Permian Conglomerate	Mg-Ca-Na-HCO_3
GW02B	Groundwater bore	Permian Conglomerate	Mg-Ca-Na-HCO_3
GW03B	Groundwater bore	Permian Conglomerate	Mg-Ca-Na-HCO_3
GW04B	Groundwater bore	Permian Conglomerate	Mg-Ca-HCO_3
GW05	Groundwater bore	Permian Conglomerate	Dry
GW06	Groundwater bore	Permian Conglomerate	Na-Cl
GT02	Groundwater bore	Coal - Seam 4	Na-Cl
GT03	Groundwater bore	Coal - Seam 4	Na-Cl
GT04	Groundwater bore	Coal - Seam 4	Na-Cl
SP(3279C)	Groundwater bore	Coal - Seam 4	Na-SO4
GW07	Groundwater bore	Spoil	Na-Cl
GW08	Groundwater bore	Spoil	Na-Mg-SO_4-Cl
GW10	Groundwater bore	Spoil	Na-Mg-HCO_3
MB02	Groundwater bore	TSF Embankment	Ca-Na-Mg-SO_4
MB03	Groundwater bore	TSF Embankment	Mg-Na-SO_4
MB04	Groundwater bore	TSF Embankment	Mg-Ca-Na-SO_4
MB05	Groundwater bore	TSF Embankment	Mg-Ca-SO_4
TSF	Surface Water		Mg-Ca-SO_4
East Dam	Surface Water		Na-Mg-HCO_3
West Dam	Surface Water		Na-Mg-Cl-HCO_3 (1986-1994) Na-Ca-Mg-HCO_3 (2011-2012)
Industrial Dam	Surface Water		Na-Cl (1995-1998) Na-Mg-Cl-SO_4 (2011-2012)
No. 2 Pit	Surface Water		Na-Cl (1984-1989) Na-Mg-Cl-HCO_3-SO_4 (1990-1992)
Ramp 1 Pond	Surface Water		Na-Mg-Cl-SO_4
Ramp 3 North	Surface Water		Na-Mg-SO_4-Cl
Ramp 4 Pond	Surface Water		Na-Mg-SO_4
Transfer Dam 1	Surface Water		Na-Mg-SO_4
Environmental Dam	Surface Water		Na-Cl (1985-1993) Na-Mg-Cl-SO_4 (2012)

DRAFT

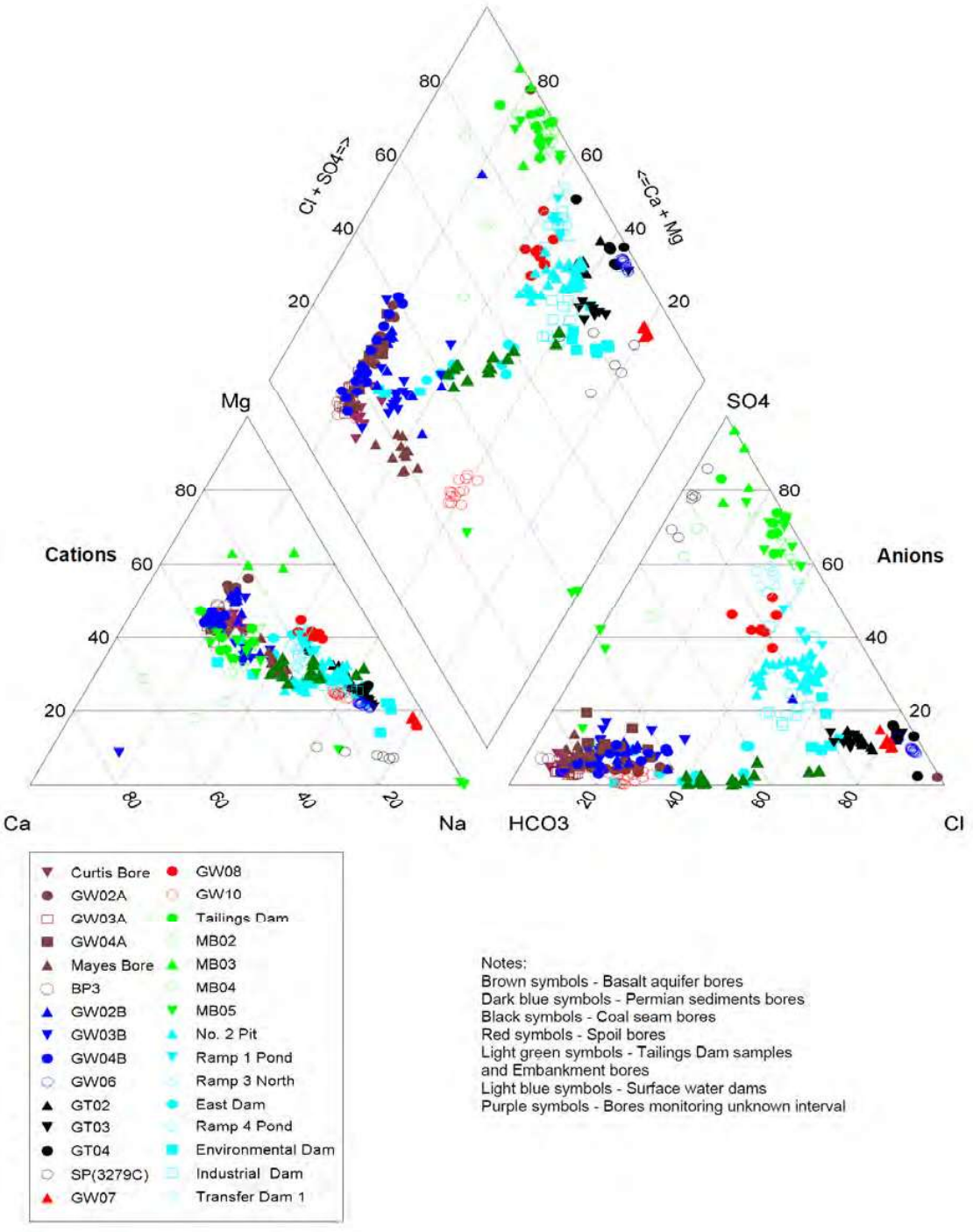


Figure 8-38-3: Piper Diagram – Blair Athol Surface Water and Groundwater Samples

8.3.1.2 Discussion

The following observations are made with respect to water type analysis and the Piper diagram:

Basalt Aquifer

- Basalt water samples are of magnesium-calcium-bicarbonate (Mg-Ca,HCO_3) type (Table 8-2). The cation mineralogy is interpreted to be related to the weathering products of basalt minerals, (e.g. Na, Ca, Mg, K silicates). The bicarbonate is interpreted to be present due to the interaction of recharge water with CO_2 from the atmosphere and the root zone of plants (H_2O and CO_2 combining to form carbonic acid (H_2CO_3), which dissociates to bicarbonate (HCO_3-) and carbonate (CO_3)
- On the Piper diagram (Figure 8-3) the basalt water plots to the lower left of the anion plot, indicating that the samples are low in chloride and sulphate, and high in HCO_3.
- The samples plot to the middle left of the cation plot, in a region that indicates a slight domination of magnesium (40-50 %) over sodium and calcium, which each comprise 20 – 30% of the equivalent weight.
- On the combined graph the plots cluster in the middle left corner of the plot, in a region that indicates high calcium + magnesium (60-80% of the equivalent weight) and low chloride + sulphate (between 10 and 40% of the equivalent weight).

Permian Conglomerate

- Water samples from bores screened in the Permian conglomerates are of two distinct water types, including:
    - Mg-Ca-Na,HCO_3 water in areas where the Permian conglomerates are overlain by basalt. At these sites (GW02B, GW03B, GW04B) the water level in the corresponding basalt bore (GW02A, GW03A, GW04A) is higher, indicting a potential for downward leakage of water from the basalt aquifer to the underlying Permian sediments; and,
    - Sodium-Chloride (Na-Cl) water, in areas where basalt is absent (e.g. GW06).
- On the Piper diagram (Figure 8-3) the groundwater samples from the Permian conglomerate bores plot in two distinct clusters:
    - For water samples from bores where the Permian conglomerate underlies the basalt (GW02B, GW03B, GW04B) the data points for the anions, cations, and combined plots are all in the same region as the basalt aquifer, indicating that the water in the Permian sediments at these locations is derived from downward leakage from the overlying basalt aquifer;
    - For water samples from the bore where the Permian conglomerates are not overlain by basalt (GW06) the data plots in a distinctly different area of each plot, i.e. towards the lower right of the cation plot (sodium dominated), to the lower right of the anion plot (chloride dominated) and in a region of the combined plot that indicates over 90% chloride + sodium, and less than 40% calcium + magnesium.

Spoil

- Water samples from bores that screen spoil show distinctly different chemical types, including Na-Cl (GW07), Na-Mg-SO_4-Cl (GW08) and Na-Mg-HCO_3 (GW10)
- On the Piper diagram the samples plot relatively close together , though GW07 plots to the lower right of the plot, indicating the strong dominance of the sodium ion. However, the

samples plot in markedly different regions of the anion plots, with GW07 strongly dominated by chloride, GW08 dominated by sulphate, and GW10 dominated by bicarbonate.

- On the combined graph indicates high chloride and relatively low calcium + magnesium at GW07; low chloride + sulphate and 50-60% calcium + magnesium at GW08, and low chloride + sulphur (~30%) and moderate calcium + magnesium (~40%) at GW10.

Tailings Storage Facility

- Water quality in the area of the tailings storage facility (TSF), including TSF water samples as well as groundwater samples from embankment monitoring bores MB1, MB03, MB04, and MB05, are strongly sulphate dominated. The water samples have a relatively even mix of cations (calcium magnesium and sodium all ~30%) indicated by the clustering of sample points towards the middle of the cation plot.
- On the combined graph the cluster towards the top of the graph indicates a dominance of chloride + sulphate (more than 90% of cations, with sulphate accounting for ~70% and chloride 20%) and calcium + magnesium (60-80% of anions).

Surface Water Storages

- Surface water sources plot over a relatively wide area of each graph, indicating variability and mixing from different water sources. The following observations are made with respect to surface water major ion chemistry:
    - The early major ion chemistry appears to be dominated by the geological environment in which the dam is developed, as the initial major ion chemistry matches the groundwater chemistry. However, over time the major ion chemistry of the surface water bodies has evolved in all cases to a mixed water type. Examples include:
        - The industrial dam, where:
            - Early data (between May 1995 and February 1998) indicates a sodium-chloride (Na-Cl) water type. The industrial dam is located in an area where basalt does not exist, on an area of outcropping basement metamorphics and Permian sediments. Groundwater samples from the closest monitoring bore (GW06 – Permian conglomerate) are Na-Cl type water.

              In terms of cations, sodium was dominant over magnesium, with calcium the least dominant cation. In terms of anions, chloride was dominant over bicarbonate, with sulphate the least dominant anion.
            - Later data (November 2011 to April 2012) indicates an evolution in water type from Na-Cl to Na-Mg,Cl-SO_4. In terms of cations, the percentage of magnesium has increased relative to sodium, with the percentage of calcium relatively unchanged. In terms of anions, the relative concentrations of both chloride and bicarbonate have decreased, and sulphate has increased.
        - The environmental dam, where:
            - Early data (between March 1985 and December 1993) indicates a sodium-chloride (Na-Cl) type water, with sodium dominant over magnesium, with calcium the least dominant anion. In terms of anions, chloride was dominant over bicarbonate, with sulphate a relatively minor ion (approximately 10% of the anion total – refer also Appendix B)

- Later data (January to April 2012) indicates an evolution in water type from Na-Cl to Ca-Mg-Cl-HCO_3. In terms of cations, the relative concentration of sodium has more than halved (from ~65% to ~30%), and the relative concentration of calcium has more than doubled (from ~12% to ~32%). In terms of anions, the relative concentration of chloride has reduced by approximately one-third (from ~60% to ~20%) and the concentration of bicarbonate has trebled (from ~25% to ~75%). The concentration of sulphate is relatively unchanged.

▪ West Dam, where:

- Early data (January 1986 to November 1994) indicates a Na-Mg-Cl-HCO_3 type water. Unlike the dams mentioned above, the west dam is located in an area where the catchment includes basaltic rocks, so the early chemistry of the dam is similar to the groundwater chemistry of the basalt aquifer (as seen in bores such as GW02A, GW03A, and GW04A – refer
- Later data (November 2011 to January 2012) indicates an evolution towards Na-Ca-Mg-HCO_3 water, with a relatively lower percentage of sodium, higher percentage of calcium, and a slight increase in the bicarbonate ion relative to chloride.

  The chemistry of the west dam has altered only slightly compared to other dams at site. The current major ion chemistry is now similar to other storages on site, but the west dam started with similar chemistry, whereas other dams evolved to this chemistry type

8.3.1.3 Summary

The major ion chemistry at site is summarised as:

- Cation chemistry:
  - Water samples from the coal seam, the Permian conglomerate (in areas where basalt does not exist), and some spoil bores (e.g. GW07) is sodium dominated;
  - Cation chemistry for the basalt aquifer, and for the Permian conglomerate underlying basalt, is calcium-magnesium dominated; and,
  - A number of surface water (industrial dam, environmental dam) were initially sodium dominated, but evolved to calcium-magnesium dominated over time. West Dam, which is in a catchment containing basalt outcrop as well as bedrock outcrop, has consistently displayed a mixed water chemistry dominated by sodium, calcium, and magnesium cations.
- Anion chemistry is more diverse, with water samples from different sources tending to be dominated by either chloride, bicarbonate, or sulphate. This manifests as a clusters of data towards the three corners of the anion plot (for groundwater samples), with surface water samples reflecting a mixing of water types; and,
- When plotted together on the combined plot, samples for the basalt aquifer, as well as the Permian sediments underlying basalt, display a dominance of calcium and magnesium over chloride and sulphate. All other sites (surface water (except the TSF) and groundwater) are more dominated by a combination of chloride + sulphate, and less dominated by calcium + magnesium. Water samples from the TSF show a similar relative concentration of calcium + magnesium as basalt aquifer samples, but a much higher concentration of chloride + sulphate, reflecting a dominance of the sulphate ion in ash dam samples).

8.3.2 Comparison of Site Water Quality with Australian Guidelines

Available surface water and groundwater data has been compared to a number of environmental standards, including:

- Stock Watering Guidelines (ANZECC 2000)
- Freshwater Ecosystem Protection (value for slightly disturbed systems) (ANZECC 2000); and,
- Australian drinking water guidelines (ADWG 6, 2011)

Available groundwater data is included from the bores listed in Table 8-1.

Available surface water data is included from the following sample points:

- Transfer Dam 1
- Ramp 3 South
- Ramp 3 North
- Environmental Dam
- East Dam
- West Dam
- Industrial Dam
- Bath Creek – EPA Licence Point
- No 2 Pit
- No 1 Pit
- Ramp 4 Pond
- Ramp 1 Pond
- Tailings Storage Facility

Table 8-3: Comparison of Site Water Quality to Australian Guidelines

Parameter	No. of Samples	No. of Samples exceeding Guideline Limits[1]			
		Stock Watering[2]	Freshwater Ecosystem[3]	Drinking Water[4]	
				Health	Aesthetic
pH – GW[5]	243	n/a	n/a	n/a	25
pH – SW[6]	340	n/a	n/a	n/a	2
TDS – GW	279	50	n/a	n/a	144
TDS – SW	340	2	n/a	n/a	258
Sodium (Na) – GW	281	n/a	n/a	n/a	56
Sodium (Na) – GW	281	n/a	n/a	n/a	2
Chloride (Cl) – GW	280	n/a	n/a	n/a	54
Chloride (Cl) – SW	454	n/a	n/a	n/a	26
Sulphate (SO4) – GW	279	n/a	n/a	68	53
Sulphate (SO4) – SW	483	n/a	n/a	59	44
Fluoride (F) – GW	71	0	n/a	0	n/a
Fluoride (F) – SW	154	0	n/a	0	n/a
Aluminium (Al) – GW	71	2	13	n/a	0
Aluminium (Al) – SW	154	0	12	n/a	0
Arsenic (As) – GW	71	0	5	8	n/a
Arsenic (As) – SW	62	0	0	0	n/a
Cadmium (Cd) – GW	71	0	6	3	n/a
Cadmium (Cd) – SW	62	0	1	1	n/a
Copper (Cu) – GW	71	0	31	0	0
Copper (Cu) – SW	62	0	8	0	0
Chromium (Cr) – GW	71	0	1	0	n/a
Chromium (Cr) – SW	39	0	0	0	n/a
Iron (Fe) – GW	71	n/a	n/a	n/a	21
Iron (Fe) – SW	139	n/a	n/a	n/a	12

Parameter	No. of Samples	No. of Samples exceeding Guideline Limits[1]			
		Stock Watering[2]	Freshwater Ecosystem[3]	Drinking Water[4]	
				Health	Aesthetic
Mercury (Hg) – GW	71	0	0	0	n/a
Mercury (Hg) – SW	39	0	0	0	n/a
Manganese (Mn) – GW	71	n/a	2	16	30
Manganese (Mn) – SW	73	n/a	1	7	16
Molybdenum (Mo) – GW	71	0	(a)	0	n/a
Molybdenum (Mo) – SW	39	0	(a)	0	n/a
Lead (Pb) – GW	71	0	0	0	n/a
Lead (Pb) – SW	64	0	1	1	n/a
Antimony (Sb) – GW	71	n/a	n/a	0	n/a
Antimony (Sb) – SW	21	n/a	n/a	0	n/a
Zinc (Zn) – GW	71	0	62	(a)	2
Zinc (Zn) – SW	62	0	18	(a)	0

* Notes
1 - Exceedences for metals/metalloids are for dissolved metals. A comparison for both total and dissolved metals is included in Appendix C.
2 – ANZECC (2000) Livestock Watering Guideline Values
3 – ANZECC (2000) Freshwater ecosystem protection – guideline limits for *slightly to moderately disturbed systems*
4 - Australian Drinking Water Guidelines (ADWG 6, 2011)
5 – GW = Groundwater Samples
6 – SW = Surface Water Samples
n/a - No standard exists

Observations from review of data in Table 8-3 include:

Stock water guideline limits

- Groundwater samples do not exceed stock water quality guidelines, with the exception of TDS, where 50 out of 279 samples exceed 4,000 mg/L, and aluminium, where 2 out of 71 samples exceed guideline limits
- Surface water samples exceed stock water guideline limits for TDS, but only 2 out of 340 samples exceed 4,000 mg/L;

Freshwater ecosystem protection guideline limits (slightly to moderately disturbed systems)

- Groundwater samples exceed guideline limits for a number of parameters, including aluminium, arsenic, cadmium, copper, chromium, manganese, and zinc
- Surface water samples exceed guideline limits for aluminium, cadmium, manganese, lead, and zinc

Drinking water guideline limits

- Groundwater samples exceed guideline limits (health-based) for sulphate, arsenic, cadmium, manganese
- Groundwater samples exceed guideline limits (aesthetic-based criteria) for pH, TDS, sodium, chloride, sulphate, iron, manganese, and zinc
- Surface water samples exceed guideline limits (health-based) for sulphate, cadmium, manganese, and lead
- Surface water samples exceed guideline limits (aesthetic-based criteria) for pH, TDS, sodium, chloride, sulphate, iron, and manganese.

The results from site groundwater sampling are consistent with previous investigations have concluded that the beneficial use for groundwater in the Clermont region is stock watering. Groundwater within the Tertiary basalt aquifer is, in some instances, suitable for potable use based on TDS criteria alone, however a number of other parameters may make groundwater in the area unsuitable for potable consumption without treatment to a potable standard.

Parameters that occur above drinking water guideline levels in regional groundwater samples include (JBT 2012):

- antimony, arsenic, lead, manganese and molybdenum (health-based criteria); and,
- aluminium, iron, and manganese (aesthetic-based criteria).

9.0 FINAL VOID

9.1 Final Void (Pit Lake) Water Levels and Water Quality

A water balance study has been undertaken for prediction of the water level and salinity of the pit lake that will be developed within the final landform (BMT-WBM 2012). The report notes that the site has a large external catchment, but the majority of flows from the catchment are directed around the site by two perimeter diversions, which are likely to remain in place after mine closure.

Two water balance scenarios were modelled:

1. With the exiting diversions in place; and,
2. With the diversions removed.

The modelled water level in the final pit lake (final void) for both scenarios is shown in Figure 9-1. The maximum water level for each simulation (279.6 mAHD for the "diversions" scenarios and 286.8 mAHD for the "no diversions" scenario) has been plotted on the hydrographs showing current and historic groundwater levels (Figure 9-2).

With respect to the modelled water level of the final void relative to historic and current groundwater levels it is noted that:

- For the majority of aquifers the current groundwater level in site monitoring bores is above the predicted final void water level, for both water balance scenarios;
- The bores for which water levels are close to or below predicted final void water levels (Figure 9-2) are generally close to the existing pit voids (refer Figure 8-1 for bore locations), and therefore affected by mining operations (including GT03 (monitoring Seam 4) and GW08 (monitoring spoil adjacent to the tailings dam);
- One bore (GW03B) monitors water levels in the Permian sediments close to the eastern boundary of the site. Water levels in this bore have been rising since the 2010/2011 wet season in response to downward leakage from the overlying basalt aquifer. The current water level at this site is now close to the maximum modelled water level for the "no diversions" scenario. Therefore this bore is well placed to monitor for potential offsite discharge of water from the pit void, via the groundwater system. This site represents the only monitored location to the west, north, or east of the site at which groundwater levels are close to the predicted maximum water level in the final void (with the groundwater level at all other sites being higher than modelled pit lake water levels – refer Figure 9-2).

The results of final void modelling therefore predict that for both scenarios modelled, the pit lake is likely to act as a groundwater sink, limiting the potential for offsite movement of water from the pit lake via the groundwater system.

With respect to water quality, final void modelling predicts that the pit lake will become progressively more saline to a level that is significantly greater than the salinity of surrounding groundwater system.

Therefore, maintenance of the existing groundwater monitoring network, and extension of the network (discussed further below) is recommended to enable monitoring of the impact of the final

landform pit lake on groundwater. With respect to offsite movement of groundwater, it is judged that a useful indicator parameter of interaction between the pit lake and the groundwater system will be chloride. This is because:

- Final void modelling predicts that that the salinity of the pit lake will be significantly higher than the salinity of surrounding groundwater, providing a contrast between the pit lake and the groundwater system; and,
- Chloride is a conservative parameter, i.e. it moves freely in the groundwater system at the rate of groundwater flow, and with little retardation along the flow-path.

Based on historic and current groundwater levels, and the results of final void water level monitoring, it is judged that the most likely pathway for offsite movement of impacted groundwater is in the area of current surface water discharge from site, i.e. the southern boundary and particularly down-gradient of the existing environmental dam. Therefore it is recommended that additional groundwater monitoring bores be placed down-gradient of the environmental dam, monitoring water levels and water quality in the alluvium, as well as the shallow bedrock at this location.

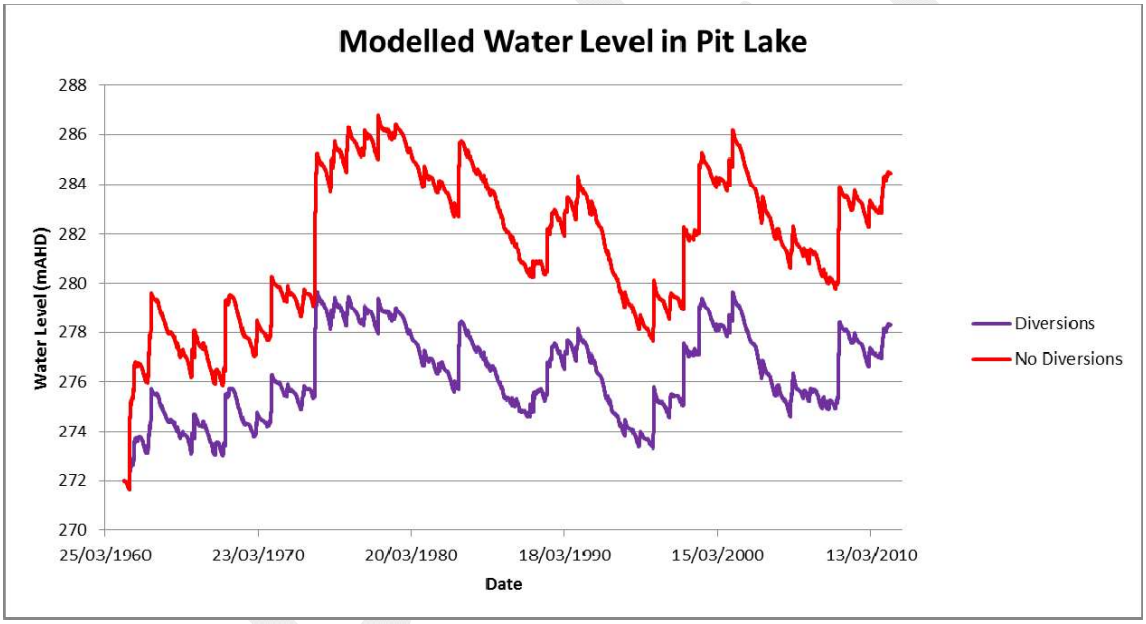


Figure 9-1: Modelled Water Level in Final Pit Lake (Source: BMT-WBM 2012)

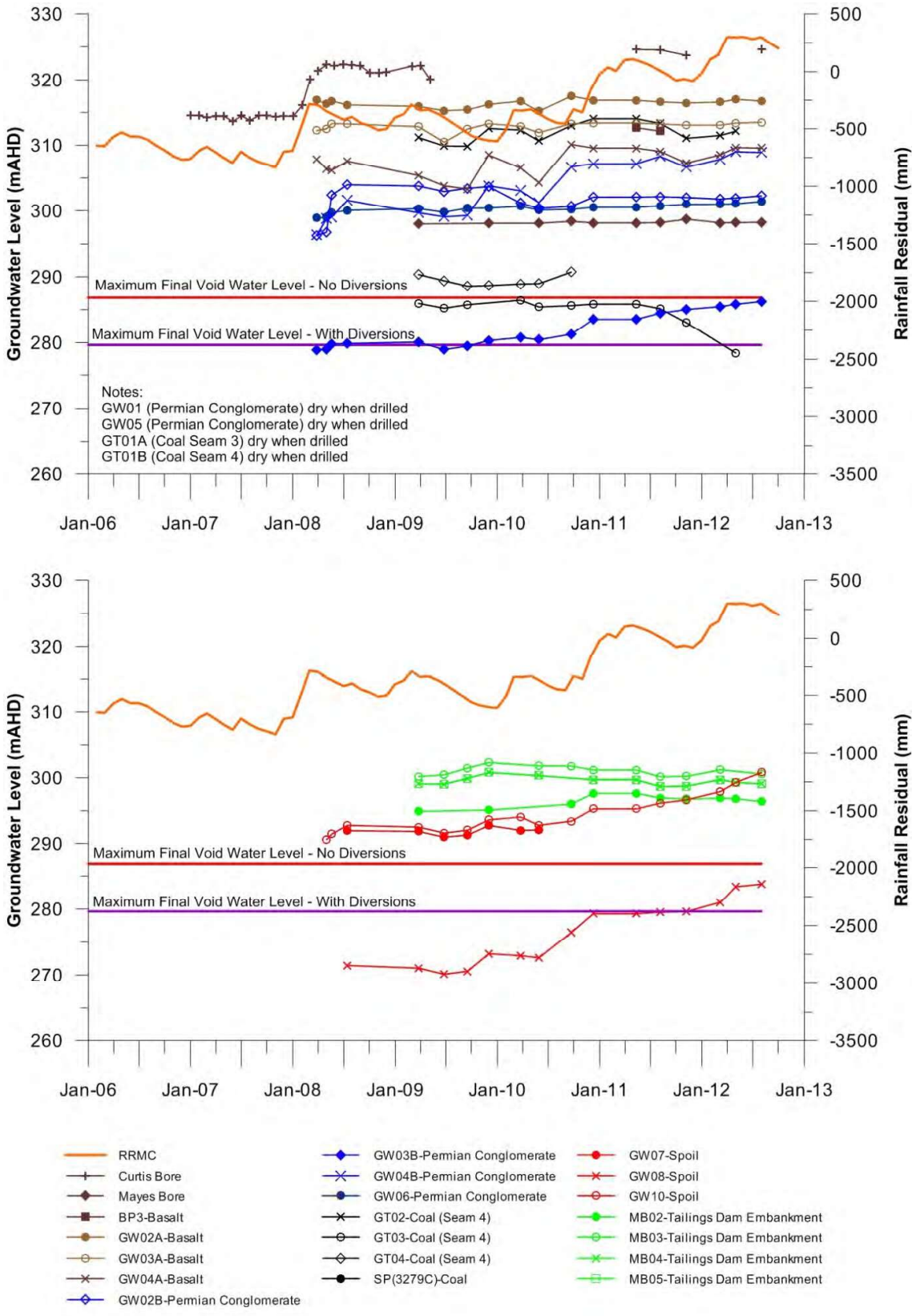


Figure 9-2: Modelled Final Void Water Levels Compared to Current Groundwater Levels

~~8.4~~9.2 Potential Groundwater Inflow Rates to Final Void

The following section presents a summary of potential long-term yields of the groundwater units at the Blair Athol site. The inflow rates presented in this section were used by BMT-WBM as input to final landform water study modelling (BMT-WBM 2012).

Observations related to potential inflow rates to the final void from groundwater units at site are presented below in Table 9-1. The potential inflow rates are based on anecdotal information from site and professional judgement. Current inflow rates (i.e. to the operating mine) have not been quantified, and no groundwater modelling has been undertaken.

Rates of groundwater inflow to the final void are likely to be highly dependent on climatic variation, as follows:

- During periods of higher than average rainfall the water level in the basalt, alluvium, and spoil can be expected to rise, and the rate of inflow to the final void from these groundwater units will increase. It is noted that the more transmissive units of the coal measures (the coal seams) have been largely removed by mining. Therefore it is judged that the Permian coal measures will not provide significant rates of inflow to the pit void; and,
- During periods of lower than average rainfall the water level in groundwater units at site can be expected to decrease and the rate of inflow to the final void to decrease over time. In particular:
    - Within the basalt aquifer groundwater occurs within discrete fractures. Over time the rate of inflow from fractures connected to the final void could be expected to decrease, unless recharge (via rainfall) is maintained; and,
    - The alluvium tends to become saturated during high rainfall events (for example as occurred during the 2010/2011 wet season), however the volume of water contained within the alluvium will decrease over time as contained water is dissipated down-gradient.

Based on the indicative inflow rates presented in Table 9-1, the total groundwater contribution to the final void is predicted to be in the order of 3-5 L/s, though the actual rate will be dependent on factors such as seasonal rainfall, the overall shape of the final landform, and the hydraulic characteristics of groundwater units (such as spoil) that occur adjacent to or within the final void.

DRAFT

Table 9-1: Potential Groundwater Inflow Rates to Final Void

Unit	Predicted Inflow (L/s)	Comment
Permian coal measures	0	• The Permian coal measures are recharged in areas where the units subcrop (Figure6-4), and via diffuse downward recharge. • The coal seams occur in an isolated basin, and the catchment area for recharge to the coal measures is small (refer Figure 6-4). • The permeability of the coal seams and interburden is low, therefore the capacity of the coal seam to transmit water is relatively low • Observations from site are that inflow rates from the coal seams during production were low • The coal seams (which are the most transmissive unit of the Permian coal measures) have been largely removed by mining. • Based on the above observations, it is concluded (for the purpose of pit void studies) that the inflow rate from the coal seams is nil
Permian conglomerate	0-2	• The Permian basal conglomerate generally only provides significant yields in areas where the unit has been remobilized. This is because the fine matrix material tends to be removed during remobilization, leaving behind the coarse clastic material which can form an aquifer (e.g. Tertiary gravels beneath Clermont Mine – refer JBT (2012). When the unit remains in-situ (i.e. in original position) the matrix remains, so that the permeability of the unit is dictated by the fine material of the matrix • At Blair Athol the basal conglomerate is saturated at depth. Where the unit exists close to surface it may contain water in areas where the unit receives recharge from direct rainfall, or via downward leakage where the unit underlies Tertiary basalt. • The Permian basal conglomerate does not form an extensive aquifer across the mine site, and the rate of inflow to the final void from this unit is expected to be low.
Tertiary basalt	1-5 (dependent on degree of rainfall recharge)	• Tertiary basalt exists only in the northern and north-eastern areas of the lease (Figure xx) • The basalt has been the main unit to contribute inflow to the pit voids during the life of the mine. Inflow rates are uncertain, but anecdotally it is believed that total flow rates are in the order of several litres per second • Inflow rates will be dependent on the position of the final void relative to the basalt aquifer.
Spoil	1-5 (dependant on spoil geometry relative to final void)	• The spoil will potentially become the most significant aquifer on site, however it is also noted that the extent of the spoil is limited, and the aerial extent (over which direct rainfall recharge will occur) is also limited; • Over time, it is judged that the spoil will be in continuous hydraulic connection with the pit lake, with the water level rising and falling in response to seasonal rainfall, as well as lake levels. • The greatest significance of the spoil aquifer to the final void is therefore likely to be geochemical, i.e. the extent to which rainfall recharge occurs through unsaturated spoil, and the extent to which the water level in the lake (and hence the spoil) rises and falls, will influence the chemistry of groundwater within the spoil, and hence within the pit lake. • The degree to which a water table develops in the spoil will be dependent on the shaping and cover of the final landform (i.e. whether rainfall recharge is enhanced or reduced) • The inflow rates to the final void will be dependent on factors such as: o The height of the water table in the spoil relative to the final void (and the hydraulic gradient available to drive groundwater flow); o The hydraulic properties of the spoil; and, o The geometry of the spoil relative to the final void
Alluvium	1-2 (dependent on degree of rainfall recharge)	• The alluvium tends to carry significant water only following periods of high rainfall, where the alluvium is directly recharged. • In periods of lower than average rainfall the groundwater level in the alluvium could be expected to continually decrease, with a corresponding decrease in inflow rate to the final void • The degree to which groundwater in alluvium could provide seepage to the pit void will be dependent on the degree of hydraulic connection between the pit void and alluvium. For example, if a significant thickness of alluvium is in hydraulic connection with the final void, and if a high rainfall period such as the 2010/2011 wet season re-occurs, the rate of groundwater inflow could be significantly in excess of the rate presented in the column to the left

~~9.0~~10.0 CONCEPTUAL GROUNDWATER MODEL

Conceptual groundwater models are presented below for pre-mining, mining, and post-closure scenarios. Each scenario is discussed with reference to conceptual cross sections. The location of the sections, sub-crop area of each coal seam, and general extent of basalt cover, is shown schematically in Figure 10-1.

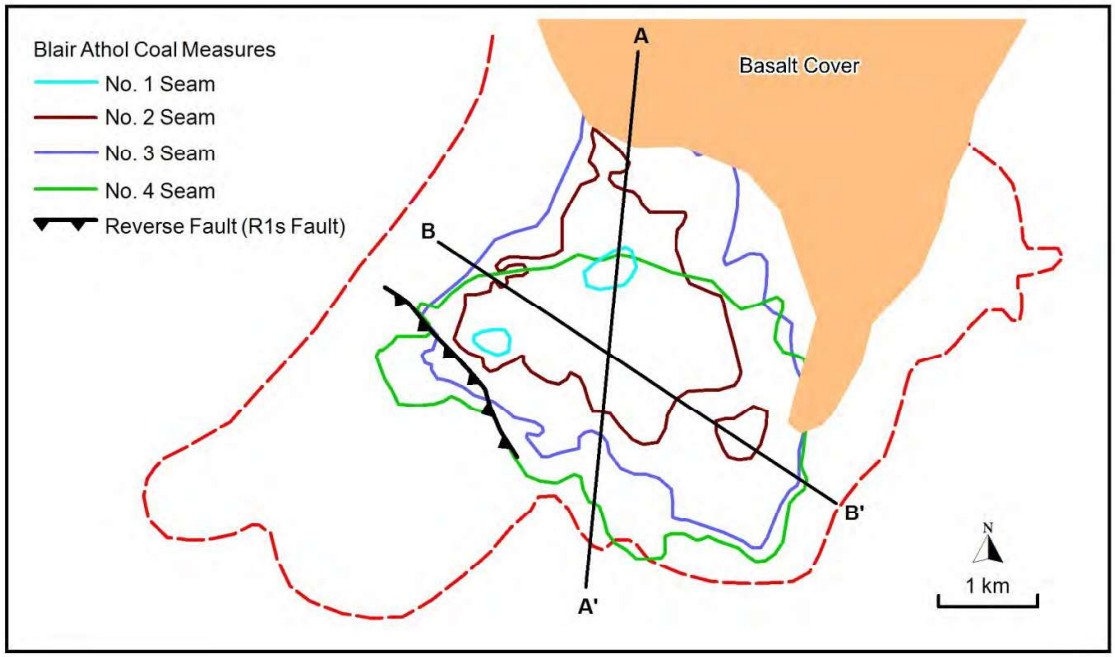


Figure 10-~~1~~10 ~~1~~: Location of Conceptual Sections (modified from RTCA 2011)

~~9.1~~10.1 Pre-Mining Conceptual Groundwater Model

No groundwater data exists prior to commencement of mining, therefore the pre-mining conceptual model is based on observations from available monitoring data at site (water level and water quality), as well as observations from ongoing reviews by JBT of regional groundwater data for the Clermont Mine, and professional judgement. The pre-mining conceptual model (Figure 10-2) is summarised as:

- The basement metamorphics, Permian sediments, Tertiary basalt, and Quaternary alluvium all occur at surface in different areas of the Blair Athol Mining Lease (refer Figure 6-3);
- Groundwater occurs in all groundwater units at site, though available data relating to groundwater yields suggests that the units are not aquifers[1] (with the exception of the Tertiary Basalt) but rather water-bearing units, as the rate at which the units are capable of yielding water to a bore would not allow the units to be classified as aquifers. Exceptions may occur locally where faulting or fracturing has increased the secondary porosity of the unit;
- Pre-Tertiary (pre-basalt deposition) surface drainage was from the northern part of the lease area to the north-east and east, along a drainage channel incised into the Permian surface (Figure 6-2). During deposition the basalt flowed up the drainage channel and into the northern area of the lease. The basalt on site represents the marginal extent of the basalt flow, and the

[1] An aquifer is defined as "rock or sediment in a formation, group of formations, or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs". (Fetter, 1994)

basalt cover on site is therefore thin in areas where it occurs on lease, thickening to the north and north-east;

- Within the basalt aquifer groundwater occurs primarily within fractures that are generally poorly connected to adjacent fractures (i.e. pumping from one fracture system may have little impact on adjacent fracture systems). This has implications for potential long-term inflow rates from the basalt aquifer to the final void (refer Sections 10.1 and 10.2);
- The Blair Athol Basin is a relatively isolated groundwater system, and the coal seams drain towards the centre of the basin. The groundwater flow paths within the coal seams are relatively short as it can be observed from Figure 10-1 that the subcrop boundaries of the individual coal seams are only several kilometres apart (i.e. the distance from one side of the basin to the other);
- Recharge to the coal seams occurs in marginal areas of the basin where the coal seams subcrop (refer Figure 10-1 for coal seam subcrop areas), or via downward drainage from overlying groundwater units;
- Recharge to other groundwater units is via direct rainfall recharge, and groundwater flow direction is topgraphically controlled. A groundwater divide exists in the basalt aquifer to the north of the mine area, at the catchment boundary between the north-west draining Miclere Creek, the south-east draining Gowrie Creek, and Bath and Washpool Creeks, which drain in a southerly direction through the mining area (refer Figure 6-3);
- All creeks in the area are ephemeral, and groundwater exists within unconsolidated alluvial deposits following rainfall recharge events; and,
- Major ion chemistry/ water types are different in different regions of the site, reflecting the chemistry of the rock units that host the groundwater (i.e. Mg-Ca-HCO3 in areas where basalt exists, Na-Cl in other areas).

DRAFT

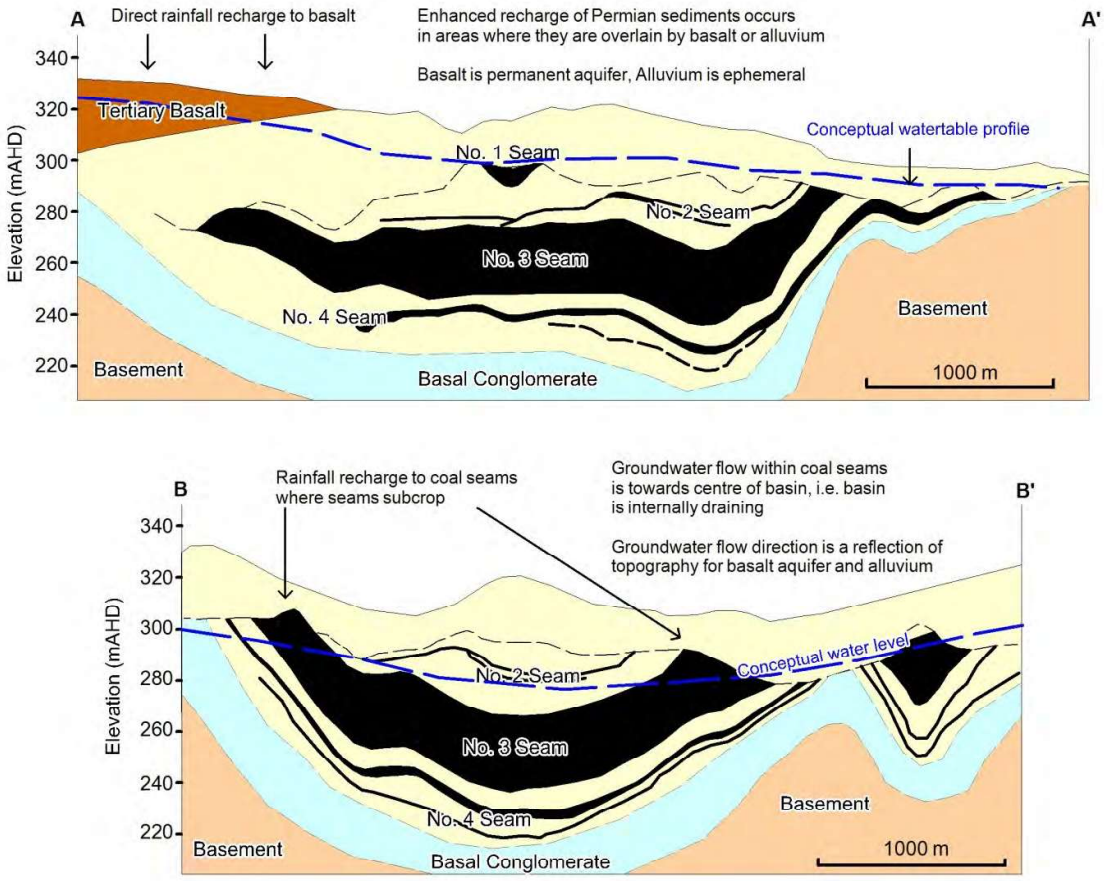


Figure 10-~~2~~10 ~~2~~: Pre-Mining Conceptual Groundwater Model (Modified from RTCA 2011)

~~9.2~~10.2 During Mining Conceptual Groundwater Model

The conceptual model for groundwater conditions during mining is shown in Figure 10-3, and is summarised as:

- Excavation of the pit voids creates groundwater sinks, which locally dewater the coal seams;
- Flow toward the pit voids is also induced from the basalt aquifer, with seepage occurring from the base of basalt (predominantly at the contact between the basalt and underlying units);
- Inflow to the pits may also occur through Permian conglomerates, especially in areas where the unit underlies (and is recharged by) the basalt aquifer;
- A localised aquifer is created within the spoil which backfills the mined-out pit voids. The hydraulic properties of the spoil aquifer are likely to be highly variable, dependant on factors such as the permeability of the original material, the dumping pattern, degree of compaction due to traffic, and variability in the rate of compaction and settlement with time. One study of groundwater conditions within spoil aquifers across a number of mining regions in the United States[2] noted a 6-order of magnitude variability in the permeability of spoil;
- The spoil aquifer is directly recharged by rainfall, as evidenced by bore hydrographs which show a correlation between rainfall and water level rise in the spoil (Section 8.2);

[2] Rehm, B.R, Groenewold, G.H. & Morin, K.A. (1980) Hydraulic Properties of Coal and Related Materials, Northern Great Plains. Groundwater Vol 18, No. 6, November-December 1980.

- Water quality has evolved from a number of distinct types (Na-Cl in areas distant from the basalt aquifer, and Ca-Mg-HCO3 within the basalt aquifer, as well as within units that underlie basalt) to mixed water types as mixing occurs between different groundwater units (Section 8.3.1).

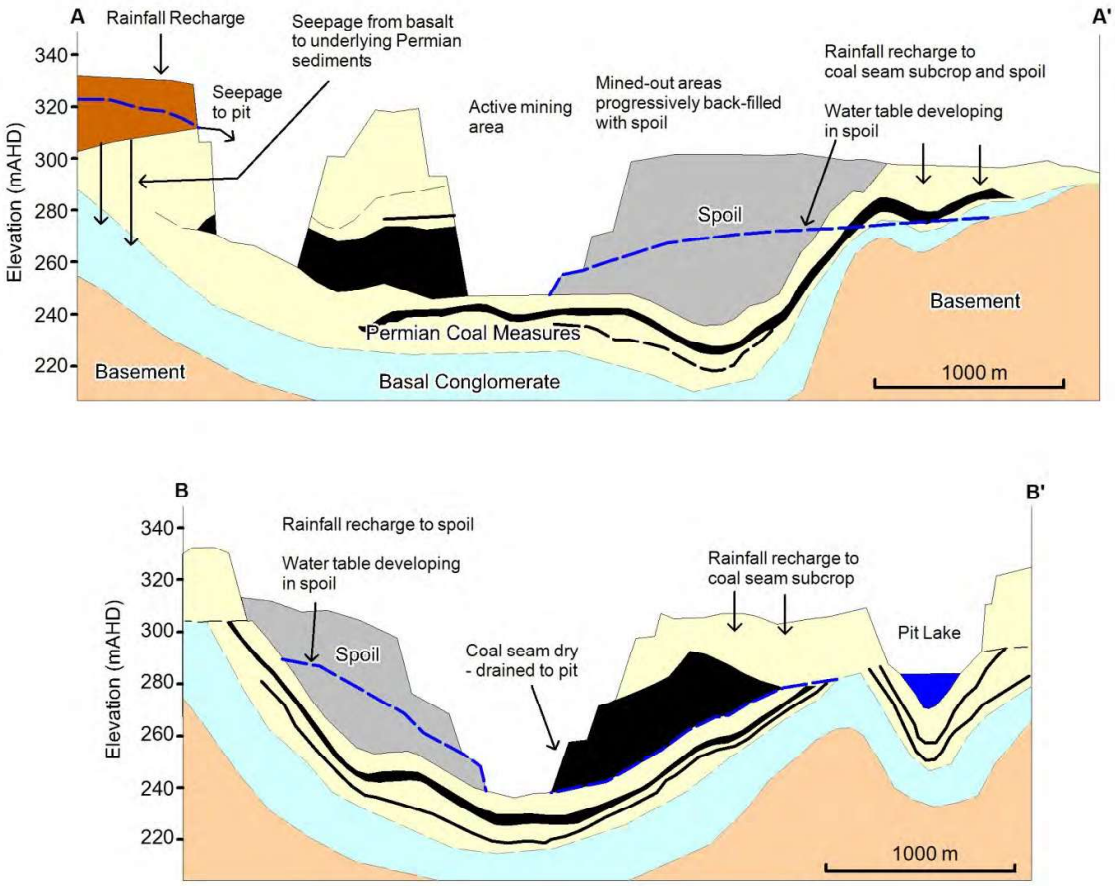


Figure 10-~~3~~10 ~~3~~: During-Mining Conceptual Groundwater Model

~~9.3~~10.3 Post-Closure Conceptual Groundwater Model

Based on review of available geological, water level, and water quality data, the post closure conceptual groundwater model (Figure 10-4) is summarised as:

- A water table will develop within the spoil, with the water level in the spoil influenced by rainfall recharge;
- The spoil will potentially become the most significant aquifer on site, however it is also noted that the extent of the spoil is limited, and the aerial extent (over which direct rainfall recharge will occur) is also limited;
- Over time, it is judged that the spoil will be in continuous hydraulic connection with the pit lake, with the water level rising and falling in response to seasonal rainfall, as well as lake levels;
- The greatest significance of the spoil aquifer to the final void is therefore likely to be geochemical, i.e. the extent to which rainfall recharge occurs through unsaturated spoil, and the extent to which the water level in the lake (and hence the spoil) rises and falls, will influence the chemistry of groundwater within the spoil, and hence within the pit lake.
- The degree to which a water table develops in the spoil will be dependent on the shaping and cover of the final landform (i.e. whether rainfall recharge is enhanced or reduced);

- The inflow rates to the final void will therefore be dependent on:
  - The height of the water table in the spoil relative to the final void, and therefore the hydraulic gradient available to drive groundwater flow;
  - The hydraulic properties of the spoil; and,
  - The geometry of the spoil relative to the final void
- Groundwater quality within the spoil aquifer will be dependent on spoil chemistry and groundwater residence times. Based on analysis of existing water quality data, it is predicted that water at the site (surface water and groundwater) will evolve to a mixed water type (dominated by Mg, Ca, and Na cations, and SO_4 and HCO_3 anions);
- Water within the basalt aquifer occurs within discrete fracture systems. Ongoing seepage from the basalt aquifer towards pit voids can be expected in areas where water-bearing fractures have been exposed by mining. The individual fractures store a finite volume of water, so the seepage rates could be expected to decrease over time, with increases in seepage rates evident following periods of rainfall recharge. Wet season rainfall has generally been above average since the 2007/2008 wet season, therefore the water level in most aquifers in the region are currently higher than has historically been the case (i.e. since prior to 2007, refer JBT 2012). Therefore it could be expected that seepage rates to the pit voids from the basalt aquifer would reduce during sustained periods of below average rainfall as the finite volume of water within the fractures discharges to the pit voids without being replenished by rainfall recharge; and,
- Groundwater levels for the majority of aquifers at site are currently higher than the predicted maximum water level in the final landform (pit lake). Therefore, it is predicted that the final landform pit lake will act as a groundwater sink, which will limit the potential for off-site discharge of water from the final void.

DRAFT

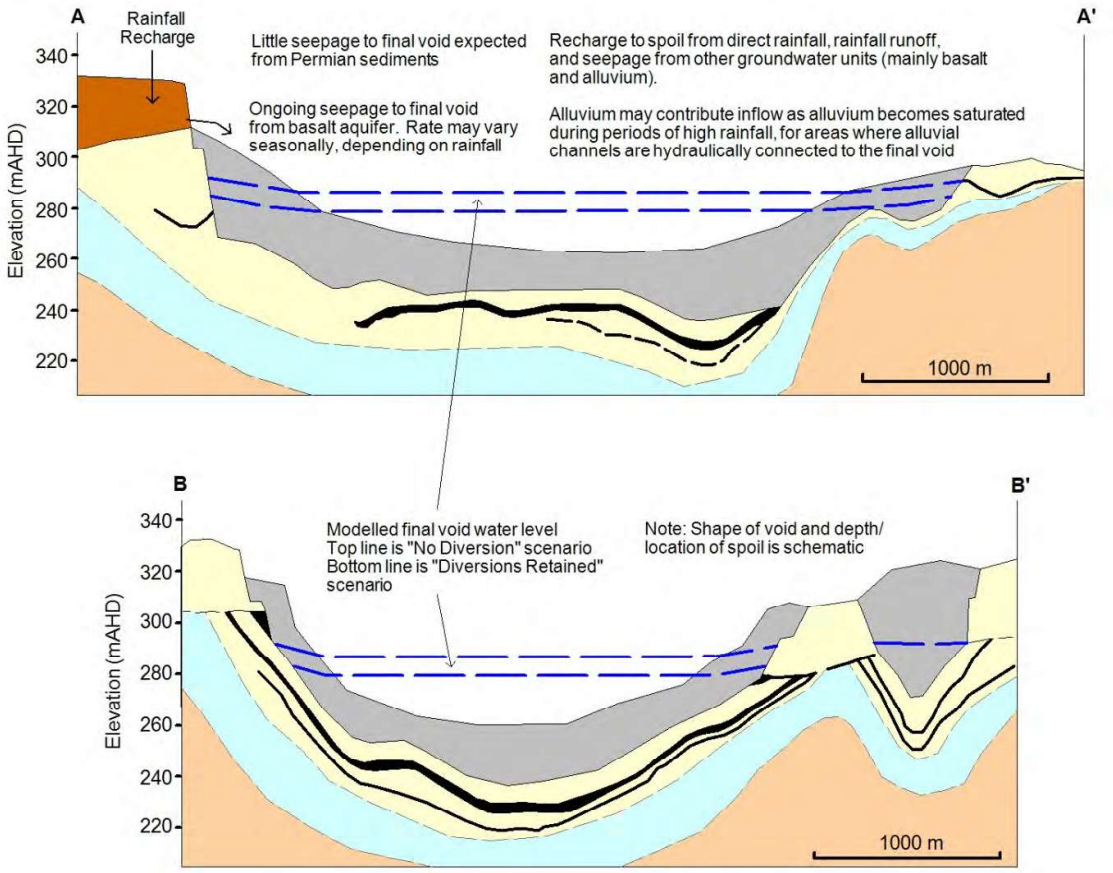


Figure 10-~~4~~10-~~4~~: Post-Closure Conceptual Groundwater Model

~~10.0~~11.0 CONCLUSIONS

~~10.1~~11.1 Hydrostratigraphy

The stratigraphic sequence in the Blair Athol Basin comprises five lithological units; these are, from stratigraphically lowest to highest:

- Proterozoic/ Cambrian Anakie Metamorphic Group, comprising schist, phyllite, metabasalt;
- Early to Middle Devonian arenites, occupying a small basement trough in the southern part of the basin;
- Permian-age Blair Athol Coal Measures, comprising:
  - The lower Coal Measures, which include basal conglomerate, sandstone, siltstone, and mudstone; and,
  - The upper Coal Measures, which include sandstone, siltstone, mudstone, conglomerate, as well as the four main coal seams of the basin (Seams 1, 2, 3, and 4)
- Tertiary basalt, which only occurs in the north and east of the lease area (Figure 6-3); and,
- Tertiary and Quaternary (recent) alluvial deposits developed within the ephemeral streams that drain the site, including Bath Creek and Washpool Creek.

~~10.2~~11.2 Groundwater Levels

Groundwater level data is summarised and analysed in Section 8.0. Observations from review of the hydrographs include:

Tertiary Basalt

- Only one bore (Curtis Bore) has water level readings that date prior to January 2008 (prior to the 2007/2008 wet season). The impact of 2007/2008 wet season rainfall is evident at this site, where the water level rise in the bore matches the rise in the residual rainfall mass (RRM) curve;
- Other basalt bores display a relatively steady water level trend, with a slight overall rise in water level evident between March 2008 and August 2012;

Coal Seam

- Monitoring bores at site are screened in either Seam 3 or Seam 4 (lower coal seams) as the seams above (Seam 1 and Seam 2) tend to be dry when drilled;
- Bore GT01 is located adjacent to the Ramp 3 South pit (Figure 8-1). Both GT01A (Seam 3) and GT01B (Seam 4) are dry, indicating that water within the coal seams has drained to the pit at this location;
- The impact of mining on water levels in the coal seam can be seen from the hydrograph for bore GT03 (Seam 4), the water level has reduced significantly at this site (7.38 m water level reduction) between May 2011 and May 2012.

Permian Conglomerate

- Water levels in bores monitoring the Permian conglomerate have tended to increase in response to rainfall recharge, i.e. water levels tend to conform to the overall trend of the RRM curve, which has displayed a rising trend since December 2007.
- Between May 2008 and May 2012 the water level has increased by 6.01 m in GW03B, 9.98 m in GW04B, and 1.36 m in GW06 (i.e. the greatest rate of water level increase has been in bores that are overlain by Tertiary basalt);
- At sites where the conglomerate is overlain by basalt (GW02B, GW03B, GW04B) the water level in the basalt aquifer is higher than the water level in the conglomerate, indicating a potential for the basalt aquifer to recharge the underlying Permian sediments.

Spoil

- Bores screened in spoil (GW08, GW10) show a rise in water level between July 2008 and August 2012 of between 8.06 m (GW10) and 12.32 m (GW08). This matches the overall rise in the RRM curve, indicating that groundwater levels within the spoil are directly impacted by rainfall recharge events.

Tailings Storage Facility (TSF)

- Bores screened within the TSF embankment (MB02, MB03, MB04, MB05) display relatively consistent water levels, suggesting that water levels in the bores are dominated by the water level within the TSF rather than by rainfall recharge (as is the case with bores in the surrounding spoil);

~~10.3~~11.3 Water Chemistry

The major ion chemistry at site is summarised as:

- Water samples from the coal seam, the Permian conglomerate (in areas where basalt does not exist), and some spoil bores (e.g. GW07) is sodium dominated;
- Cation chemistry for the basalt aquifer, and for the Permian conglomerate underlying basalt, is calcium-magnesium dominated; and,
- A number of surface water (industrial dam, environmental dam) were initially sodium dominated, but evolved to calcium-magnesium dominated over time. West Dam, which is in a catchment containing basalt outcrop as well as bedrock outcrop, has consistently displayed a mixed water chemistry dominated by sodium, calcium, and magnesium cations.
- Anion chemistry is more diverse, with water samples from different sources tending to be dominated by either chloride, bicarbonate, or sulphate. However, over time the various water sources (including surface water and groundwater) that were previously chloride dominated have evolved towards being dominated by bicarbonate or sulphate anions.
- Therefore over time, the surface water and groundwater at site has evolved from distinct water types to a mixed water type, which is increasingly dominated by calcium, magnesium, bicarbonate, and sulphate.

Water quality across the site has also been compared to a number of Australian guidelines, with observations as follows:

- Stock water guideline limits (ANZECC 2000)
    - Groundwater samples do not exceed stock water quality guidelines, with the exception of TDS, where 50 out of 279 samples exceed 4,000 mg/L, and aluminium, where 2 out of 71 samples exceed guideline limits
    - Surface water samples exceed stock water guideline limits for TDS, but only 2 out of 340 samples exceed 4,000 mg/L;
- Freshwater ecosystem protection guideline limits (ANZECC 2000 - slightly to moderately disturbed systems)
    - Groundwater samples exceed guideline limits for a number of parameters, including aluminium, arsenic, cadmium, copper, chromium, manganese, and zinc
    - Surface water samples exceed guideline limits for aluminium, cadmium, manganese, lead, and zinc
- Drinking water guideline limits (ADWG 2011)
    - Groundwater samples exceed guideline limits (health-based) for sulphate, arsenic, cadmium, manganese
    - Groundwater samples exceed guideline limits (aesthetic-based criteria) for pH, TDS, sodium, chloride, sulphate, iron, manganese, and zinc
    - Surface water samples exceed guideline limits (health-based) for sulphate, cadmium, manganese, and lead
    - Surface water samples exceed guideline limits (aesthetic-based criteria) for pH, TDS, sodium, chloride, sulphate, iron, and manganese.

In summary, the results from site groundwater sampling are consistent with previous investigations have concluded that the beneficial use for groundwater in the Clermont region is stock watering. Groundwater within the Tertiary basalt aquifer is, in some instances, suitable for potable use based

on TDS criteria alone, however a number of other parameters may make groundwater in the area unsuitable for potable consumption without treatment to a potable standard.

11.4 Final Void

11.4.1 Final Void Water Levels and Water Quality

A summary of final void modelling undertaken by BMT-WBM (2012) with respect to groundwater implications, is presented in Section 9.1 and is summarised as follows:

- Comparison of final void modelling with current and historic groundwater levels indicates that, for the majority of cases, groundwater levels are higher than the water level in the final void. This suggests that the final landform pit lake will act as a groundwater sink, limiting the potential for off-site movement of water from the pit lake via the groundwater system;
- It is concluded that the existing groundwater monitoring network (north, east and west of the site) is sufficient to monitor for offsite impacts from the final void lake;
- The groundwater monitoring network should be supplemented with:
  - Monitoring bores around the pit lake, drilled to intersect the water table and to monitor for changes in water level and water quality; and,
  - Monitoring bores to the south of the site, in the area where offsite groundwater movement is most likely to occur (i.e. down-gradient of the existing environmental dam, with bores placed too monitor water level/ water quality in the alluvium as well as adjacent/ underlying units (shallow bedrock)).

~~10.3.1~~11.4.2 Groundwater inflow to Final Void

The potential for groundwater to provide inflow to the final void is presented in Section 9-2 and Table 9-1, and is summarised as follows:

- Rates of groundwater inflow to the final void are likely to be highly dependent on climatic variation, as follows:
- During periods of higher than average rainfall the water level in the basalt, alluvium, and spoil can be expected to rise, and the rate of inflow to the final void from these groundwater units will increase. It is noted that the more transmissive units of the coal measures (the coal seams) have been largely removed by mining. Therefore it is judged that the Permian coal measures will not provide significant rates of inflow to the pit void; and,
- During periods of lower than average rainfall the water level in groundwater units at site can be expected to decrease and the rate of inflow to the final void to decrease over time. In particular:
  - Within the basalt aquifer groundwater occurs within discrete fractures. Over time the rate of inflow from fractures connected to the final void could be expected to decrease, unless recharge (via rainfall) is maintained; and,
  - The alluvium tends to become saturated during high rainfall events (for example as occurred during the 2010/2011 wet season), however the volume of water contained within the alluvium will decrease over time as contained water is dissipated down-gradient.
- Based on the indicative inflow rates presented in Table 9-1, the total groundwater contribution to the final void is predicted to be in the order of 3-5 L/s, though the actual rate will be dependent on factors such as seasonal rainfall, the overall shape of the final landform, and the hydraulic characteristics of groundwater units (such as spoil) that occur adjacent to or within the final void.

~~10.4~~11.5 Conceptual Groundwater Model

Conceptual groundwater models for pre-mining, mining, and post-mining (closure) scenarios are presented in Section 10. The conceptual models are presented in summary form, so they will not be further summarised in this section.

~~11.0~~12.0 RECOMMENDATIONS

Following review of groundwater conditions at site, as well as data from the existing groundwater monitoring network and results of final landform water study modelling, the final recommendations are made:

- Following development of the final landform, groundwater monitoring bores should be constructed around the perimeter of the lake (final number to be established once the landform is complete). Bores should be drilled to intersect the watertable, and monitored for change in water level and water quality;
- Additional groundwater monitoring bores should also be constructed at the southern end of the site (between the environmental dam and the southern boundary of the lease) to monitor for potential offsite movement of contaminants from site, particularly from the final landform pit lake;
- Following final design of the post-closure groundwater monitoring network, a plan and schedule for ongoing monitoring/sampling of water levels and water quality should be developed. Initial recommendations for monitoring include:
  - Monitoring of water levels within key bores (to be determined) via down-hole data loggers, with data loggers to be downloaded at a maximum interval of 3-monthly. For other sites water levels should be recorded manually at 3-monthy intervals. Following each data download the data should be reviewed for data integrity, and a report on groundwater levels and trends prepared on an annual basis;
  - Water quality should be monitored quarterly for a minimum of 2 years to establish a base-line data set for closure conditions, for a minimum of the following parameters:
    - Total Dissolved Solids
    - EC, pH (field)
    - Major Ions - sodium, calcium, magnesium, potassium, chloride, sulphate, alkalinity (hydroxide, carbonate, bicarbonate, total)
    - Fluoride
    - Total + dissolved metals, via ICPMS/FIMS (aluminium, arsenic, boron, cadmium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, vanadium, zinc)
  - It is recommenced that water quality data be reviewed each quarter, and a report prepared on an annual basis to present and discuss results and trends. The frequency of data collection should be reviewed following 2 years of data collection, with recommendations then made as to the frequency of ongoing data collection.
- It is acknowledged that different monitoring/reporting conditions may be required by DEHP, therefore the post-closure groundwater monitoring plan will need to be reviewed and approved by DEHP.

~~12.0~~13.0 REFERENCES

BMT-WBM (2012) BAC Final Landform Water Study. Report to Rio Tinto Coal Australia, November 2012.

Fetter (1994). Applied Hydrogeology, Third Edition. Prentice Hall Publishers, 691 pp.

Herbert, H.K. (1989) Geology and Gold Potential, Black Ridge Area, Clermont Qld. Report to Southern Aurora Joint Venture, June 1989.

JBT (2009) Regional Groundwater Model Update. Report by JBT Consulting to Rio Tinto Coal Australia, Clermont Mine Project. JBT report No. JBT01-001-008, June 2009

JBT (2012) Clermont Mine – 5th Annual Aquifer Performance Review - 2011/2012 Water Year. Report by JBT Consulting to Rio Tinto Coal Australia, Clermont Mine. JBT report No. JBT01-001-061, August 2012.

Matrix+ (2007) Groundwater Monitoring Bore Installation. Report to Riotinto Coal Australia Blair Athol Coal Mine by Matrix + Consulting, July 2007

Rehm, B.R, Groenewold, G.H. & Morin, K.A. (1980). *Hydraulic Properties of Coal and Related Materials, Northern Great Plains.* Groundwater Vol 18, No. 6, November-December 1980

RTCA (2011) The Coal Resources and Coal Reserves of the Blair Athol Mine – 2010. Report prepared to support 2010 year end statements by Rio Tinto Coal Australia (RTCA), February 2011.

Terranus (2009) Groundwater Review – Blair Athol Coal Mine. Report to Blair Athol Coal Mine by Terranus Earth Sciences, May 2009.

URS (2006) Assessment of water and sediment quality of Stockpile Dam and Environment Dam for EPA Hazardous Dam Classification. Letter report from URS to Blair Athol Coal Mine, Document No. 311006, 31 October 2006.

Water Solutions (1999) Report to RTCA Clermont Mine/ Blair Athol Coal on Permanent Waterworks Options Overview Investigations. Water Solutions Document No. WS990292.

Water Solutions (2012) Report to RTCA Clermont Mine/ Blair Athol Coal on OPSIM Water Management Metered Data Review. Water Solutions Document No. WS120175 (Draft) 3 May 2012.

DRAFT

APPENDIX A

GROUNDWATER LEVEL DATA

APPENDIX A

WATER-TYPE ANALYSES

APPENDIX B

COMPARISON OF SITE WATER QUALITY

TO AUSTRALIAN GUIDELINES

Blair Athol Coal Mine – Environmental Management System

TerraCom

APPENDIX D — BMT WBM 2012 FINAL LANDFORM WATER STUDY



BMT WBM

"Where will our knowledge take you?"

Rio Tinto

BAC Final Landform Water Study

November 2012



“at a Glance ....”

Objectives

Rio Tinto Coal Australia (RTCA) is undertaking closure planning for the mine site at Blair Athol, Central Queensland.

Upon closure of the mine site, the final landform will likely contain at least one final void with a series of waterbody depressions scattered throughout the site (hereafter referred to as the ‘pit lake’). The site has a large external catchment, but the majority of flows from this external catchment are redirected around the site by two perimeter diversions, which are likely to remain in place after the mine is decommissioned.

BMT WBM has undertaken a preliminary assessment of the water balance of the pit lake under two scenarios: (i) with the existing diversions in place and (ii) with the diversions removed. Our assessment includes both water quantity and quality and has applied a combination of catchment and hydrodynamic models for the assessment – assessing how the final landform would function using 50 years of historical climate data (from 1961 to 2011).



Key Findings

- Under both scenarios, the water level within the pit lake is predicted to be much lower than its crest height during the 50 year simulated. The pit lake is subsequently highly unlikely to ‘over-top’ and discharge into downstream waterways, except during very large flood events.
- The pit lake is subsequently unlikely to have any impact on water quality within the downstream waterways through surface flows. There still exists the potential for impacts on the downstream environment through groundwater interactions, but the likelihood of this occurring is unknown.
- The pit lake is predicted to experience seasonal thermal stratification during summer under both scenarios, with lake ‘turn-over’ (mixing of surface and bottom layers) during winter. After approximately 25 years, the lake is predicted to become more saline with ‘haloclines’ developing (large differences in salt concentrations between the surface and bottom waters) and remaining in place for extended periods of time.
- Water quality within the pit lake is likely to be poor. Deep layers are likely to become anoxic (with very low oxygen levels), pollutants (e.g. heavy metals) will accumulate, and there may be algal blooms (and associated impacts, such as reduced oxygen levels).

Where to from here ?

The creek diversions around the site should remain in place and be maintained to ensure that flow from upstream catchment areas continues into downstream waterways.

Further work should be undertaken to determine whether water within the lake could flow to the downstream environment through groundwater interactions.

Further work should also be undertaken out to provide a more detailed understanding of future likely water quality of the lake – with a view to determining beneficial uses of the site (if any).

BAC Final Landform Water Study

Prepared For:	Rio Tinto
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

Offices

Brisbane
Denver
Mackay
Melbourne
Newcastle
Perth
Sydney
Vancouver

DOCUMENT CONTROL SHEET

BMT WBM Pty Ltd

BMT WBM Pty Ltd
Level 8, 200 Creek Street
Brisbane 4000
Queensland Australia
PO Box 203 Spring Hill 4004

Tel: +61 7 3831 6744
Fax: + 61 7 3832 3627

ABN 54 010 830 421

www.bmtwbm.com.au

Document :	R.B19180.001.01.BAmineModelling.docx
Project Manager :	Brad Dalrymple
Client :	Rio Tinto
Client Contact:	Scott Diggles
Client Reference	

Title :	BAC Final Landform Water Study
Author :	Rob Holmes
Synopsis :	preliminary assessment of the water balance of the final proposed landform for the Blair Athol mine

REVISION/CHECKING HISTORY

REVISION NUMBER	DATE OF ISSUE	CHECKED BY		ISSUED BY	
0	15/11/2012	Michael Barry		Rob Holmes	
1	16/11/2012	Michael Barry		Rob Holmes	

DISTRIBUTION

DESTINATION	REVISION			
	0	1	2	3
Rio Tinto	PDF	PDF		
BMT WBM File	PDF	PDF		
BMT WBM Library	PDF	PDF		

CONTENTS

Contents i
List of Figures ii
List of Tables ii
Executive Summary iii

1 INTRODUCTION 1-1

2 METHODOLOGY 2-1
2.1 Catchment modelling 2-1
2.1.1 Source Catchments Model Setup 2-1
2.1.1.1 Subcatchment Map 2-1
2.1.1.2 Land Use 2-4
2.1.1.3 Climate – Rainfall and Evapotranspiration 2-4
2.1.2 Source Catchments Hydrologic and Water Quality Parameterisation 2-7
2.1.2.1 Hydrologic Parameterisation 2-7
2.1.2.2 Salinity 2-7
2.2 DYRESM Hydrodynamic Modelling 2-8
2.2.1 DYRESM Structure 2-8
2.2.2 Meteorological Forcing 2-11
2.2.3 Groundwater Inflows 2-14
2.2.4 Surface Inflows 2-14

3 RESULTS 3-1
3.1 Catchment Results 3-1
3.2 DYRESM Results 3-2
3.2.1 Scenario Results 3-2
3.2.2 Sensitivity Analysis 3-5

4 CONCLUSIONS AND RECOMMENDATIONS 4-1

5 REFERENCES 5-1

APPENDIX A: SENSITIVITY ANALYSIS FIGURES A-1

LIST OF FIGURES

Figure 1-1	Site Layout	1-2
Figure 1-2	Digital Elevation Model of the Site	1-3
Figure 2-2	Blair Athol Subcatchments With No Diversion	2-3
Figure 2-3	Total and Mean Annual Rainfall	2-5
Figure 2-5	Digital Elevation Model of Proposed Final Landform	2-10
Figure 2-6	Profile of The Mine Void as Simulated By DYRESM	2-11
Figure 2-7	Monthly Means of Meteorological Data Used in DYRESM	2-13
Figure 3-2	Total and Mean Annual Dissolved Solids Loads	3-2
Figure 3-3	Temperature and Salinity Profiles Under The 'diversions' Scenario	3-3
Figure 3-4	Temperature and Salinity Profiles Under the 'no diversions' Scenario	3-3
Figure A-2	Groundwater flow set to 5 L/s	A-1
Figure A-3	Groundwater salinity set to 0.5	A-1
Figure A-4	Groundwater salinity set to 2.0 (the run did not complete as salinity exceeded 42)	A-2
Figure A-5	Inflow temperatures set to 2 °C below ambient air temperature	A-2
Figure A-6	Inflow temperatures set to 4 °C below ambient air temperature	A-2
Figure A-7	Wind sensor height set to 5 m above lake crest	A-3
Figure A-8	Wind sensor height set to 15 m above lake crest	A-3
Figure A-9	Wind sensor height set to 20 m above lake crest	A-3

LIST OF TABLES

Table 2-2	Daily PET Rates	2-5
Table 2-3	Source Hydrologic Parameterisation	2-7
Table 2-6	Relative Humidity Climatology Used in DYRESM	2-12
Table 3-1	Flow and Total Dissolved Solids Load Statistics	3-1

Executive Summary



EXECUTIVE SUMMARY

Rio Tinto Coal Australia (RTCA) is undertaking closure planning for the mine site at Blair Athol, Central Queensland, and has commissioned BMT WBM to conduct a water study of the site's final landform. The Blair Athol sites has an upstream catchment of 64 km^2, but the majority of flows from the catchment are redirected around the site by two perimeter diversions, which are likely to remain in place after the mine is decommissioned. This study examined the hydrodynamics of the mine pit lake under two scenarios: (i) with the diversions in place and (ii) with the diversions removed.

The study comprises two components, a catchment model of the mine site and upstream catchment, and a hydrodynamic model of the mine pit lake.

The catchment model was created using Source Catchments, developed by the eWater CRC, which is widely used for studies of this nature. The model requires rainfall and potential evapotranspiration data, which were provided by the Bureau of Meteorology (BoM), while salinity data were derived from total dissolved solids (TDS) measurements taken from nearby creeks. Flows and salinities for both scenarios were simulated and the results provided for use as inputs to the hydrodynamic model. Flows under the 'no diversions' scenario were approximately 3.3 times those under the 'diversions' scenario over the course of the run (1961 to 2011).

The hydrodynamic model of the pit lake was created using DYRESM, developed by the Centre for Water Research at University of Western Australia. DYRESM is a one dimensional, laterally-averaged model, which requires meteorological data (sourced from BoM), surface inflows (the catchment model results) and groundwater inflows (provided by JBT Consulting) to run. The DYRESM structure was derived from a DEM (Digital Elevation Model) of the final landform, provided by RTCA. Using these inputs, the model was simulated for 50 years from 1961 to 2011.

The results of the hydrodynamic modelling indicate that, under both scenarios, the water level within the lake is not predicted to reach the lake crest height during the 50 year simulation. The model subsequently predicts that there would be zero flows from the lake to the downstream environment (during the 50-year historical climate period) and the only loss of water volume would be through evaporative flux. This makes the lake a closed system, with salinity that gradually increases over time as more dissolved solids are brought into the lake through catchment and groundwater inflows.

Initially, the system is predicted to experience seasonal thermal stratification under both scenarios. During summer, surface waters warm and become more buoyant, leading to the creation of a thermocline (a thin layer between surface and bottom layers over which a strong temperature gradient exists). The thermocline is then destroyed and the water column overturns during winter, as the surface waters cool and become more dense. After approximately 25 years of salt accumulation, however, the system is predicted to become more saline and haloclines are predicted to develop, which are strong salinity gradients between surface and bottom waters. The haloclines can be much more long-lived, with the water-body becoming strongly stratified for years at a time.

Long-term stratification of a lake can have negative implications for water quality, with deep layers becoming anoxic as they lack atmospheric oxygen exchange. The lack of flushing of the closed lake may also result in the accumulation of nutrients over time, which may results in algal blooms, further reducing oxygen levels within the lake. Pollutants such as heavy metals may also accumulate over time.

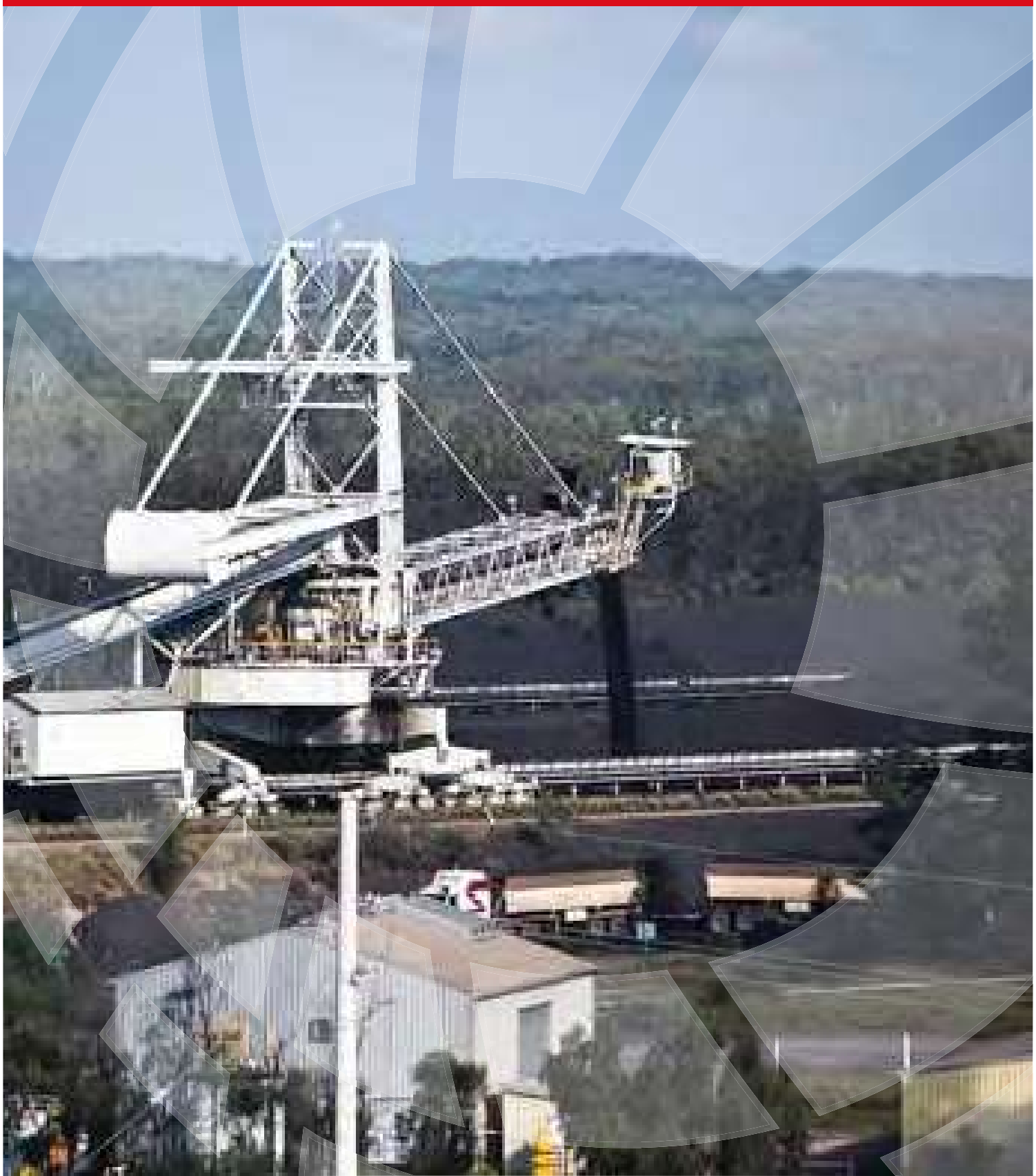
A benefit of the lack of flow from the lake to the downstream environment is that, if the water quality within the lake is poor (which appears likely), then the probability of negative effects on the downstream environment from the lake overflowing is low. This does not take into account groundwater interactions, however, which may provide a pathway for lake water to flow downstream of the mine site.

BMT WBM recommends that the creek diversions around the site remain in place and are maintained to ensure that flow from the upstream catchment during a rainfall event reaches the downstream environment. Removing the creek diversions would result in the majority of surface flow from the catchment entering the pit lake, and not flowing to the creeks downstream of the site. Such an outcome would likely have a negative effect on the downstream environment.

BMT WBM also recommends that a further groundwater study should be performed to determine if water quality within the lake is likely to affect the downstream environment through groundwater interactions.

Furthermore, BMT WBM recommends that additional work be carried out to determine the future likely water quality of the lake, with a view to determining beneficial uses of the site, if any.

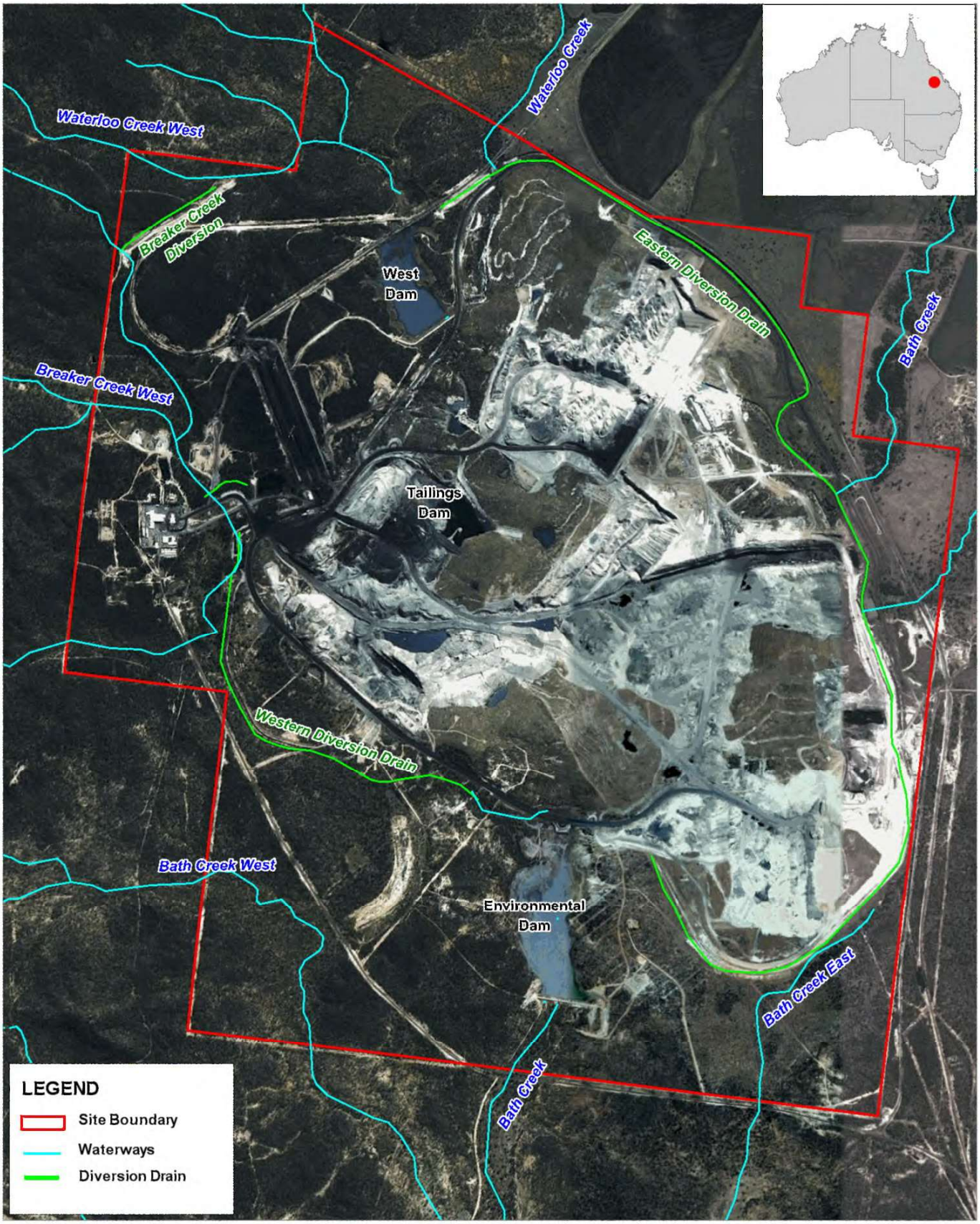
1: Introduction



1 INTRODUCTION

Blair Athol Mine is located in the Bowen Basin in Central Queensland, 25 km north-west of the township of Clermont. Coal mining has been undertaken at the site since 1882 and the current mining operation supplies customers in Asia and Europe with up to 12 million tonnes of coal per annum. Rio Tinto Coal Australia (RTCA) manages the existing operation on behalf of a joint venture and is currently undertaking closure planning for the mine site. Upon closure of the mine site, the final landform will likely contain at least one final void with a series of water-body depressions scattered throughout the site. RTCA commissioned BMT WBM to conduct a modelling assessment of the long-term water balance of the final landform, which is described in this report.

The mining lease extends over approximately 1030 hectares and is located downstream of an external catchment (see Figure 1-1 and Figure 1-2). The external catchment upstream of the site comprises of number of ephemeral creeks that are known as Breaker, Bath and Washpool Creeks. Perimeter diversions (to divert these creeks around the site) have been necessary to enable mining of the Blair Athol coal measures. These diversions are expected to remain in place upon closure of the mine. Nevertheless, this study examined two scenarios for the upstream catchment: (i) with the diversions in place and (ii) with the diversions removed..



Title:

Site Layout

Figure: 1-1

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

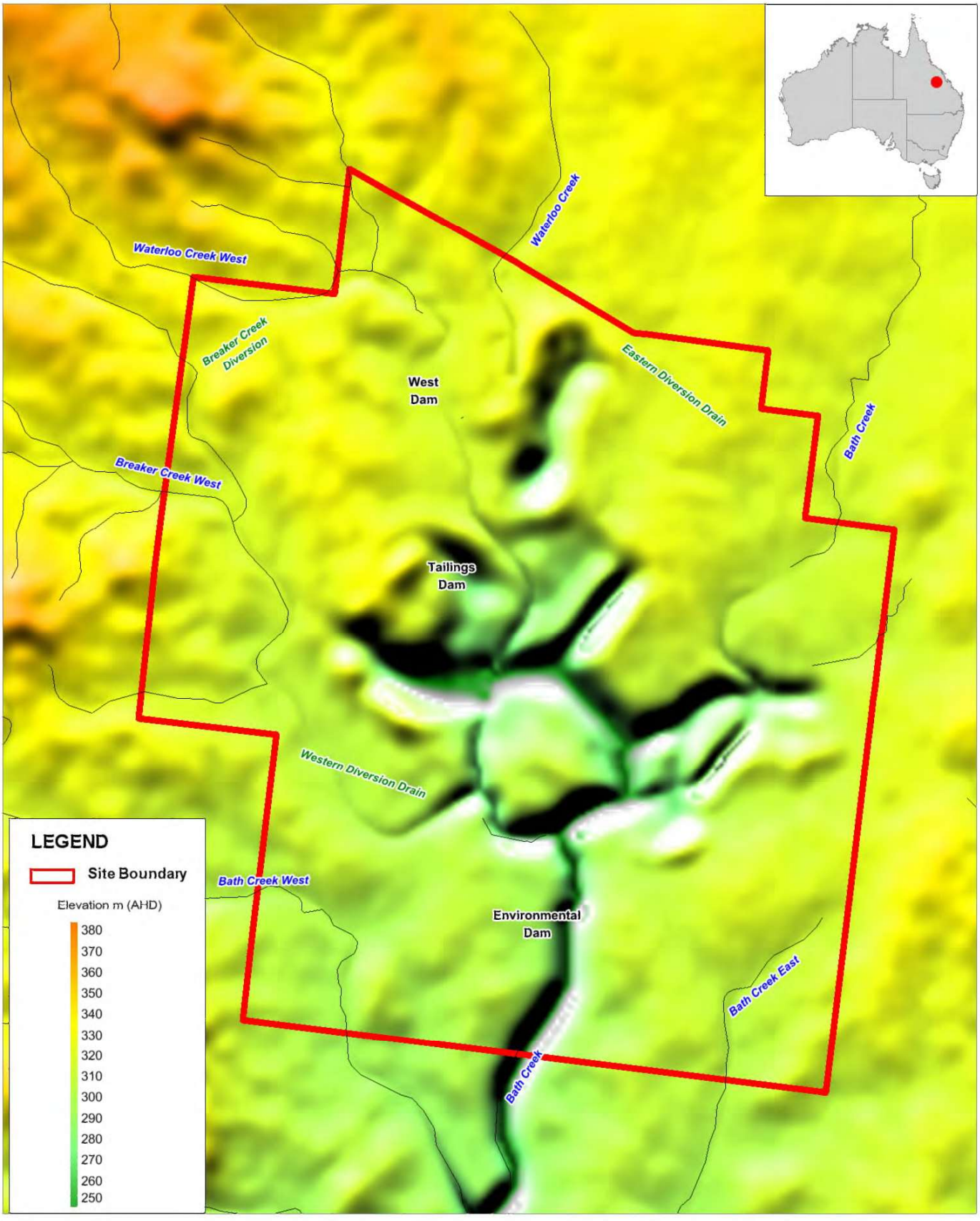
N

0 0.5 1km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B19180_I_GML Blair Athol BAD\DRG\UW_005_120713 Layout.wor



Title:

Digital Elevation Model of the Site

Figure: 1-2

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

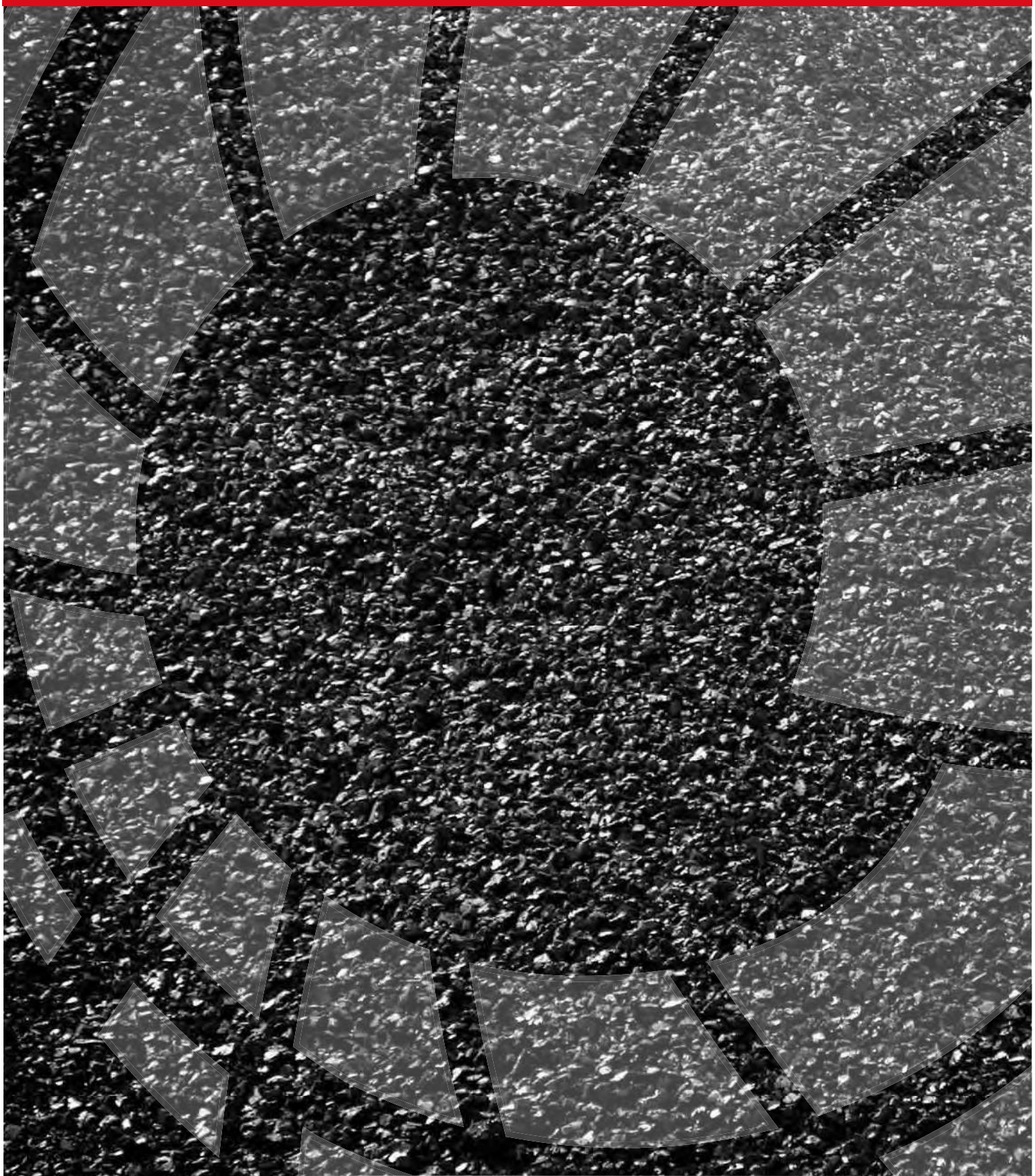
0 0.5 1km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B19180_I_GML Blair Athol BAD\DRG\UW_004_120718_DEM_Sites.wor

2: Methodology



2 METHODOLOGY

BMT WBM applied a staged approach to the assessment, with catchment modelling of the surrounding area informing the surface flows to the water body within the final landform.

The catchment modelling was conducted using the Source Catchments software and is described in Section 2.1 below. The hydrodynamic water-body modelling was conducted using DYRESM (DYNamic REServoir Simulation Model) and is described in Section 2.2.

2.1 Catchment modelling

Catchment flows and runoff salinities were derived using a lumped hydrologic model that allowed for the simulation of current catchment characteristics and hydrological responses to rainfall. Source Catchments (Source) was the model used in this study to define flows and salinity draining from the catchments upstream of and within the final Blair Athol landform. The Source modelling framework was developed by the eWater CRC (eWater CRC 2010), a federally funded Cooperative Research Centre combining Australia's pre-eminent research organisations, State Government water regulators and industry practitioners. Details of the Source data requirements and model construction methodology are described in the following sub sections.

2.1.1 Source Catchments Model Setup

Construction of the Source catchment model required transforming the physical catchment information into a mathematical form used to convert rainfall to runoff and constituent loads for the hydrodynamic water balance modelling. The outcome was a numerical representation of the physical and chemical features that represented the land-based framework, hydrological processes and salinity load generation aspects of the catchment.

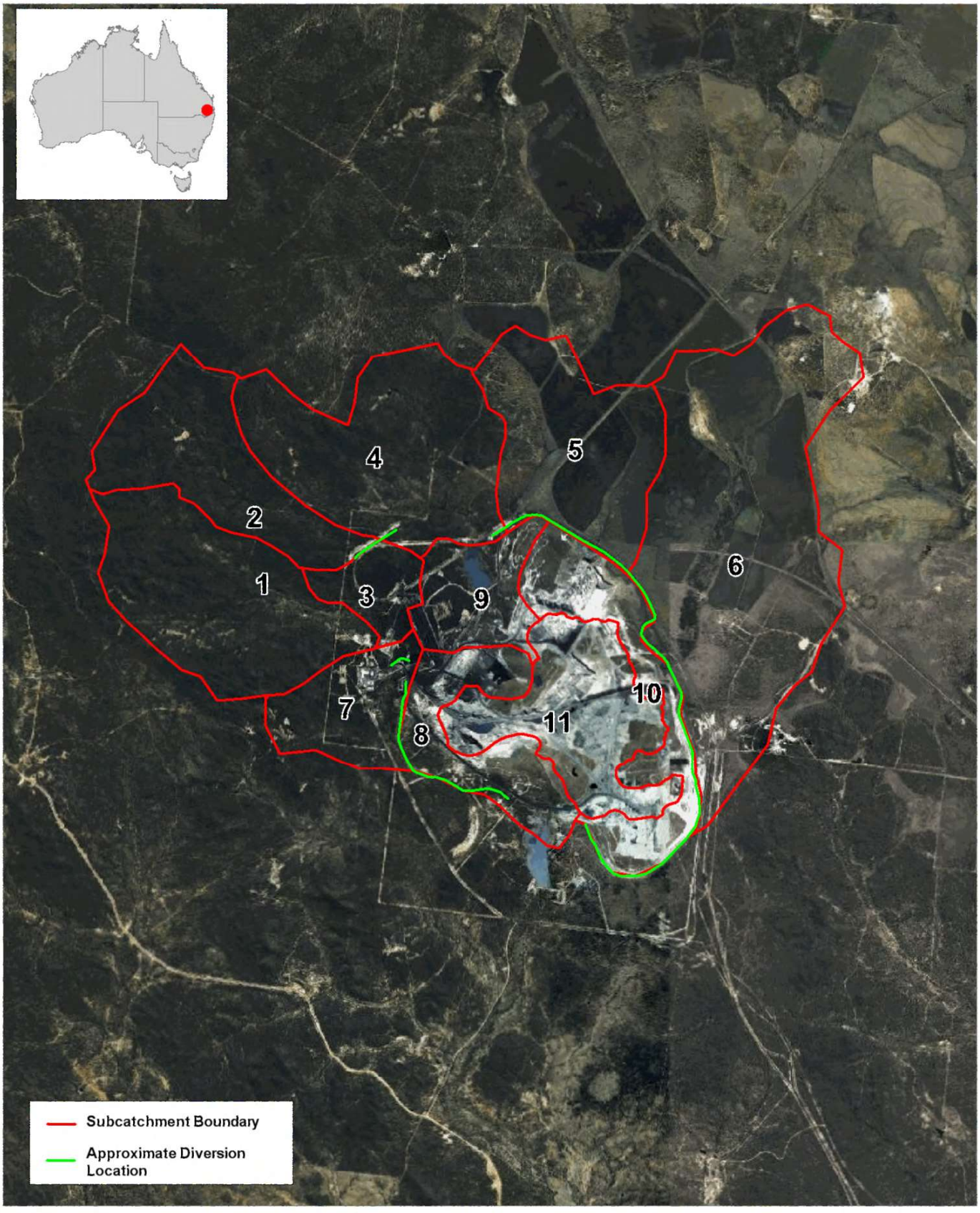
Constructing the catchment model required the following data inputs:

- Digital elevation model (DEM). The DEM was used to delineate catchment boundaries.
- Land use data. Land use data were used to characterise the hydrologic and salinity export modules because they are likely different for various land uses (e.g. forested and grazing).
- Climate data (daily rainfall and evapotranspiration). Climate data are the input data used in the water balance model to generate runoff through the various components of the hydrologic cycle.
- Stormwater salinity export rates for the aforementioned land use types. The Source Catchment modelling used salinity export rates to quantify only stormwater runoff.

These data and their sources as adopted for this model are discussed in the following sections.

2.1.1.1 Subcatchment Map

Subcatchment maps of the areas draining to the Blair Athol landform were developed from the final landform and existing 2005 Australia/New Zealand Land Information Council elevation data. Catchment delineation was performed for the areas draining to the flow diversion and the landform.



Title:

Blair Athol Subcatchments - With Existing Diversions

Figure: 2-1

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

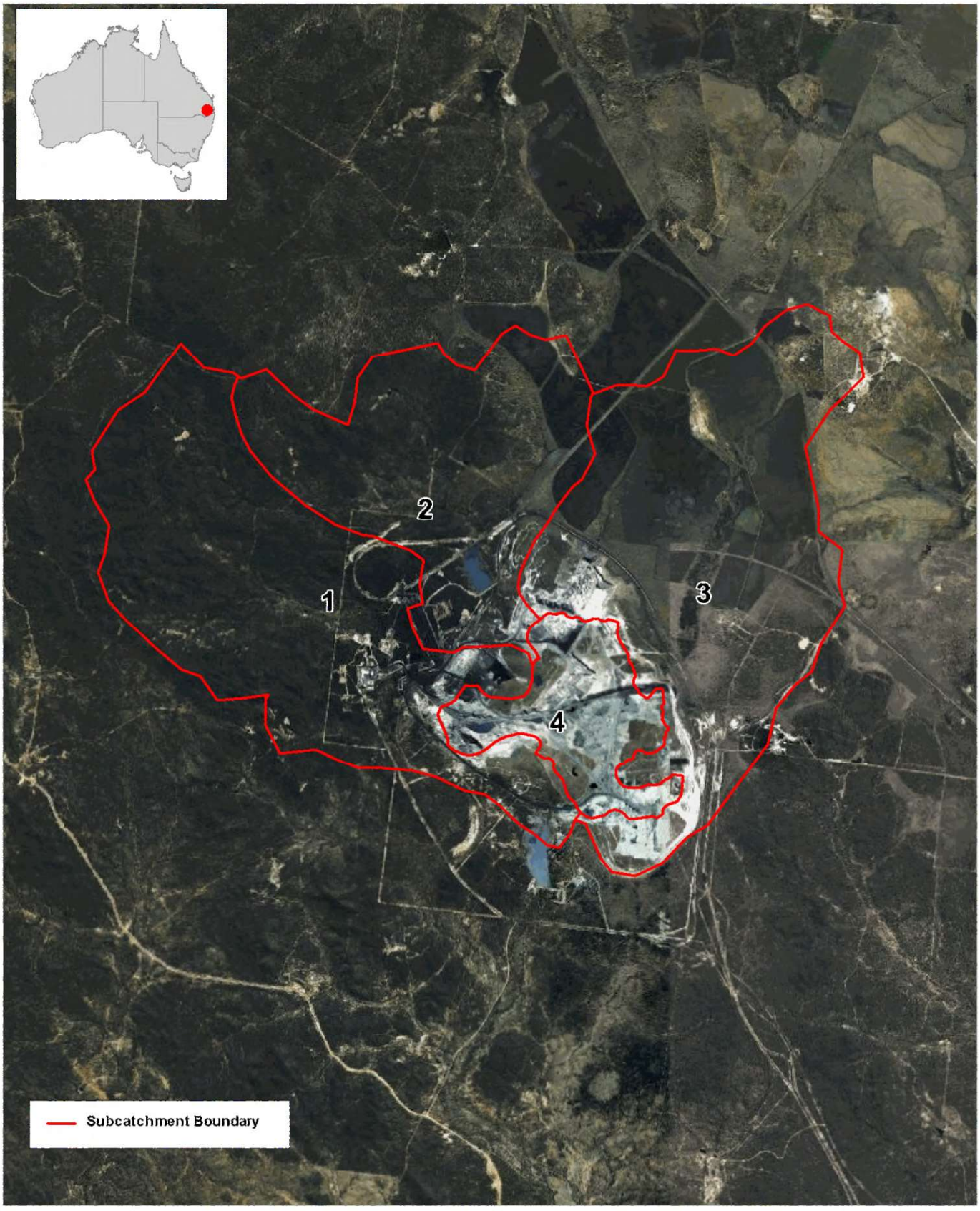
0 37.5 75m

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B19180_I_GML Blair Athol BAD\DRG\CARE_001_subcatch_w_div.wor



Title:

Blair Athol Subcatchments - With Existing Diversions Removed

Figure: 2-2

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 37.5 75m

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B19180_I_GML Blair Athol BAD\DRG\CARE_002_subcatch_no_div.wor

shows the catchment boundaries for the scenario in which the diversions are maintained and shows the boundaries for the scenario in which existing diversions are removed. The total catchment area, including the Blair Athol Mine site landform is approximately 64 km^2.

2.1.1.2 Land Use

Each subcatchment was further divided into regions of similar hydrological characteristics based on typical land use designations. Land use data were taken from 1999 DERM land use data. These data were categorised into 6 broad functional units: dryland cropping, forested, grazing, water, mining & urban. Figure 2-4 shows the land use data for the contributing catchments. Table 2-1 shows the functional unit breakdown by subcatchment for the contributing catchments with and without diversions.

Table 2-1 Land Use Areas

	With Diversions		With No Diversions	
Land Use	**Area (km^2)**	**% of Total**	**Area (km^2)**	**% of Total**
Dryland Cropping	0.00	0%	10.03	17%
Forested	6.58	35%	24.09	41%
Grazing	3.88	20%	13.06	22%
Water	0.32	2%	0.32	1%
Mining	8.26	43%	10.72	18%
Urban	0	0%	0.23	0%
Total Area	**19.0**		**58.5**	

2.1.1.3 Climate – Rainfall and Evapotranspiration

Source requires daily rainfall and potential evapotranspiration (PET) data as an input to determine catchment runoff. These datasets were sourced from the Bureau of Meteorology (BoM). Rainfall data were sourced from 4 stations within the area (Blair Athol, Clermont, Hillside, and Araluen). Rainfall for each catchment was determined by using a modified natural neighbour/inverse distance weighting interpolation method.

Total annual rainfall for the Blair Athol rainfall gauge (Station 35010) is presented in Table 2-2. The mean annual rainfall is 635mm. It should be noted these annual rainfall totals represent a hydrologic year beginning on 1 July and ending 30 June. The hydrologic year is defined by the end year of that year. For example, the hydrologic year 1984 began 01/07/1983 and ended 30/06/1984.

PET data obtained were average monthly values and converted to mm/day. These data are presented in Table 2-2.

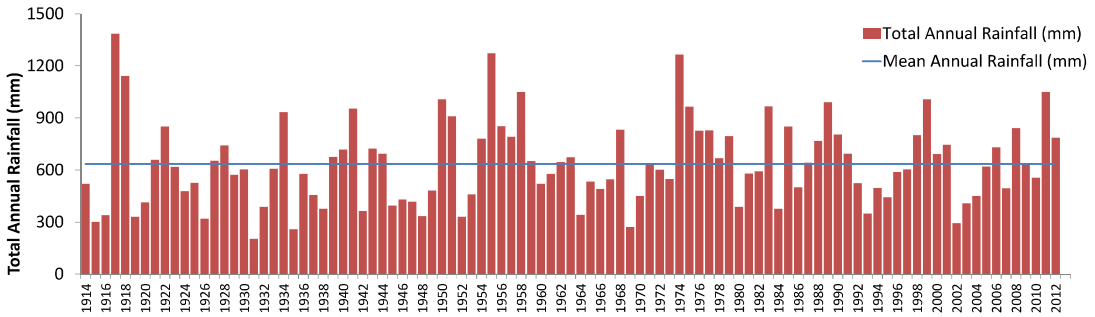
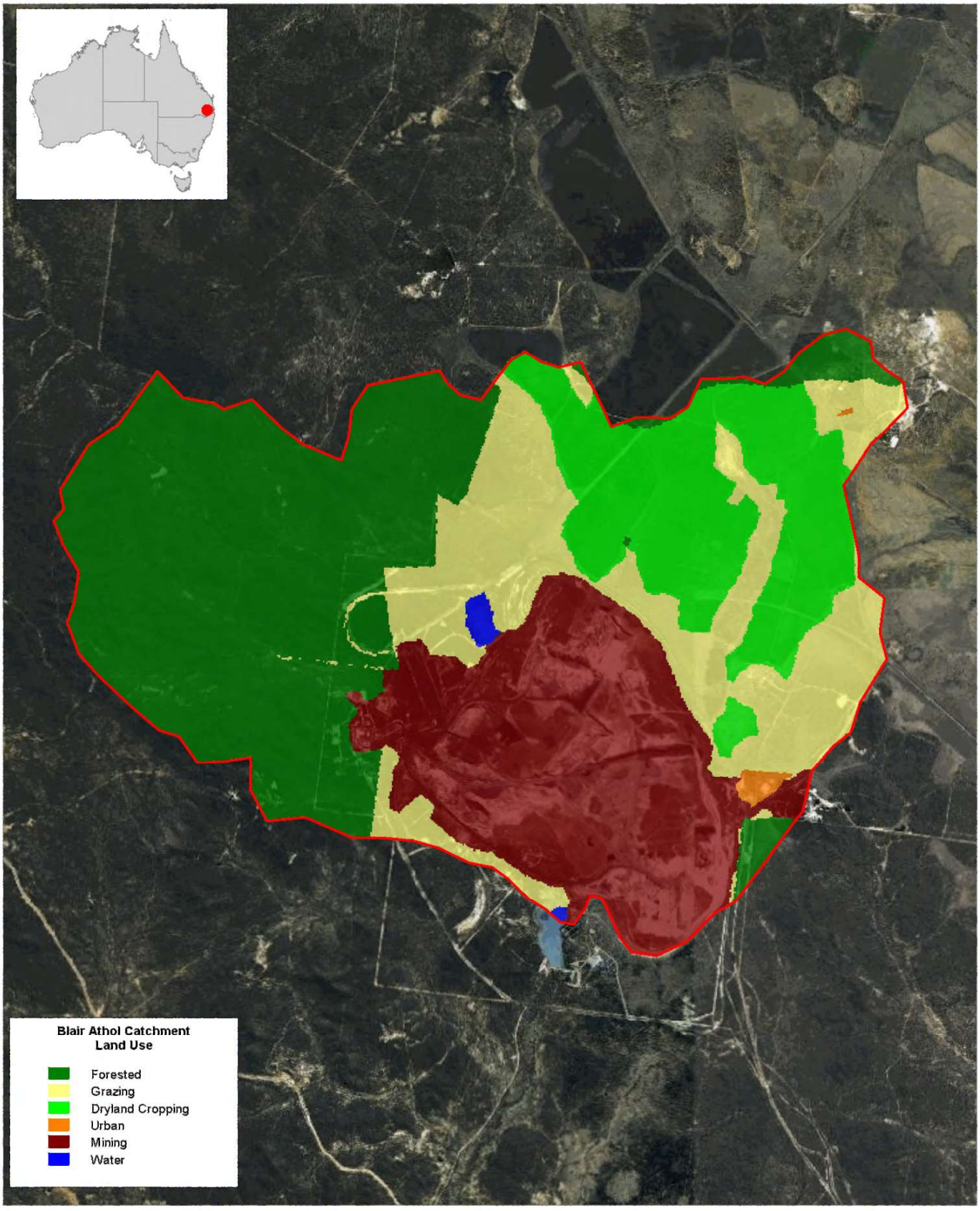


Figure 2-3 Total and Mean Annual Rainfall

Table 2-2 Daily PET Rates

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PET (mm/day)	2.81	2.86	3.13	2.27	2.81	1.73	2.52	2.26	2.17	2.23	1.97	0.87



Title:

Land Usage for Sub-catchments

Figure: 2-4

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 37.5 75m

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B19180_I_GML Blair Athol BAD\DRG\CARE_002_subcatch_no_div.wor

2.1.2 Source Catchments Hydrologic and Water Quality Parameterisation

2.1.2.1 Hydrologic Parameterisation

Ellis *et al* (2009) constructed and calibrated a catchment model of the entire Fitzroy basin using WaterCAST, the predecessor to Source. From this model, hydrologic parameters for characterising catchment runoff were taken. These parameters include storage characteristics and coefficients of proportionality that Source uses to convert the rainfall and PET data into surface water runoff. A summary of the hydrologic parameters used in the Source modelling is presented in Table 2-3.

Table 2-3 Source Hydrologic Parameterisation

Parameter	Dryland Agriculture	Forested	Grazing	Mining	Urban
Baseflow Coefficient	0.27	0.19	0.72	0.25	0.25
Impervious Threshold (mm)	1.5	1.5	1.5	1.5	1.5
Infiltration Coefficient	156	400	251	200	200
Infiltration shape	1.84	0.52	1.11	1.5	1.5
Interflow Coefficient	0.24	0.05	0.07	0.22	0.22
Pervious Fraction	1.00	1.00	1.00	1.00	1.00
Recharge Coefficient	0.11	0.1	0.07	0.11	0.11
Rainfall Interception Storage (mm)	3.01	4.31	3.08	2.93	2.93
Soil Moisture Storage (mm)	117	500	242	187	187

It should be noted that from the catchment modelling, only the components of the climate data that were directly converted to surface water runoff (storm events) were used to force the DYRESM model. Groundwater contributions to total runoff were not included because that was characterised by the groundwater report of JBT Consulting (JBT, 2012). The groundwater components in the Source modelling were important, however, in determining the surface water (storm event) flows.

2.1.2.2 Salinity

Salinity loads were estimated in the modelling using conductivity values observed in regional creeks reported in the Blair Athol Mine Receiving Environment Monitoring Programme (REMP; Rio Tinto 2011). The REMP examined regional water quality observed in two creeks in the region of the mine site, Sandy and Wolfgang Creeks.

Sandy Creek is characterised by forested and mountainous regions while Wolfgang Creek is predominantly grazing and clay cropping soils. The water quality in these creeks was assumed to characterise different land use categories within the Blair Athol catchment (Rio Tinto 2011)

Conductivity values, used as a surrogate for salinity, were different between the two catchments. These values are presented in Table 2-4 along with the land use categories they were applied to in the Source modelling.

Table 2-4 Conductivity Values for Regional Creeks

Catchment	Land Use	Conductivity (µS/cm)
Sandy Creek	Forested, Urban	440.3
Wolfgang Creek	Grazing, Cropping and Mining	1157.4
Catchment	Land Use	Conductivity (µS/cm)

2.2 DYRESM Hydrodynamic Modelling

DYRESM (http://www.cwr.uwa.edu.au/software1/models1.php?mdid=2) is a one-dimensional (laterally averaged) hydrodynamic model developed by the Centre for Water Research at the University of Western Australia. The software is often applied for predicting the vertical distribution of temperature, salinity and density in lakes and reservoirs, including mine pit lakes (Castendyk & Eary, 2009).

The key inputs required by DYRESM are as follows:

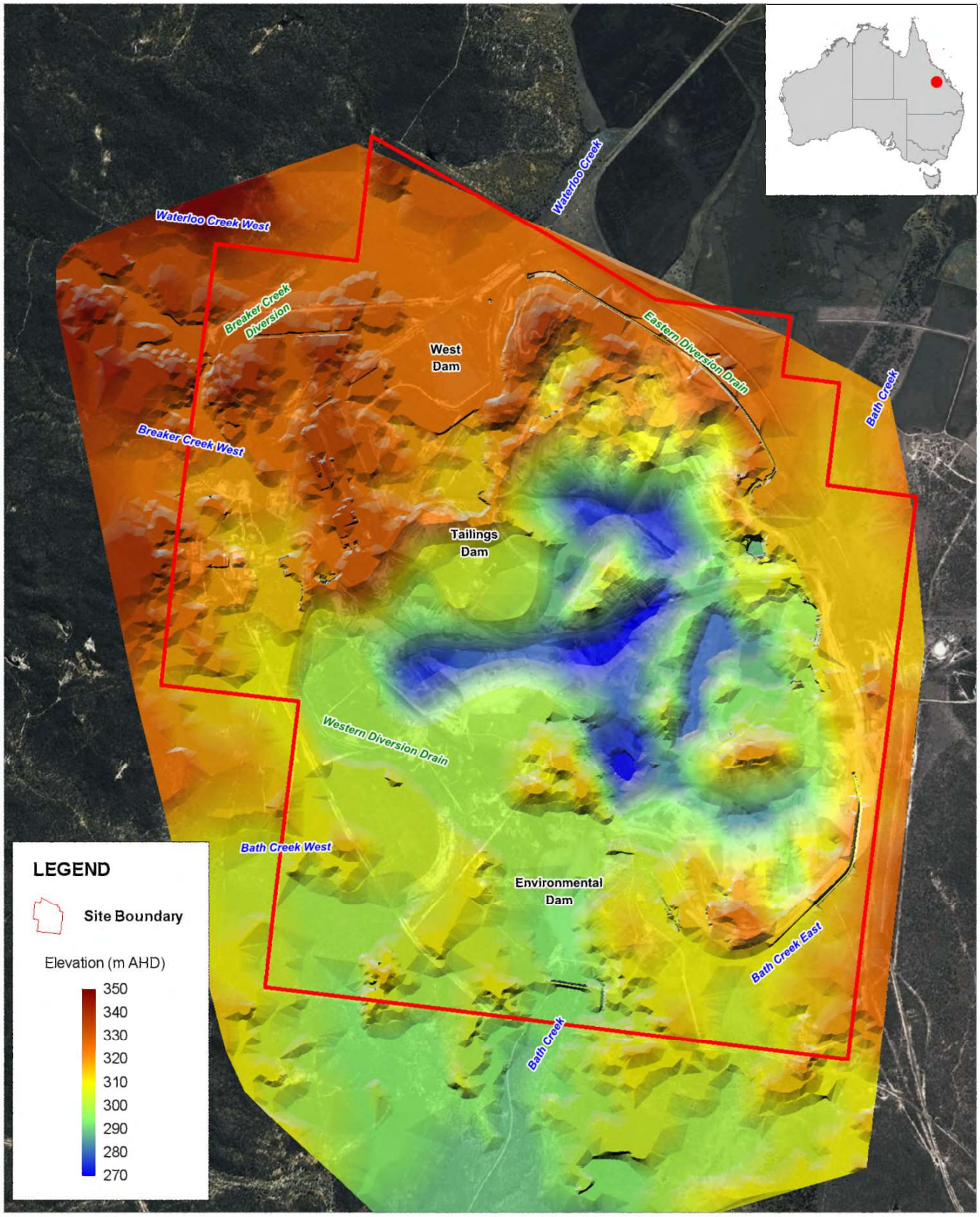
- Lake morphometry, comprising a hypsometric curve (area with height) of the water body;
- Catchment flows, including the salinity and temperature of the flows;
- Groundwater flows, including salinity and temperature; and
- Meteorological data.

More detailed descriptions are provided in the following sub-sections.

Using the above inputs, DYRESM was run for a period of 50 years from 1st July 1961 to 1st July 2011 under both the 'diversions' and 'no diversions' scenarios, with an initial depth of 2m, initial temperature of 25 °C and initial salinity of 5. In addition, a number of runs were completed to examine the sensitivity of the results to some of the assumptions made, including the magnitude of groundwater flow, groundwater salinity, the temperature of inflows and wind speed, which has a strong influence on evaporation. Results for the scenarios and sensitivity runs are presented in Section 3.

2.2.1 DYRESM Structure

A DEM (digital elevation model) of the final landform was provided by RTCA (Figure 2-5), which was discretised into 1m contours to derive an elevation vs area relationship (hypsometric curve). This relationship was used by DYRESM to create an aggregated, one-dimensional representation of the final landform, which is illustrated in Figure 2-6. The resulting pit void is 30 m deep with a crest height at 300 m AHD, and a total volume of 64×10^6 m^3.



Title:

Digital Elevation Model of Proposed Final Landform

Figure: **2-5**

Rev: **A**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 0.5 1km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : I:\drafting\B19180_I_GML Blair Athol BAD\DRG\UW_006_121113_DEM_FinalLandform.wor

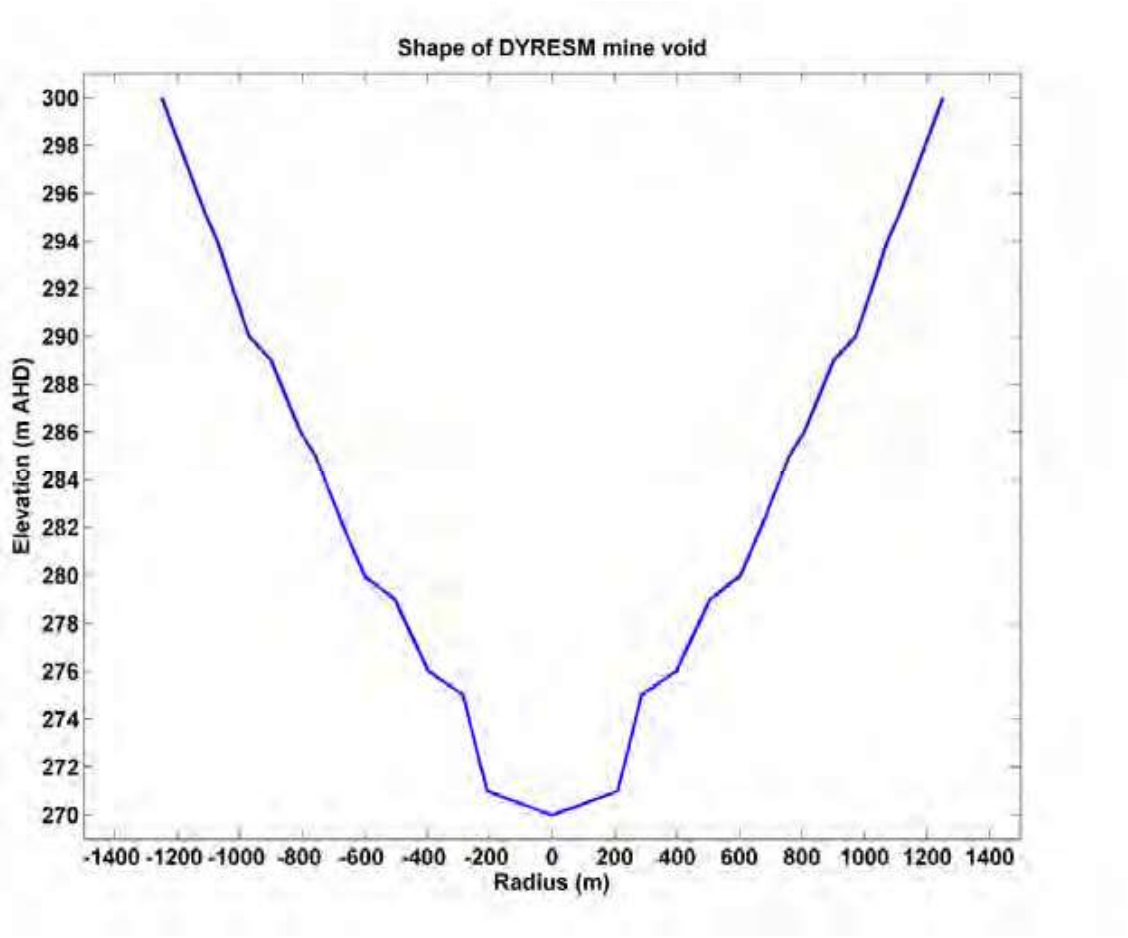


Figure 2-6 Profile of The Mine Void as Simulated By DYRESM

2.2.2 Meteorological Forcing

A number of variables are required by DYRESM, namely:

- Rainfall (m/day);
- Air temperature (°C);
- Wind speed (m/s);
- Solar radiation (W/m^2);
- Vapour pressure (hPa); and
- Cloud cover (decimal fraction).

These data were sourced from the BoM sampling site at Clermont Post Office, which is located approximately 25km from the mine site, and is the closest BoM site that samples each of the required variables. The exceptions are rainfall, which was taken from the interpolated rainfall map derived as input for the catchment model (Section 2.1.1.3), and solar radiation which was taken from a regional monthly climatology provided by BoM (Table 2-5). Vapour pressure was calculated from air temperature and relative humidity using the equation outlined in Tennessee Valley Authority (1972).

Table 2-5 Solar Radiation Climatology Used in DYRESM

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Solar Radiation (W/m^2)	277.8	266.2	243.1	219.9	196.8	162.0	185.2	219.9	254.6	277.8	289.4	289.4

The Clermont PO dataset spanned the period 1/4/1881 to 31/7/2012 but not all the required variables were sampled over this period. After careful analysis of the dataset, it was determined that the period 1/1/1991 to 1/1/2011 provided the most suitable coverage for the required variables and therefore this period was used as meteorological forcing for the entire model run. The twenty year period was repeated to provide full coverage over the simulation for air temperature, wind speed and cloud cover (Figure 2-7). Relative humidity did not have sufficient coverage for an uninterrupted time series spanning this period, so a monthly climatology was derived from the available data instead (Table 2-6).

Table 2-6 Relative Humidity Climatology Used in DYRESM

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Relative Humidity (%)	55.7	59.5	54.1	53.4	53.2	55.1	50.6	46.9	42.7	43.0	47.4	49.8

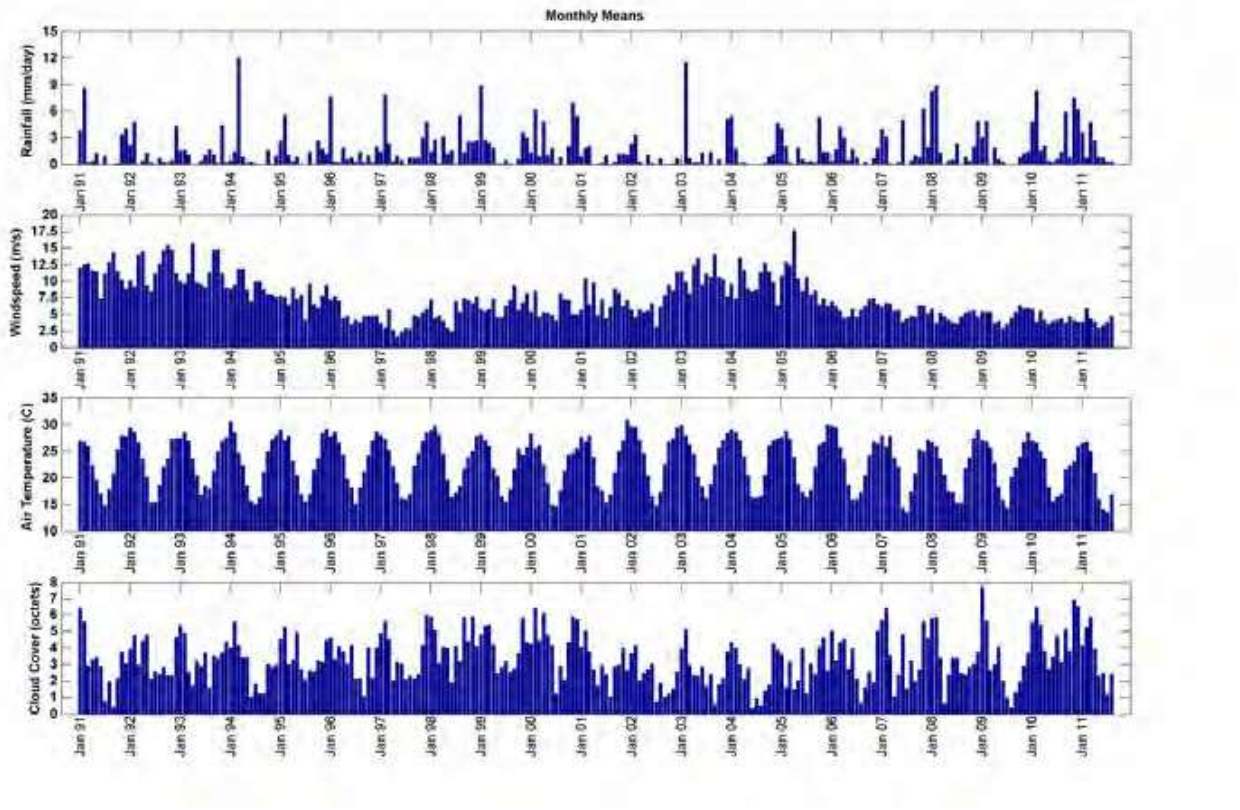


Figure 2-7 Monthly Means of Meteorological Data Used in DYRESM

2.2.3 Groundwater Inflows

Inputs from groundwater were provided by a report by JBT Consulting (JBT, 2012), which determined that the rate of groundwater flow to the final void would be approximately 3-5 L/s. Accordingly, a value of 4 L/s was adopted for the baseline model run, with sensitivity runs conducted to include values of 3 L/s and 5 L/s.

Salinity values were calculated from groundwater measurements of total dissolved solids (TDS) presented in the groundwater report. The mean TDS reported was 2.252 g/L, while the median was 0.6185 g/L, reflective of a wide range of measured values (0 – 101 g/L). A conversion factor of 0.65 was applied to convert TDS values to conductivity values, which was derived from the mean TDS and conductivity values measured as part of the REMP (Rio Tinto, 2011); salinity values were in turn calculated from conductivity using the UNESCO equations (UNESCO, 1983). A value of 1.0 was chosen as the baseline salinity for groundwater, with values of 0.5 and 2.0 applied as part of the sensitivity analysis. Groundwater inflows were assumed to have temperatures matching the surface flows, as no temperature data were included in the groundwater report.

2.2.4 Surface Inflows

Surface flows were taken from the catchment modelling outlined in Section 2.1, with the conductivity values provided by the catchment model converted to salinities using the UNESCO (1983) equation. In the absence of data, surface inflows were given temperatures equal to the ambient air temperature. To test the sensitivity of the model to this assumption, a range of temperatures were applied, the results of which are presented in Section 1.1.1.

3: Results



3 RESULTS

3.1 Catchment Results

The Source model output daily runoff flows and salinity loads to the Blair Athol mine for both the diverted and undiverted scenarios. These were used to force the DYRESM model. Summarised in this section are total annual runoff volumes and salinity loads for the years of record. Total dissolved solids (TDS) were used as a surrogate for conductivity/salinity loads because conductivity (measured in µS/cm) and salinity (measured in psu) cannot be summarised in terms of a load to the river. To derive TDS loads from conductivity, conductivity was multiplied by a conversion ratio of 0.65. This is based on the conductivity and total dissolved solids data presented in the REMP (Rio Tinto 2011).

Table 3-1 presents annual flow and TDS load statistics of the model data for the data shown in Figure 3-1 and Figure 3-2. It should be noted that the hydrologic year used to define these annual flows and loads is the same as that used to define annual rainfall.

Table 3-1 Flow and Total Dissolved Solids Load Statistics

	Annual Flows (ML/yr)		Annual TDS Loads (t/yr)	
Statistic	**With Diversions**	**Without Diversions**	**With Diversions**	**Without Diversions**
Minimum	28.8	88.0	19.7	58.8
25th %-ile	184.5	587.0	129.8	407.1
50th %-ile	449.3	1665.6	319.4	1184.2
75th %-ile	985.1	3335.0	696.2	2342.5
Maximum	4034.2	12655.1	2904.6	9010.4
Mean	699.2	2317.9	496.0	1627.1

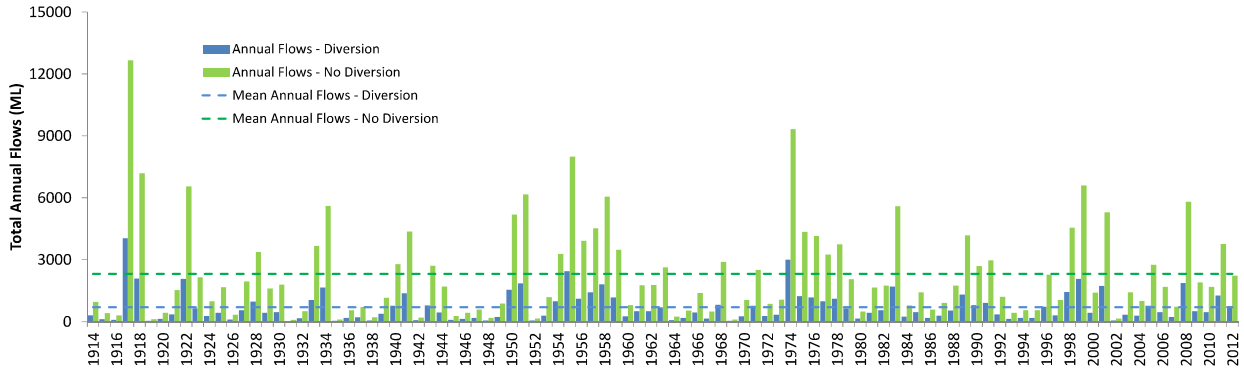


Figure 3-1 Total and Mean Annual Flow Volumes

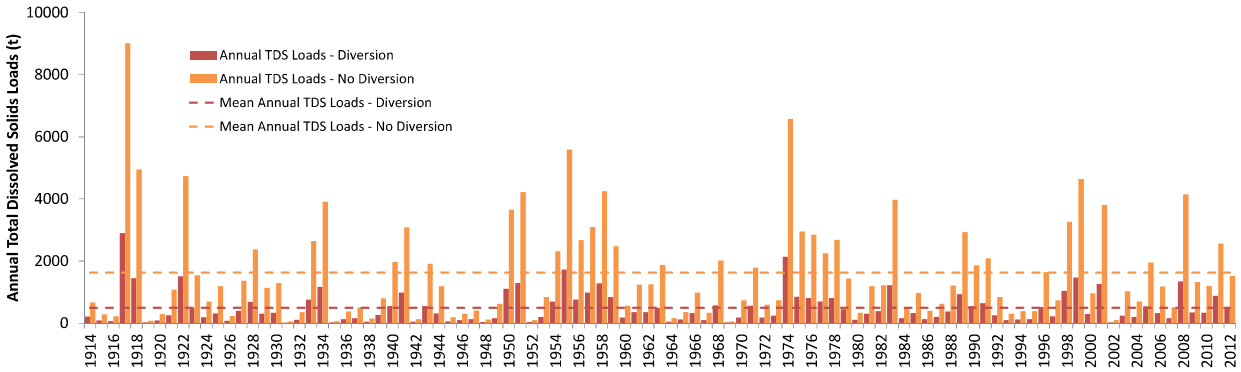


Figure 3-2 Total and Mean Annual Dissolved Solids Loads

The catchment area with the diversion is approximately 33% of the catchment area without the diversion (). This corresponds approximately to the contributions of flows and loads from the diversion and no diversion scenarios (Table 3-1). While the land use changes from the diverted scenario to the undiverted scenarios, the percentage of land use that is characterised as forested is largely the same (35% - diverted; 41% - not diverted), and it is the forested land use that demonstrates significantly different characteristics in terms of soil moisture storage capacity and infiltration coefficients compared to the other land uses (Table 2-3).

Figure 2-3, Figure 3-1 and Figure 3-2 demonstrate the rainfall conversion to runoff in the diversion scenario was very sensitive to the total rainfall, whereas this was not observed in the undiverted scenario. For the diverted scenario, the percentage of rainfall directly converted to runoff ranged from 0.6% in one of the driest year (1969) to 15.3% in the wettest year (1917). Contrastingly, for the undiverted scenario, the percentage for the same years was 5.0% for 1969 and 5.4% for 1917. This suggests that the land use composition of the two scenarios is significant. The percentage area of forested land for the undiverted scenario is only 7% greater than the diverted scenario, however, in both scenarios, the forested land comprises more than 33% of the total area of the catchment. The capacity of forested land to result in infiltration to groundwater and storage of moisture in the soil is much higher than for any of the other land uses

3.2 DYRESM Results

The results of both the 'diversions' and 'no diversions' scenarios, including temperature and salinity profiles and stratification analysis, are presented below. In addition, a summary of the sensitivity analysis conducted is included in Section 3.2.2, with more detailed results presented in Appendix A.

3.2.1 Scenario Results

The temperature and salinity profiles from the 'diversions' and 'no diversions' scenarios are presented in Figure 3-3 and Figure 3-4, respectively. As expected, the 'diversions' scenario results in a more saline and shallower pit lake than the 'no diversions' case.

Under both scenarios, however, the water level does not approach the crest height of the lake at any stage during the 50 year simulation, indicating that the mine void is unlikely to fill and overflow into the downstream environment during typical climatic conditions, although it is possible it may overflow during extremely large rainfall events.

This creates a closed water body, where any groundwater or catchment loads (e.g. salinity, TDS, pollutants) accumulate within the void, and resulting concentrations will steadily increase over time, as is illustrated by the salinity profiles in Figure 3-3 and Figure 3-4.

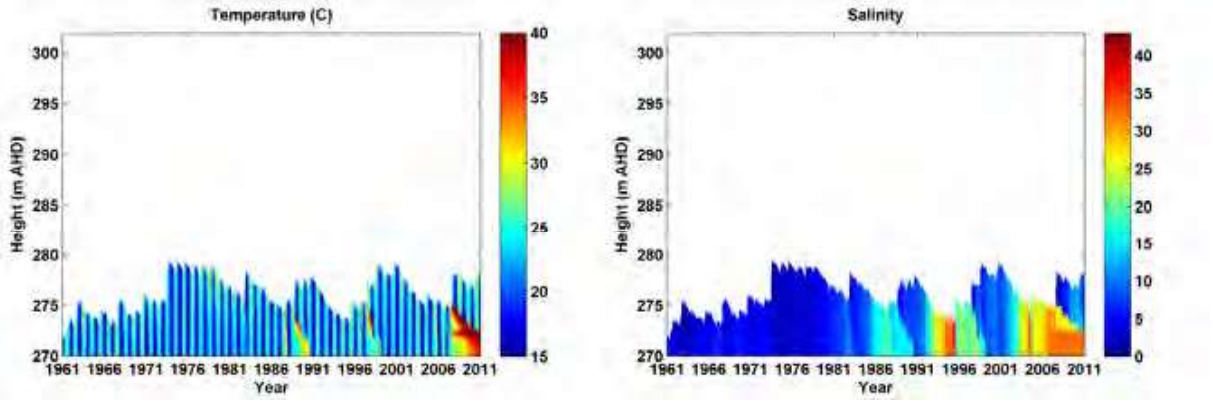


Figure 3-3 Temperature and Salinity Profiles Under The 'diversions' Scenario

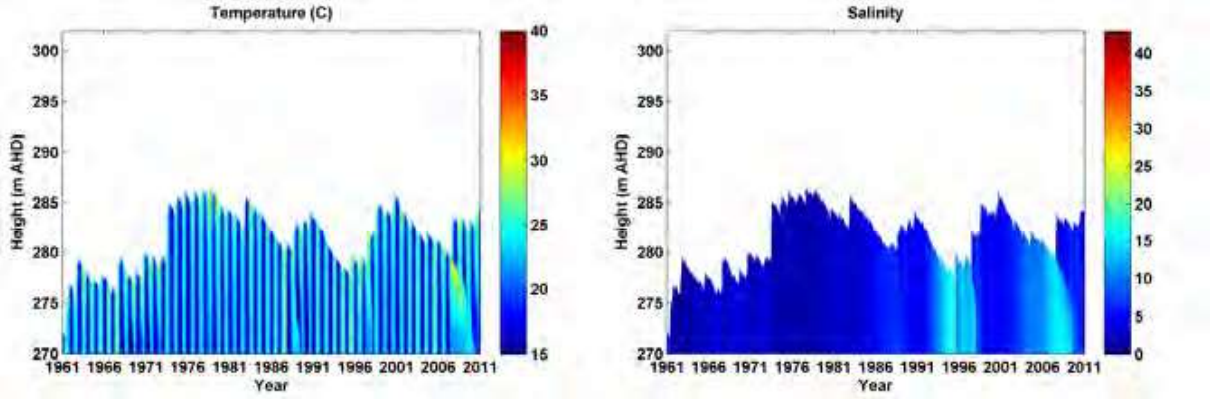


Figure 3-4 Temperature and Salinity Profiles Under the 'no diversions' Scenario

As the lake becomes increasingly saline, the hydrodynamic regime changes. Temperature profiles illustrate that, for the first 25 years of the run, the water body undergoes thermal stratification in the summer, followed by a cooling of the surface layer and an 'overturning' of the water column during winter (Figure 3-5). This dynamic is more pronounced in the 'no diversions' scenario due to the deeper water column allowing for a larger vertical density gradient (Figure 3-6). This seasonal stratification and destratification is expected behaviour for a pit lake of this type, and the temperature distribution is broadly in line with expectations. Later in the simulation, however, as the lake becomes more saline, salinity exerts more of an influence on the density profile and regular seasonal thermal stratification can be interrupted by the creation of haloclines.

Under the 'with diversions' scenario, several dry years in the mid to late 1980's result in a drop in water level and an increase in salinity to approximately 17 (Figure 3-7). Subsequently, a large rainfall event triggers a surface inflow which does not mix fully with the water body; and the freshwater inflow remains above the denser, more saline lake water, creating a halocline. The resulting strong vertical density gradient gradually weakens, but persists until it is finally destroyed in early 1991. Similar events occur in the late 1990's and from the mid 2000's until the end of the simulation. The model predicted that a temperature inversion would occur as the halocline develops (Figure 3-7), trapping

warm water below cooler surface water. While this type of inversion can occur given the competing effects of temperature and salinity on density, it is unlikely to persist for the length of time predicted here. The temperature inversion is probably an artefact of the numerical model in this case, although the development of a halocline has a high probability of occurring as the pit lake becomes more saline.

The 'without diversions' scenario does not exhibit the same frequency of halocline creation, but it does occur in the late 2000's. Under this scenario, the pit lake is still a closed system with no outflows, so it is likely that these events would also become more frequent over time, although over a longer timescale than the 'with diversions' scenario as it experiences a greater volume of freshwater inflow.

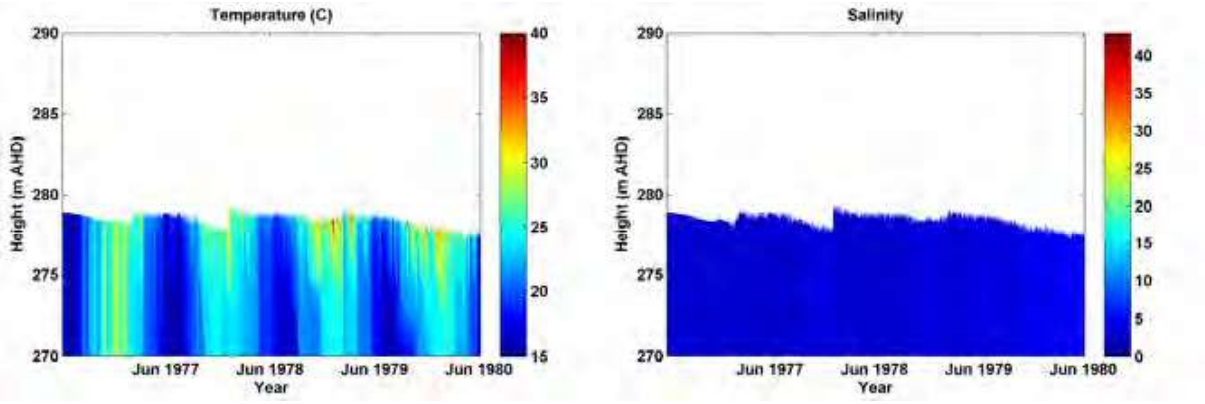


Figure 3-5 Thermal stratification under the 'with diversions' scenario

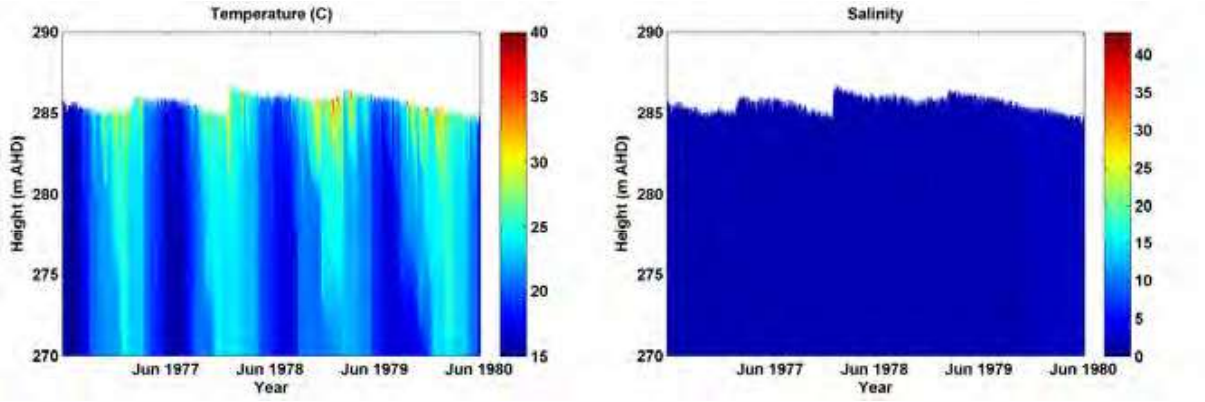


Figure 3-6 Thermal stratification under the 'without diversions' scenario

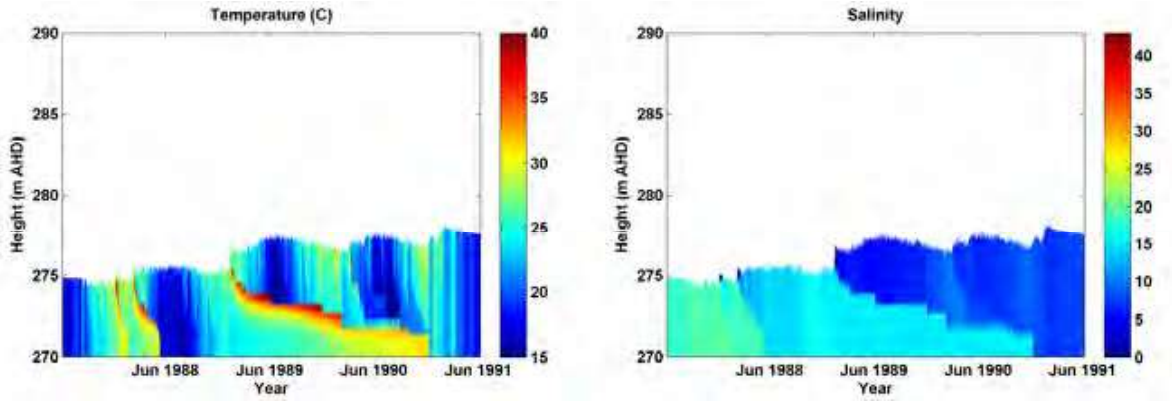


Figure 3-7 Development and destruction of a halocline under the 'diversions' scenario

3.2.2 Sensitivity Analysis

In addition to the two scenario simulations, a further nine runs were conducted to examine the sensitivity of the model to some of the assumed parameters. The nine runs included the following assumptions:

- Groundwater flow set to 3 L/s, the lower end of the provided estimate
- Groundwater flow set to 5 L/s, the upper end of the provided estimate
- Groundwater salinity set to 2.0, double the value used in the scenario runs
- Groundwater salinity set to 0.5; half the value used in the scenario runs
- Temperature of inflows set to 2 degrees below ambient temperature
- Temperature of inflows set to 4 degrees below ambient temperature
- Wind sensor height set to 5 m above lake crest
- Wind sensor height set to 15 m above lake crest
- Wind sensor height set to 20 m above lake crest.

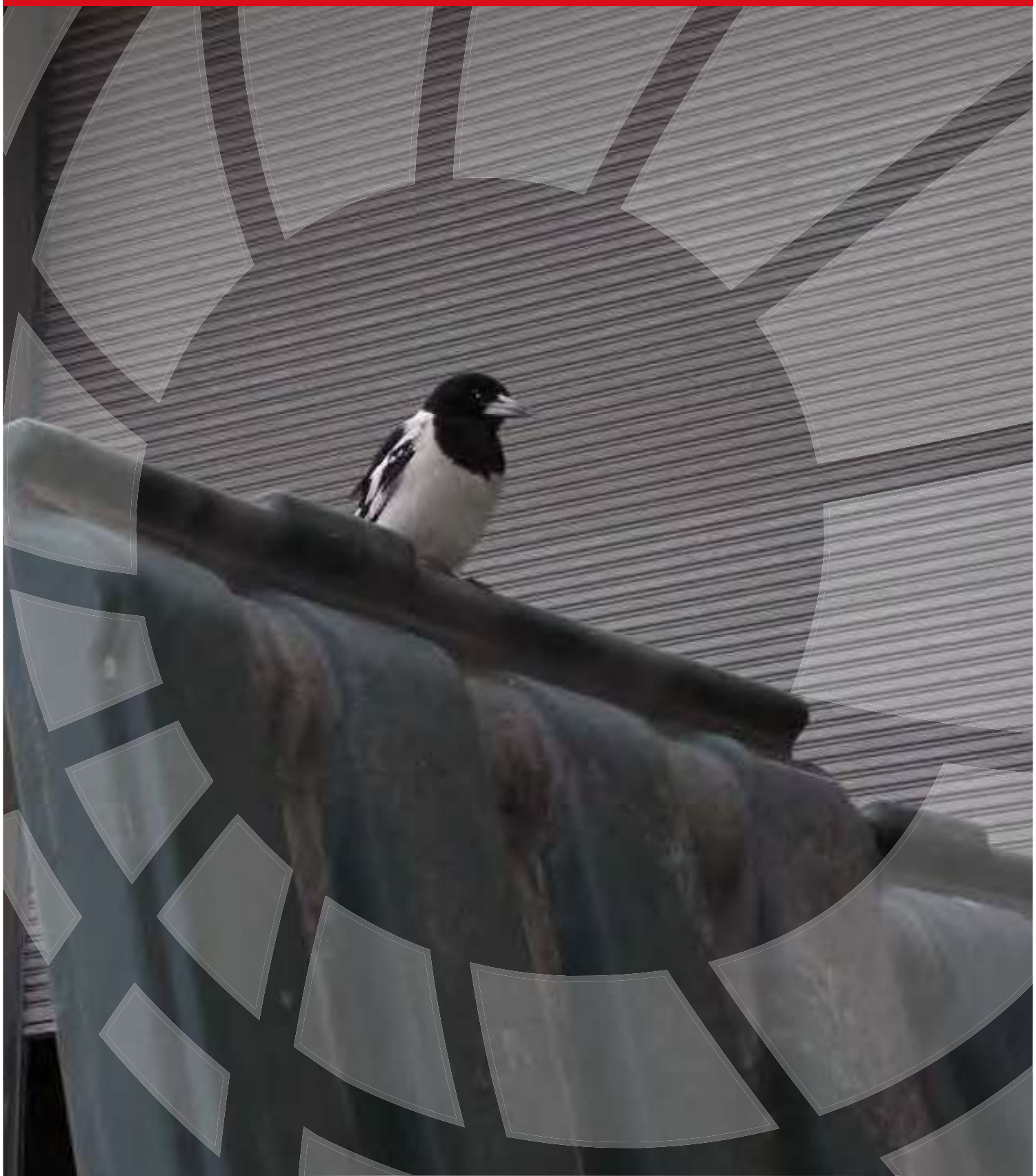
Wind sensor height is an important parameter as it determines the wind stress experienced at the lake surface, with wind stress inversely proportional to sensor height. Evaporative flux is sensitive to wind stress, which is why a sensitivity analysis was conducted on this parameter. It was difficult to determine a reasonable value for this parameter, as the surface of the water body is likely to be sheltered by the pit walls and experience lower wind stress than that measured at the Clermont Post Office sampling site. Nevertheless, the wind sensor height was assumed to be 10 m above the lake crest for the scenario runs, which is the standard measurement height employed by BoM.

The summary results of the sensitivity analysis are as follows, with the associated plots included in Appendix A:

- Groundwater flow:
  - Varying the magnitude of the flow has a minimal impact on the dynamics of the water body. A groundwater flow of 5 L/s results in a higher water level than 3 L/s by a mean of 36 cm over the length of the run. The water body is less saline by a mean of 0.06, and cooler by a mean of 0.1 °C under the higher flow rate.

- Groundwater salinity:
  - Increased groundwater salinity results in a more saline water body, but the general dynamics of the system do not change substantially. Vertical density gradients are slightly stronger but turnover frequency is unaffected. A groundwater salinity of 2.0 results in the water body having mean salinity of 8.9 over the course of the run, while a groundwater salinity of 0.5 results in a fresher water body with mean salinity 5.9. Temperature is also slightly affected with the more saline run warmer by a mean of 0.2 °C.
- Temperature of inflows:
  - The model was relatively insensitive to the temperature of the surface and groundwater inflows. Reducing the temperatures by 4 °C resulted in a mean cooling of the water body of 0.05 °C, indicating that the temperature profile is primarily determined by surface dynamics rather than inflows. The lower inflow temperatures result in a slightly higher water level (2 cm) and salinity (0.6).
- Wind sensor height:
  - Varying the wind sensor height did not have as great an impact as expected. Lowering the wind sensor height from 20 m to 5 m resulted in higher evaporation rates, which resulted in a lower water level within the lake by a mean of 12 cm over the course of the run. Salinity increased by 0.2, while the water body cooled by 0.3 °C. Stratification within the water body was slightly affected, with a strong halocline developing in the mid 1990's during the 50 m sensor height run, which did not develop during the 35 m run. No other stratification features were substantially affected.

4: Conclusions and Recommendations



4 CONCLUSIONS AND RECOMMENDATIONS

The key findings of the modelling study are as follows:

- The lake is unlikely to overflow into the downstream environment, except during very large flood events. This is especially true under the 'with diversions' scenario;
- Groundwater and catchments loads, including pollutants, will accumulate in the pit lake;
- Salinity will steadily increase, leading to the development of persistent haloclines over time;
- The pit lake exhibits seasonal thermal stratification, except during periods where a strong halocline is present, which could result in isolation of the bottom water over extended periods; and
- As the salinity of the pit lake increases, haloclines are likely to become more frequent and have stronger density gradients.

The pit lake is likely to be a self-contained system, with inflows from the upstream catchment and groundwater infiltration, and with evaporative flux as the only loss of volume. If this is the case, the system will become hyper-saline over time, as dissolved solids accumulate within the void, which has implications for long-term water quality at the site. A more saline water-body is likely to develop persistent haloclines and become stratified for periods up to several years, which has implications for long-term water quality at the site.

A closed, stratified system may also result in other undesirable water quality outcomes, such as algal blooms or toxic concentrations of pollutants as they accumulate over time. Determining the likelihood of these outcomes is beyond the scope of this study, but could be examined using a coupled hydrodynamic and water quality model with the ability to simulate the interactions of phytoplankton, nutrients, oxygen and potentially toxic pollutants such as heavy metals. The water-quality module bundled with DYRESM (CAEDYM) is capable of simulating such processes and could be used for such a study, if required.

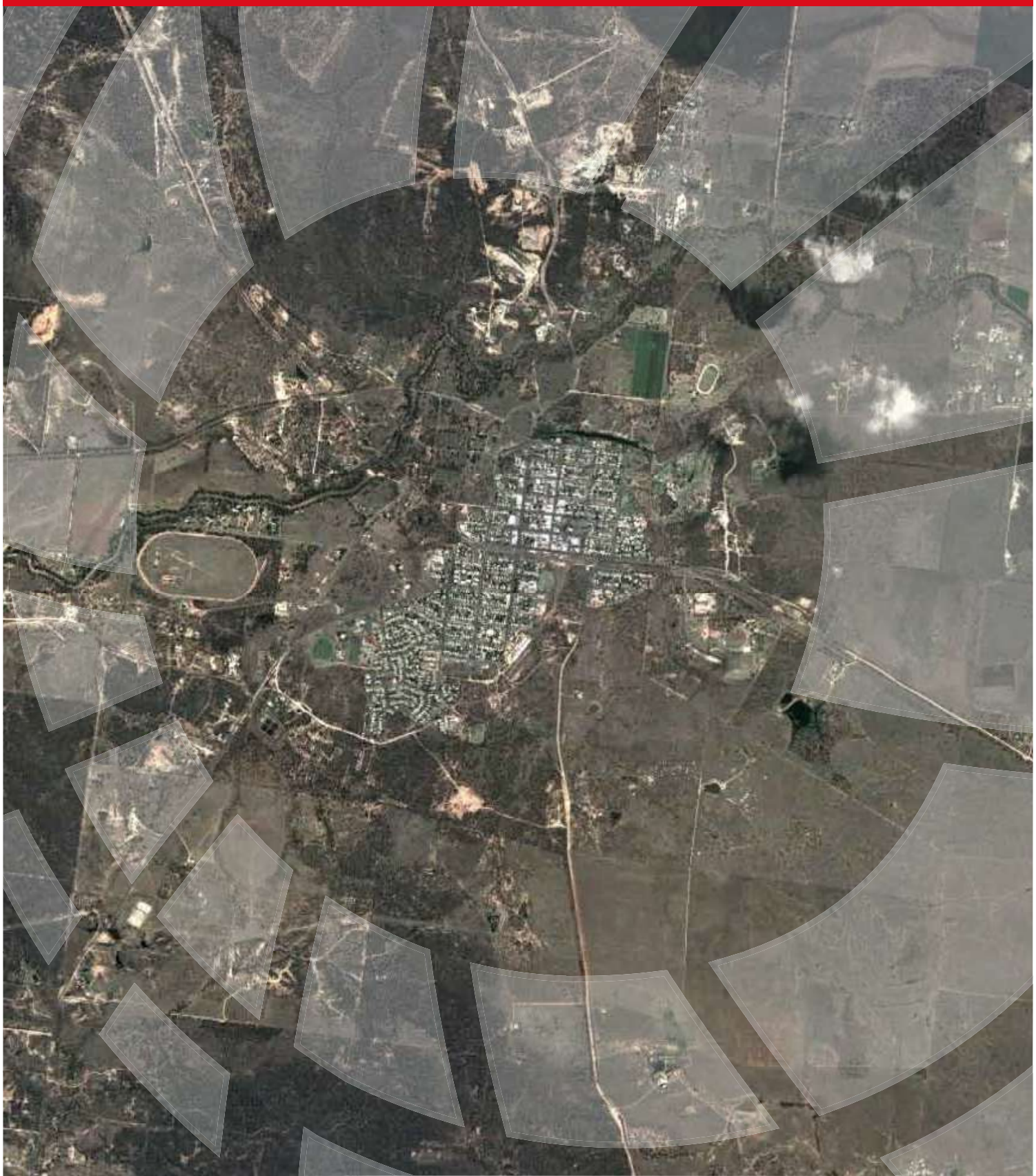
An advantage of a closed system such as this, is that the downstream environment may be relatively unaffected by the closure of the mine, as all flows are contained within the void and do not flow downstream. This assumes that the existing creek diversions are kept in place, which will provide ephemeral flows to the downstream environment. If the diversions are removed, then these flows will likely be contained within the void, removing the flows from regions downstream. Even if the lake does not overflow, the downstream environment may potentially be affected by groundwater interactions that could result in water within the pit lake affecting areas outside the mine site, although the likelihood of this occurring is unknown.

The key recommendations of this study are as follows:

- The existing creek diversions should be kept in place and maintained, to provide environmental flows to the downstream environment;
- A further groundwater study should be performed to determine if water quality within the lake is likely to affect the downstream environment through groundwater interactions; and
- The resulting pit lake is likely to exhibit poor water quality over time, and is unlikely to be suitable for use as a recreational area or for stock watering. If the site is to be opened to the public, then

a further study into the future water quality of the pit lake is recommended to evaluate possible risks to public health.

5: References



5 REFERENCES

Castendyk, D. and Eary, E.,2009. Mine Pit Lakes: Characteristics, Predictive Modeling, and Sustainability (Management Technologies for Metal Mining Influenced Water). ISBN 978-0873353052.

eWater CRC 2010. Source Catchments Scientific Reference Guide. eWater Cooperative Research Centre, Canberra. ISBN 978-1-921543-30-2.

Ellis, R.J., Doherty, J., Searle, R.D. and Moodie, K. 2009. Applying PEST (Parameter ESTimation) to improve parameter estimation and uncertainty analysis in WaterCAST models. 18th World IMACS/MODSIM Congress, Cairns, Australia 13-17 July 2009.

JBT Consulting, 2012. Blair Athol Mine Closure Groundwater Investigation, September 2012.

Rio Tinto 2011. Blair Athol Mine Receiving Environment Monitoring Programme. February 2011.

Tennessee Valley Authority. 1972. Heat and mass transfer between a water surface and the atmosphere. Water Resources Research Laboratory Report 14, Report No. 0-6803.

Appendices



APPENDIX A: SENSITIVITY ANALYSIS FIGURES

Groundwater Analysis

Figures relating to the variation in groundwater flow and salinity.

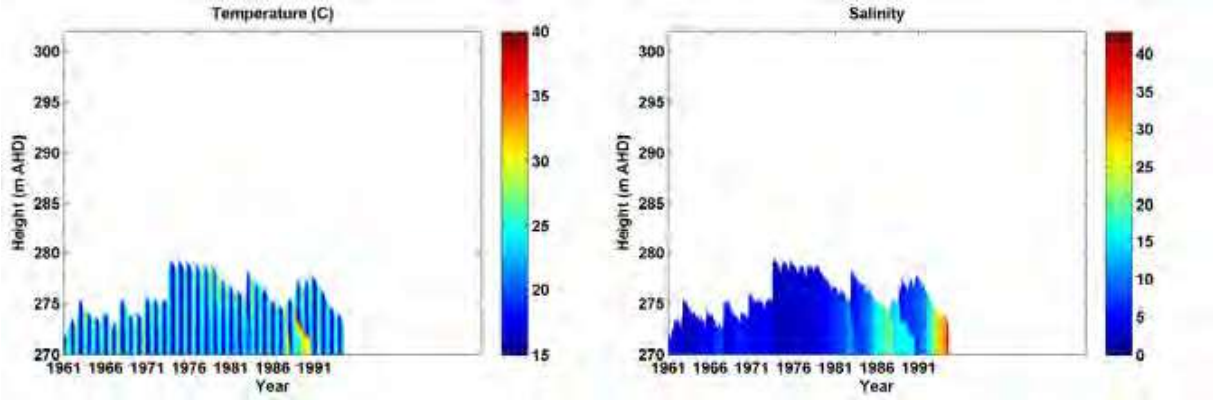


Figure A-1 Groundwater flow set to 3 L/s (the run did not complete as salinity exceeded 42)

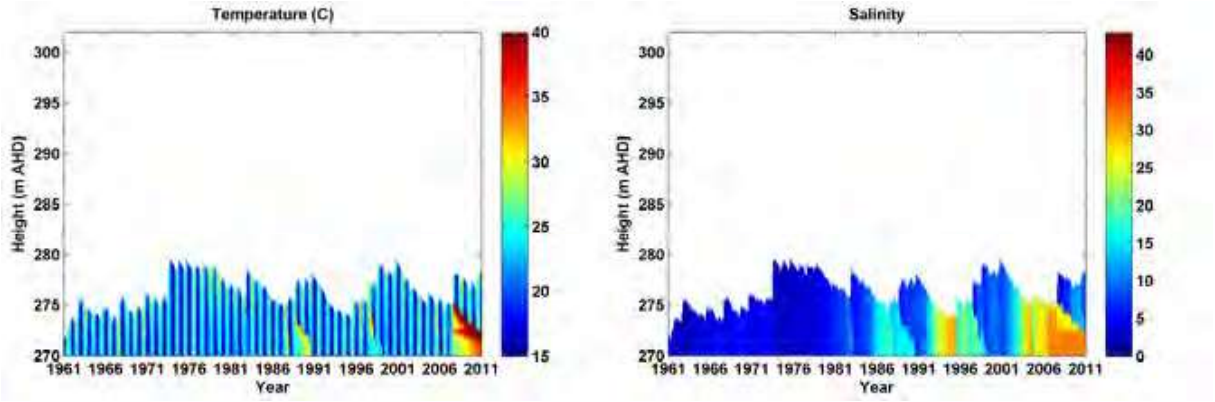


Figure A-2 Groundwater flow set to 5 L/s

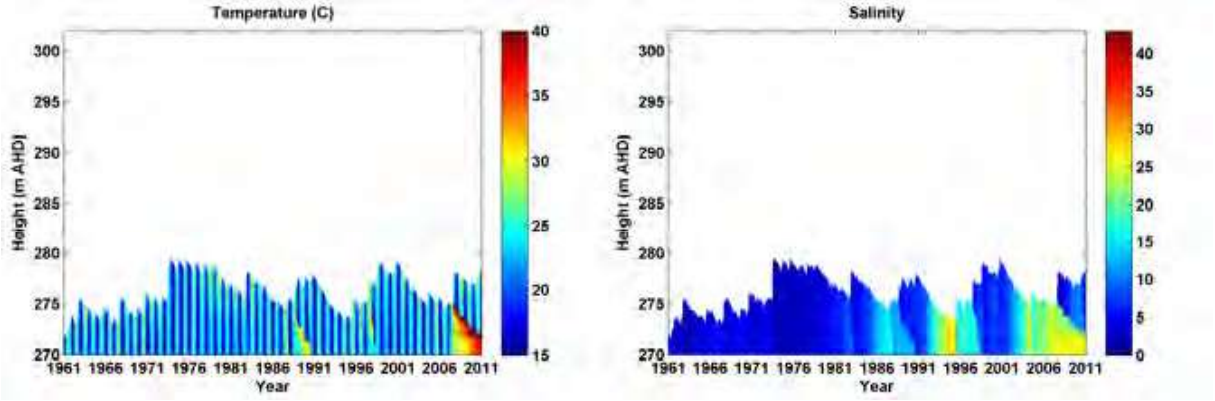


Figure A-3 Groundwater salinity set to 0.5

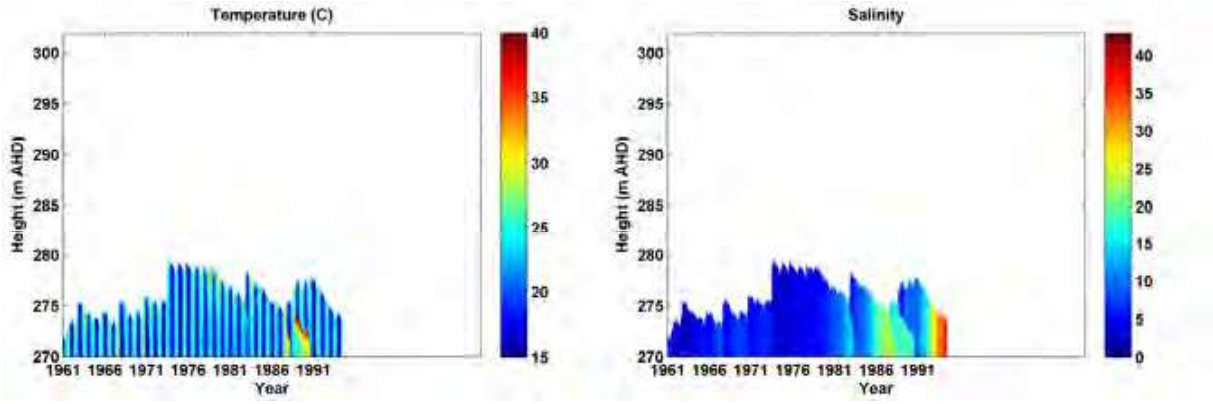


Figure A-4 Groundwater salinity set to 2.0 (the run did not complete as salinity exceeded 42)

Temperature Analysis

Figures relating to the variation in temperature of surface and groundwater inflows.

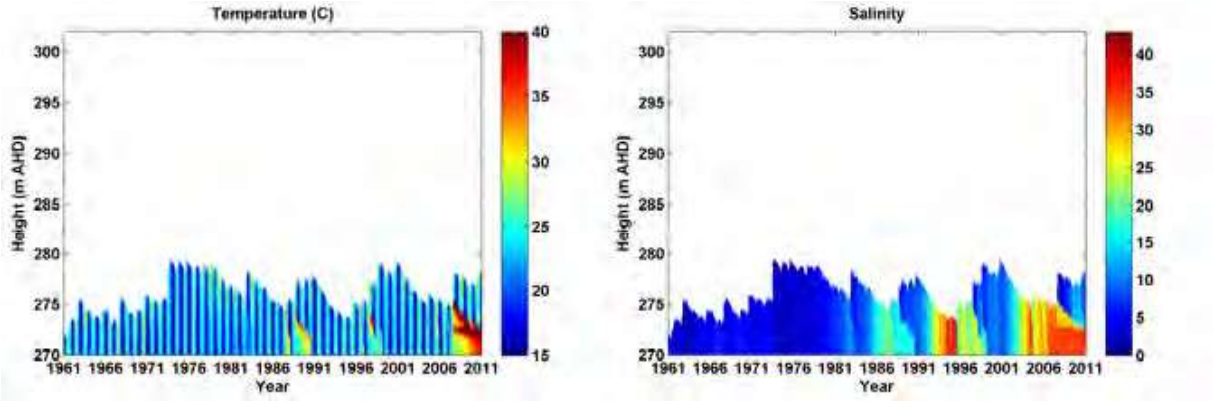


Figure A-5 Inflow temperatures set to 2 °C below ambient air temperature

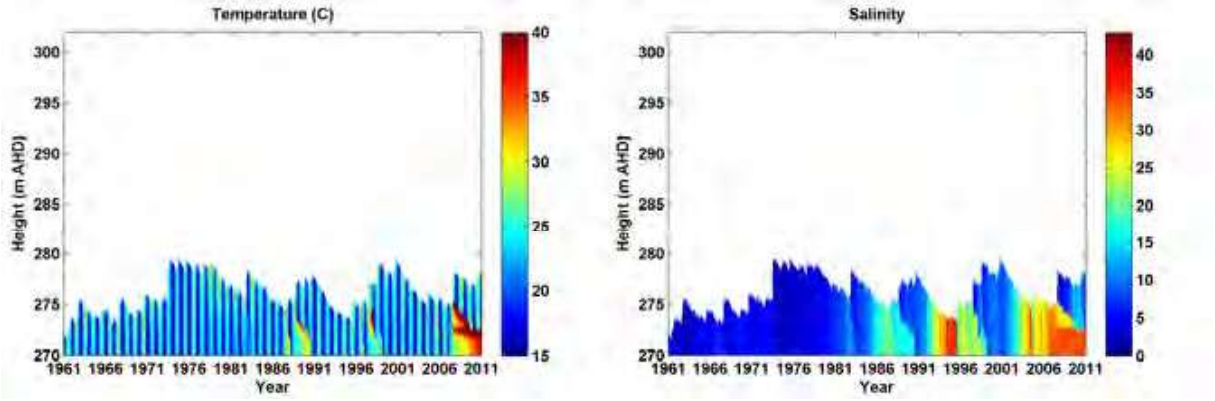


Figure A-6 Inflow temperatures set to 4 °C below ambient air temperature

Wind Sensor Height Analysis

Figures associated with variations in wind sensor height.

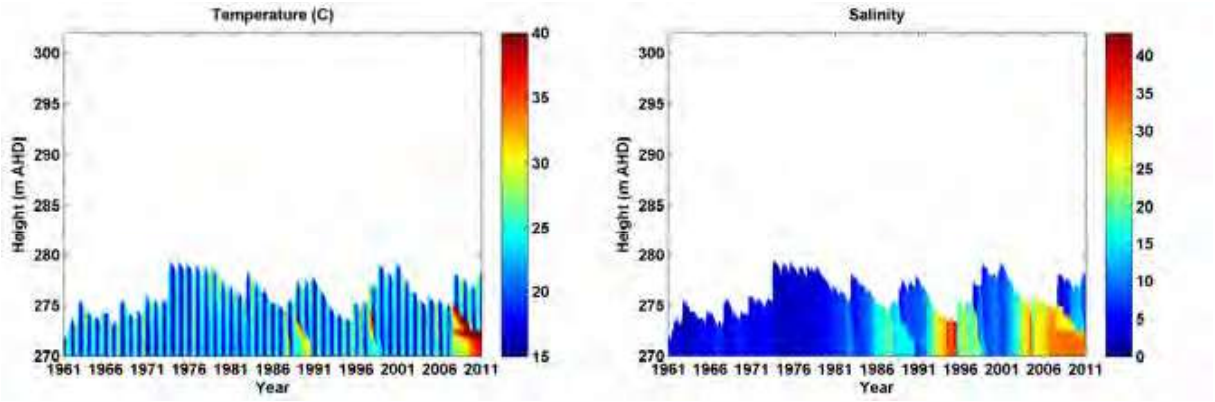


Figure A-7 Wind sensor height set to 5 m above lake crest

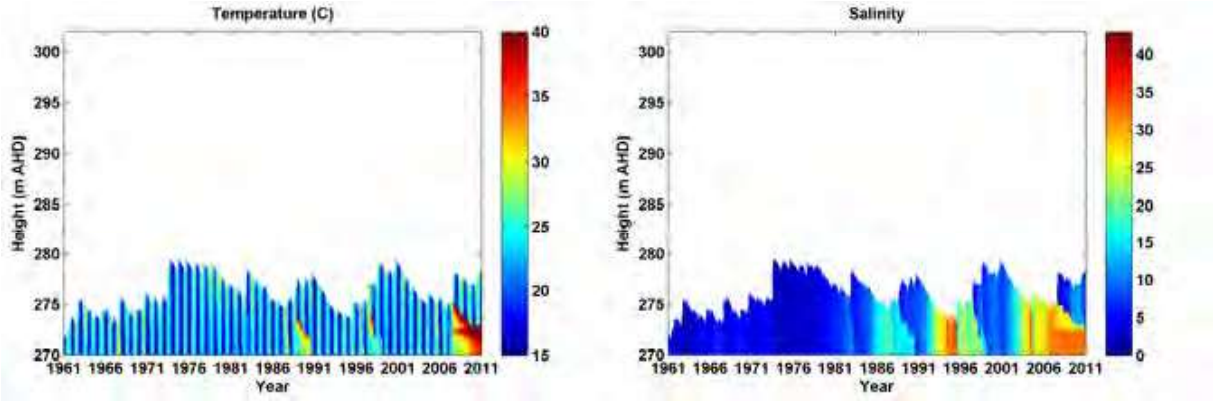


Figure A-8 Wind sensor height set to 15 m above lake crest

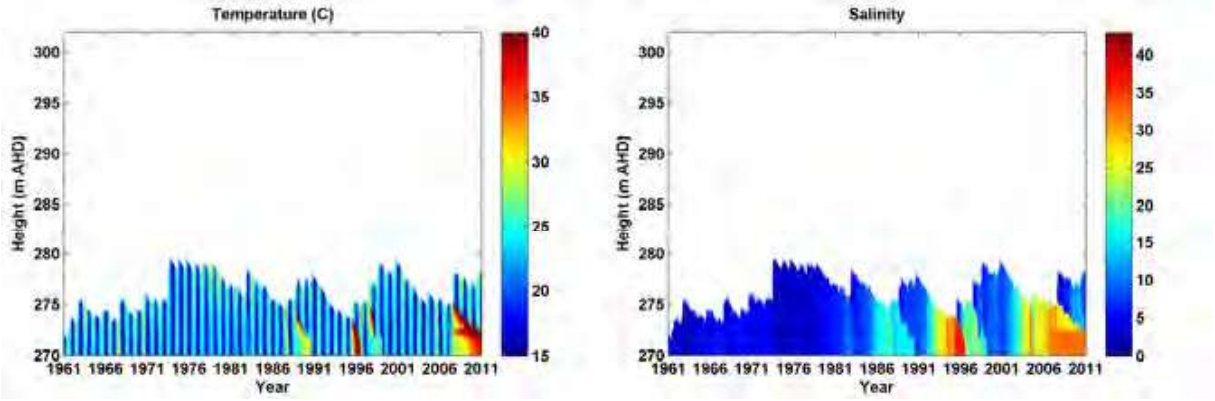


Figure A-9 Wind sensor height set to 20 m above lake crest



BMT WBM Brisbane
Level 8, 200 Creek Street Brisbane 4000
PO Box 203 Spring Hill QLD 4004
Tel +61 7 3831 6744 Fax +61 7 3832 3627
Email bmtwbm@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Denver
8200 S. Akron Street, Unit 120
Centennial Denver Colorado 80112 USA
Tel +1 303 792 9814 Fax +1 303 792 9742
Email denver@bmtwbm.com
Web www.bmtwbm.com.au

BMT WBM Mackay
Suite 1, 138 Wood Street Mackay 4740
PO Box 4447 Mackay QLD 4740
Tel +61 7 4953 5144 Fax +61 7 4953 5132
Email mackay@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Melbourne
Level 5, 99 King Street Melbourne 3000
PO Box 604 Collins Street West VIC 8007
Tel +61 3 8620 6100 Fax +61 3 8620 6105
Email melbourne@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Newcastle
126 Belford Street Broadmeadow 2292
PO Box 266 Broadmeadow NSW 2292
Tel +61 2 4940 8882 Fax +61 2 4940 8887
Email newcastle@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Perth
Suite 3, 1161 Hay Street West Perth 6005
Tel +61 8 9328 2029 Fax +61 8 9484 7588
Email perth@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Sydney
Level 1, 256-258 Norton Street Leichhardt 2040
PO Box 194 Leichhardt NSW 2040
Tel +61 2 9713 4836 Fax +61 2 9713 4890
Email sydney@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Vancouver
401 611 Alexander Street Vancouver
British Columbia V6A 1E1 Canada
Tel +1 604 683 5777 Fax +1 604 608 3232
Email vancouver@bmtwbm.com
Web www.bmtwbm.com.au

Blair Athol Coal Mine – Environmental Management System

TerraCom

APPENDIX E — GEOTECHNICAL STUDIES



Rio Tinto Coal Australia Pty Limited
123 Albert Street
Brisbane Queensland 4000
Australia
T +61 (0) 7 3625 3000
F +61 (0) 7 3625 3001

Blair Athol Mine

Ramp 1 South West Contingency 4 (R1SWC4)

Geotechnical Review

From	Alex Hossack – Acting Principal Geotechnical Engineer
Department	Resource Assessment
To	Rishi Verma – Manager Technical Services Stephen Ramage – Superintendent Short Term Mine Planning Rachel Arnold – Superintendent Geology Adam McDonald – Senior Mining Engineer Scheduling Vrotnesky Cediel – Senior Mining Engineer Andrew Rathbone – Mine Planner John Williams – Dragline Engineer Nathan Niaga – Geotechnical Engineer
CC	Sabine Stam – Senior Geotechnical Engineer Ken Preston – Manager Resource Assessment
Reference	NA
Date	20/02/12
Number of pages	11

Introduction

During mining of Strip 1 in Ramp 1 South West Contingency 3 (R1SWC3) at Blair Athol Mine (BA) on the 10/01/12, cracking was observed near the base of the lowwall approximately North East of where the dragline was operating. This cracking extended rapidly and sometime between the 10/01/12 and 11/01/12 a significant lowwall failure occurred.

Geotechnical modelling and subsequent back analysis of the R1SWC3 lowwall failure has determined that conditions leading to slope failure were a combination of:

1) Poor quality spoil material.
2) An aggressive lowwall design (lowwall height >60m in some places).
3) An increased phreatic surface due to a rainfall event that occurred on the 10/01/12.

Due to this failure, it has been requested by the Senior Mining Engineer of Clermont Region that a geotechnical review of the proposed lowwall design for R1SWC4 strip be completed in order to determine suitable mining recommendations and reduce the likelihood of further lowwall failures in this area.

This report forms part of a larger investigation which is composed of four elements:

1) Back analysis of the R1SWC3 lowwall failure.
2) Mining recommendations to reduce the likelihood of further lowwall instability during coaling operations.
3) Determine if recovery of the coal from underneath the toe of the lowwall failure is feasible and discuss mining recommendations.
4) Determine suitable lowwall design parameters for future strips.

This report will cover Part 4 while a separate report discussing the results of Parts 1 and 2 has already been issued.

Figure 1 below is a plan showing R1SWC3 and R1SWC4 while Figure 2 shows the BO5 cross section.

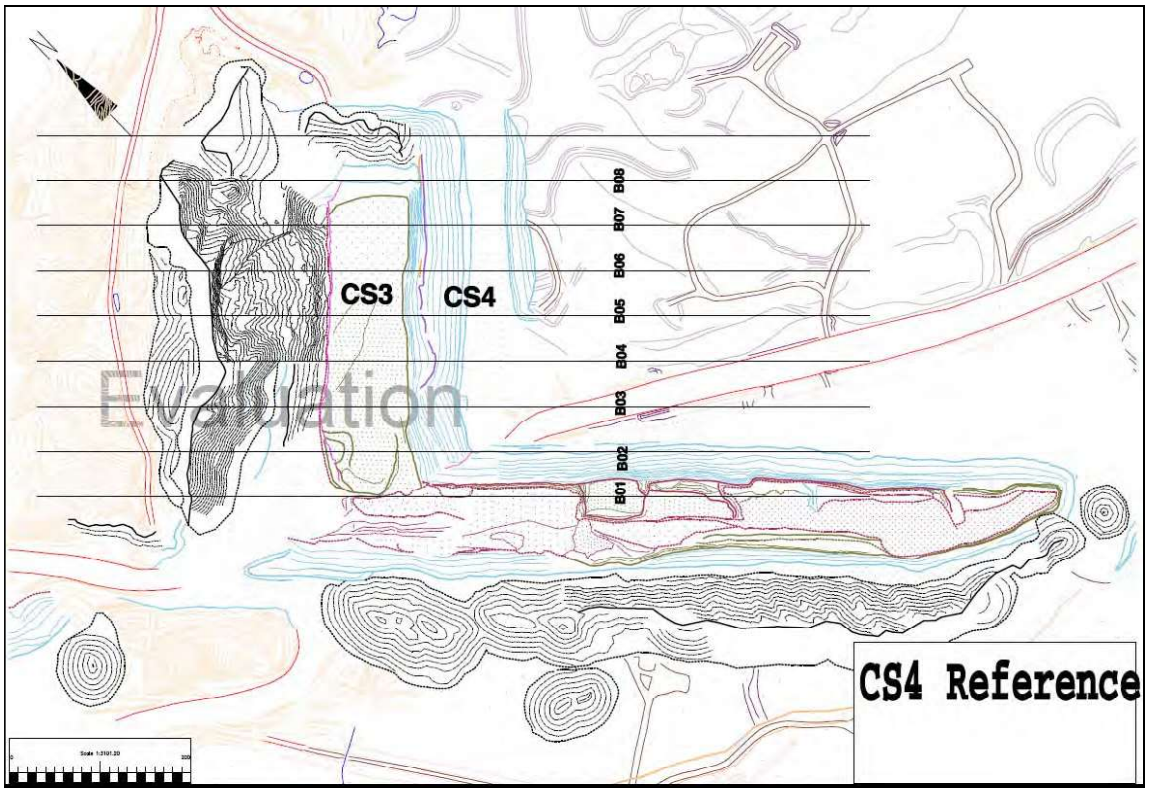


Figure 1 Plan of R1SWC3 and R1SWC4

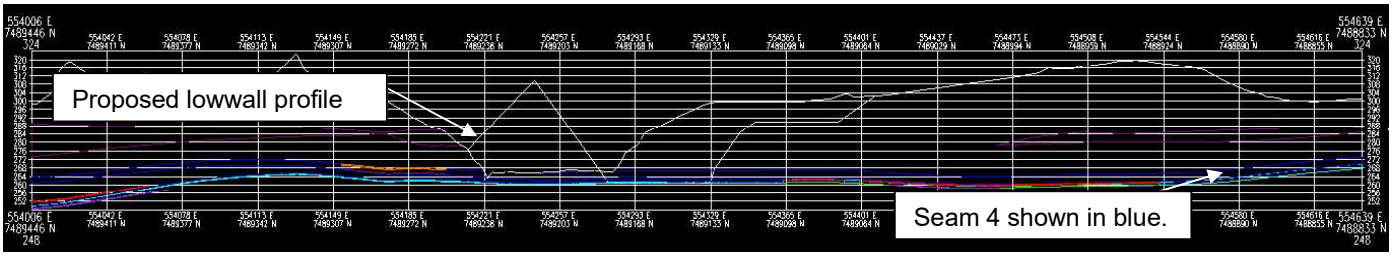


Figure 2 Cross Section BO5

R1SWC4 Conditions

The lowwall of R1SWC4 is likely to consist of weathered material. Groundwater is likely to percolate through the spoil and conditions are predicted to be similar to those experienced during mining of R1SWC3.

The base of the Lower Seam 4 is assumed to be composed of fresh Permian siltstone that is relatively hard. This assumption is aligned with observations made in R1SWC3 pit and R1SW Strip 1 pit. The floor dips towards the endwall of R1SWC4 and ranges between 0 and 2 degrees away from the lowwall.

The highwall is likely to be characterised by moderate to highly weathered sandstone. The highwall in R1SWC3 has performed relatively well and it is predicted that the proposed highwall design in R1SWC4 will perform similarly.

R1SWC4 Geotechnical Risk Assessment

A risk assessment checklist was completed for the proposed highwall and lowwall designs in R1SWC4. The following high risks were identified with the proposed highwall and lowwall designs in R1SWC4:

- The dragline bench width is <5m.
- The material type in the passive block of the lowwall is likely to be composed of fine grained, low plasticity material with some framework. Using the Simmons and McManus system this type of spoil can be defined as a category 2.
- A lowwall failure has occurred in the previous strip.

Moderate risks include:

- Overall lowwall slope height is between 50m and 60m in some places.
- Overall lowwall slope angle is between 35 and 40 degrees.
- The material type in the active block of the lowwall is likely to be composed of fine grained, low plasticity material with no to some framework. Using the Simmons and McManus system this type of spoil can be defined as a category 2.

Refer to Appendix 1 of this report for the complete geotechnical risk assessment checklists.

Lowwall Stability Assessment

A slope model was developed and assessed using the slope stability assessment software Galena looking at stability of the lowwall under the following conditions:

- Slope geometry was as presented in R1SWC4 design strings provided by BA Mine Planning personnel.
- Spoil types consistent with those assumed for R1SWC4, that being; category 2 unsaturated spoil on top of category 2 saturated spoil.
- Lowwall floor conditions consistent with fresh Permian sequences common in the area and as determined from observations in R1SWC3.
- A ‘normal’ phreatic surface condition as defined below:
    - Water level approximately 5m above the floor of the lowwall and tapering towards the toe of the lowwall.
- A large scale, bi-wedge failure mechanism.

The Sarma method as implemented in the Galena stability analysis code was used during the stability analysis as well as the shear strength parameters in Table 1. Material shear strengths were adopted based on the known or derived properties of the exposed geology observed in the excavation during the inspection conducted on the 18/01/12.

Table 1 Material Shear Strength Parameters

Material	C’(kPa)	ϕ’(°)	γ(kN/m^3)
Tertiary Material	52	30	20
Category 2 Spoil – Unsaturated	30	28	18
Category 2 Spoil – Saturated	15	23	20
Fresh Coal	30	35	15
Fresh Permian	100	45	22

Results of the assessment are presented in Table 2 and Appendix 2.

Table 2 Analysis of R1SW Failure

Description	Factor of Safety (FoS)
At the end of dragline pad removal.	1.23

The FoS in Table 2 above indicates that large scale, bi – wedge type failure is unlikely and that currently the proposed lowwall for R1SWC4 meets criteria specified in the Clermont Region SDMP relating to lowwall design.

Highwall Stability Assessment

Historically, instances of highwall instability at Blair Athol (and other Rio Tinto coal mines) are dominated by either:

- Failure within over-steepened weak material, namely spoil or weathered rock due to the rockmass strength being inadequate to support the proposed slope profile, or
- Defect driven kinematic failure of more competent rock due to the interaction and orientation of rock defects (joints, faults, shears and bedding) with respect to the wall angle and orientation. Adversely orientated defects can result in planar, toppling or wedge type failures.

Both of these mechanisms are assessed below using borehole data obtained from the original Ramp 1 design report written by the RTCA Principal Geotechnical Engineer at the time (Glen Guy).

Global Stability

Global slope stability, which involves whole slope failure, is more common in weaker low strength material. Weaker overburden is typically associated with the edge of a basin where weathering profiles are close to or intercept the coal seam. This is seen in R1 SWC3 strip and should be expected for the R1SWC4 strip where overburden comprises weathered and weak coal measure material. However, given R1SWC3 highwall performed relatively well during mining, showing no signs of large scale instability, it is predicted that the highwall of R1SWC4 will also perform relatively well.

Kinematic Analysis

A kinematic analysis was undertaken on defect data that was derived from downhole acoustic scanner results from four cored holes in the Ramp 1 area.

The defect data was plotted on equal area, lower hemisphere stereonets in an attempt to determine the likelihood of planar, toppling and wedge type failure from the in-situ sections of the highwall. Refer to Table 3 below for the orientations of major and minor defect sets:

Table 3 R1SWC4 Defect Orientations

Set No.	Mean Dip (°)	Mean Dip Direction (°)	Comments
Joint Set 1 (J1)	78	313	Major
Joint Set 2 (J2)	67	218	Minor
Joint Set 3 may be associated with J1 (J3)	83	133	Minor
Joint Set 3 (J3)	77	109	Minor
Joint Set 4 (J4)	77	265	Minor
Bedding	10	026	Major

Stereographs used for analysis are presented in Appendix 3 of this report. A 75 degree pre-split wall at the orientation indicated on the strip and block plans for R1SWC4 was used for the analysis.

Results indicate that:

- There is a low risk of planar sliding type failure.
- There is a low risk of toppling type failure.
- There is a low risk of wedge failure.

Buffer Blasting Techniques

A request has been made by the Superintendent Geology and the Senior Mining Engineer at Clermont Region Operations to assess the feasibility of using buffer blast techniques for R1SWC4 highwall excavation.

It has been predicted that the use of buffer blast techniques for the excavation of R1SWC4 highwall will improve productivity during the final dragline pass by reducing:

- Time taken to pull the coal edge.
- Amount of dozing time due to hard bands of material at the toe.
- Dragline downtime for maintenance.

From a geotechnical point of view; buffer blast techniques have been successfully used at other Rio Tinto coal mines such as Bengalla (BMC), Hunter Valley Operations (HVO) and Hail Creek (HCK) to reduce the likelihood of kinematic failure. Risks associated with a buffer shot wall include but are not limited to:

- Over steepening of faces during excavation creating/increasing the risk of rock roll.
- Formation of large tension cracks at the power trough boundary which may restrict access.
- Material at toe of blast not pulling adequately causing operational delays.

The risks detailed above have been managed successfully at HCK, HVO and BMC via normal operating processes and procedures.

Given the information above, it is recommended that buffer blast techniques be used in R1SWC4 and if successful these techniques should be implemented in future strips. Refer to Figures 3 and 4 below for two buffer blast wall designs that could be implemented.

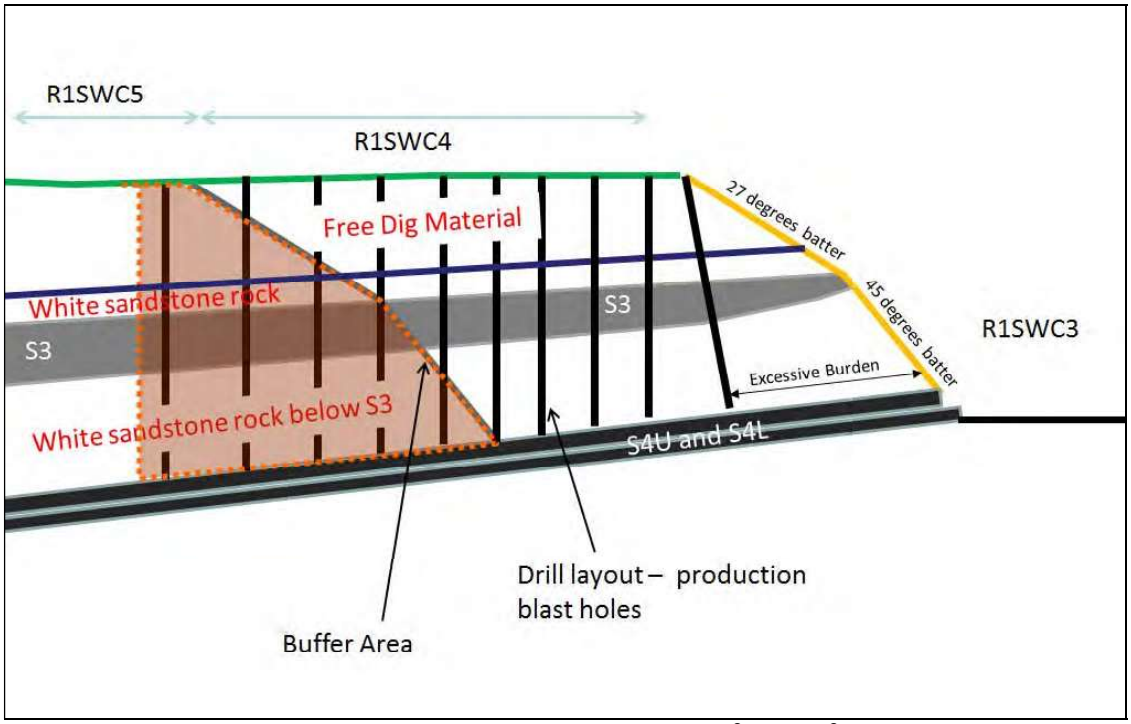


Figure 3 R1SWC4 Buffer Shot Highwall with 45° and 27° Batters

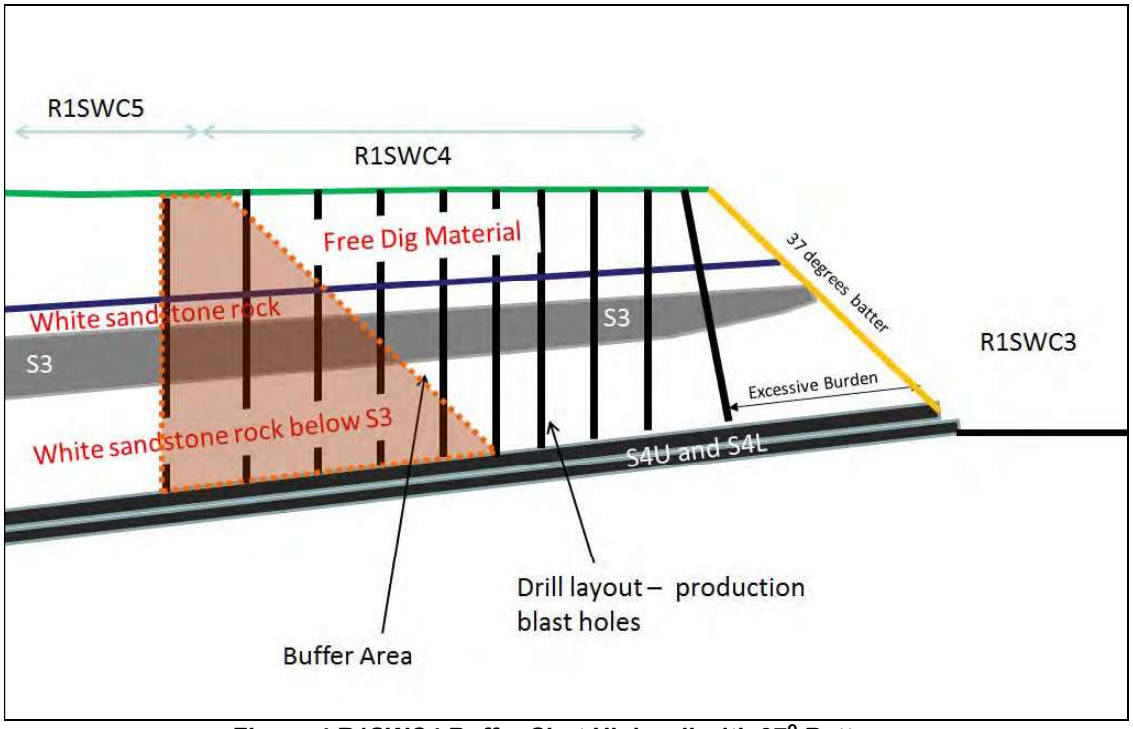


Figure 4 R1SWC4 Buffer Shot Highwall with 37° Batter

Conclusions

The following conclusions have been made:

- The proposed lowwall design in R1SWC4 has a dragline bench width <5m which increases the risk of rock roll to operators and equipment working in the strip.
- Slope stability analyses results indicate a low likelihood of large scale lowwall instability during mining of R1SWC4.
- Given R1SWC3 highwall performed relatively well during mining, it is predicted that the highwall of R1SWC4 will also perform relatively well as conditions are similar.
- Kinematic analyses results indicate:
  - There is a low risk of planar sliding type failure from the high wall of R1SWC4.
  - There is a low risk of toppling type failure from the high wall of R1SWC4.
  - There is a low risk of wedge failure occurring from the high wall of R1SW4.

Recommendations

It is recommended that:

- The lowwall in R1SWC4 should be designed with a remnant dragline pad at least 5m in width.
- Given the risks associated with buffer blast techniques have been managed successfully at other RTCA operations, it is recommended that this technique be used for R1SWC4 highwall and if successful should be implemented in future strips.

- The maximum allowable height of an unbenched buffer shot wall should not exceed 30m.

- Water should not be allowed to pool in the strip at any time, especially at the toe of the lowwall.

- Regular inspections should continue to occur by the Operations and Technical Services teams to ensure that the proposed design is being met, major assumptions are confirmed and possible deterioration of the lowwall or highwall does not go unnoticed, especially during and/or after rainfall events. Major assumptions to confirm include:
    - Presence or absence of weak layers at the base of coal seams.
    - Presence of groundwater with the lowwall and highwall.

If you have any further questions regarding this issue or would like clarification on any of the above don't hesitate to contact the undersigned:

Yours faithfully,



_____

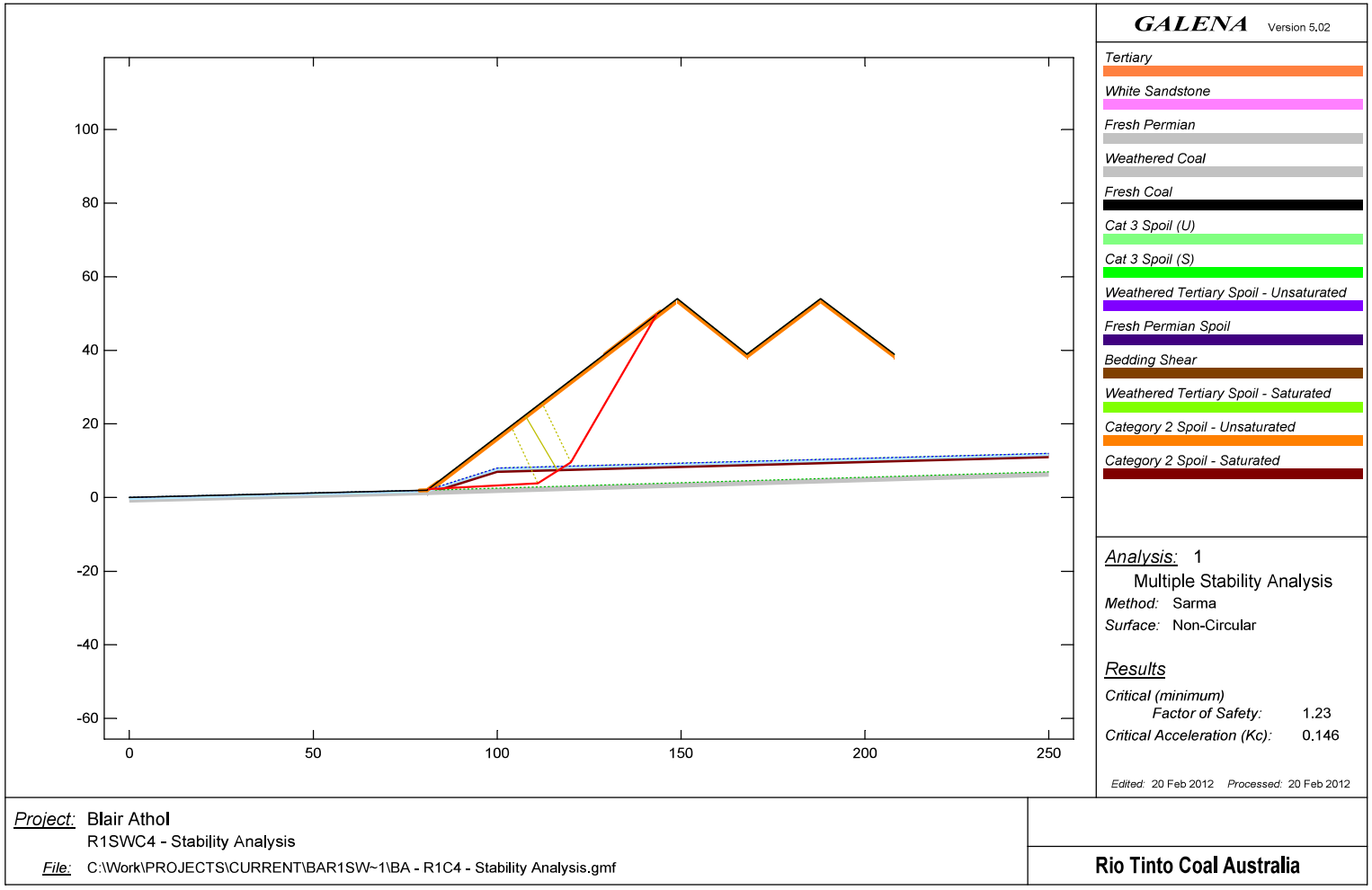
Alex Hossack (RPEQ 11165)
Acting Principal Geotechnical Engineer
Rio Tinto

Appendix 1 – Risk Assessment Checklists

BA MINE GEOTECHNICAL DESIGN CHECKLIST - LOWWALL					
Pit design:	**R1SWC4**				
		RISK RATING			
ITEM	FACTORS	Low	Moderate	High	NA
Design Engineer to fill section below					
Final Low Wall Geometry	Floor Dip Beneath Proposed Spoil Profile	All ≤ 9 degrees	Majority ≤ 9° with areas >9° < 50m wide	Areas >50m wide > 9°	
	Dragline Batter Height (after coal removal)	< 50m	50 - 60m	> 60m	
	Dragline Batter Angle	≤ 42 degrees	42 - 50 degrees	> 50 degrees	
	Bench Width (at pad level)	> 10m	5 - 10m	< 5m	
	Overall Slope Height	< 50m	50 - 60m	> 60m	
	Max. Overall Slope Angle (incl. bench/ramps)	< 35 degrees	35 - 40 degrees	> 40 degrees	
Engineer Comments	NA				
Geologist to fill from this point down					
Spoil Condition	Material Type: Passive Block (Base, Toe)	Cat.4 - Cat.3.5	Cat.3 - Cat.2.5	Cat.2 - Cat.1	
	Material Type: Active Block (Bulk, Crest)	Cat.4 - Cat.2.5	Cat.2 - Cat.1.5	Cat.1	
	Exposure Time Prior to Blasting	< 1 year	1 to 2 years	> 2 years	
Spoil Floor Conditions	Sub-floor materials (up to 3.0m)	Sandstone/Siltstone	Siltstone/Mudstone	Clays, shears or laminated strata	
	Floor surface condition	Strong	Moderate Slake	High Slake or Weak	
	Any Weak Material Disrupted (Blasted or Ripped)	N/A	Yes for majority of strip width	No or only for part of strip width	
	Condition of floor prior to overburden blasting	Clean over majority of strip or with minor mud/water	Dewatered and weak material pushed up against low wall	Water and mud present over much of the strip	
	Floor Exposure Time Prior to Overburden Blasting	< 1 year	1 to 2 years	> 2 years	
Groundwater & Pit Water	Wet zones or springs above floor (prev. strip)	NO	Yes (< 2m high)	Yes (>2m high)	
	Water/mud on pit floor	NO	Minor (<1m)	Yes (>1m deep)	
	Ponding time	N/A or < 2 months	2-6 months	> 6 months	
History	Failure Last Strip	No	Localised or ravelling	YES	
	Failure(s) Previous Strips	No	Localised or ravelling	YES	
Geologist Comments	NA				

BA MINE					
GEOTECHNICAL DESIGN CHECKLIST - HIGHWALL					
Pit design:	**R1SWC4**				
		RISK RATING			
ITEM	FACTORS	Low	Moderate	High	NA
Design Engineer to fill section below					
Hard Wall Geometry. (excavated high walls & end walls)	Maximum Batter Height after coal removal	≤ 45m	45 - 50m	> 50m	
	Maximum Batter Angle (Fresh Coal Measures)	≤ 75 degrees	75 - 80°	> 80 degrees	
	Inter Ramp Slope Angle if highwall is benched (Excl. Benches >20m)	≤ 55 degrees	55 - 60	> 60 degrees	
	Minimum Bench Width	≥ 25m	15 - 25m	< 15m	
	Overall slope angle (for multiple benches)	≤ 55 degrees	55 - 70	> 70 degrees	
Soft Wall Geometry. (soft walls, spoil, weathered rock walls & boxcut low walls)	Maximum Batter Height after coal removal	< 20m	20 - 30m	> 30m	
	Maximum Batter Angle	≤ 45 degrees	45 - 55 degrees	> 55 degrees	
	Overall slope angle (for multiple benches)	≤ 37 degrees	37 - 45 degrees	>45 degrees	
	Overall slope height (for multiple benches)	≤ 60m		> 60m	
Blasting	Face splitting/Buffer Shot technique	Presplit/Buffer Shot	Midsplit	None	
	Do blast lines intersect faults or defect zones?	NO	Yes but defect intercept slope at >30°	YES	
Engineer Comments					
Geologist to fill from this point down					
Groundwater /Surface Water	Seepage from Face	None/minor	Confined to coal seam	>20m high	
	Is run-off beyond crest controlled	Yes	Mostly with only minor run-off	No, ponding or stored water	
Rock Mass Defects & Structure	Pitwards-dipping bedding (strike length)	None	Yes but less than length of wall height.	Yes greater than length of wall height.	
	Does defect data indicate structures leading to the formation of wedges?	No or low likelihood	Yes, moderate likelihood	Yes, high likelihood	
	Does defect data indicate pitwards-dipping structure greater than 30 ° (planar failure)	No or low likelihood	Yes, moderate likelihood	Yes, high likelihood	
	Does defect data indicate pitwards-leaning joints (toppling failure)	No or low likelihood	Yes, moderate likelihood	Yes, high likelihood	
	Joint Set spacing	> 10m	2 - 10m	< 2m	
	Defect Continuity	< 5m	> 5m	Entire unbenched wall height	
History	Failure Last Strip	No, or <50m3	Don't know	Yes, >50m3	
	Failure(s) Previous Strips	No, or <50m3	Don't know	Yes, >50m3	

Appendix 2 – Stability Analysis Result



Appendix 3 – Kinematic Analyses Results

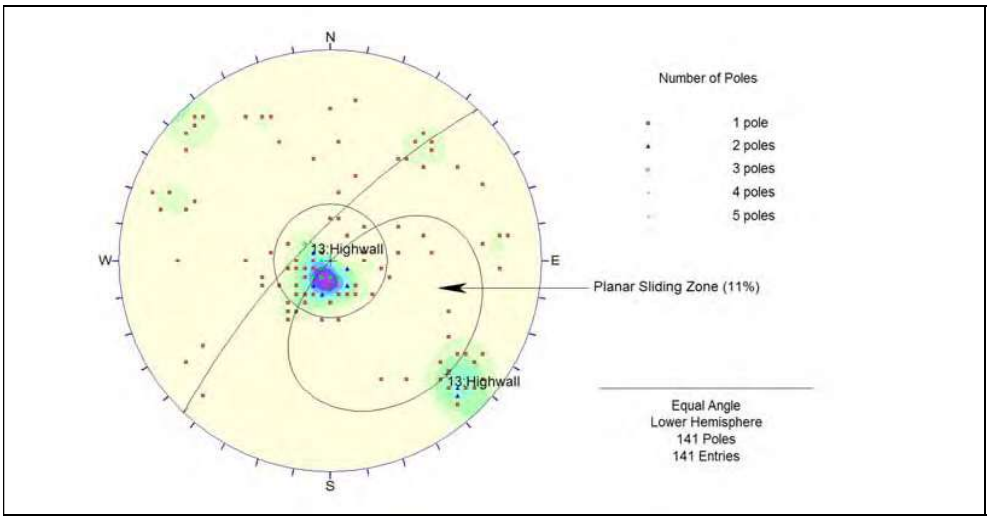


Figure 5 R1SWC4 Highwall - Sliding Type Failure Analysis

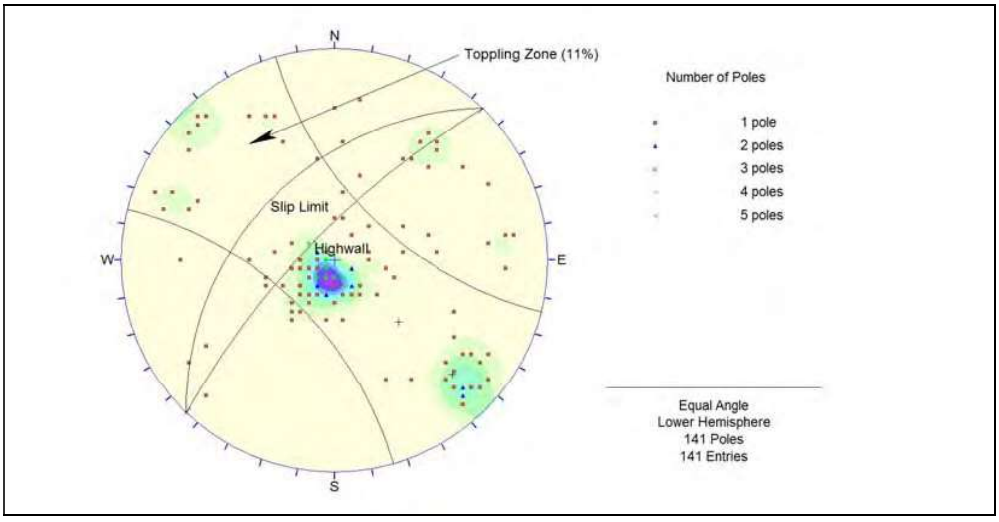


Figure 6 R1SWC4 Highwall - Toppling Type Failure Analysis

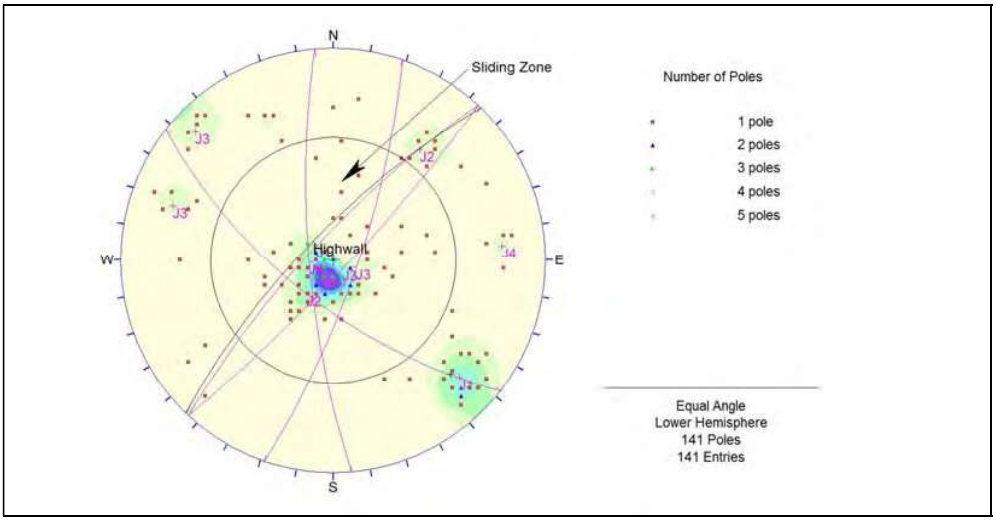


Figure 7 R1SWC4 Highwall - Wedge Type Failure Analysis

1.0 GEOTECHNICAL CHARACTERISTICS

Geotechnical hazards or failures at Blair Athol are generally related to discontinuities such as joints and faults; weak bedding parallel materials; and isolated rock or blockfalls. The rock types predominantly associated with these failures are the white sandstone, coal and basalt.

Design changes of the highwall and lowwalls have occurred over the last few years and specific criteria developed for each ramp. Local pit controls have also been introduced such as a golden rule of a 10 metre exclusion zone from any operating face, daily monitoring, and training of all site personnel in the mechanisms and hazards associated with the failures.

In 2003, a geotechnical assessment was completed by the site geotechnical consultant on selected drilling data for stability characteristics of the different rock types. Table 1 is a summary of these different rock type characteristics.

Table 1 - Stability characteristics of the different rock types

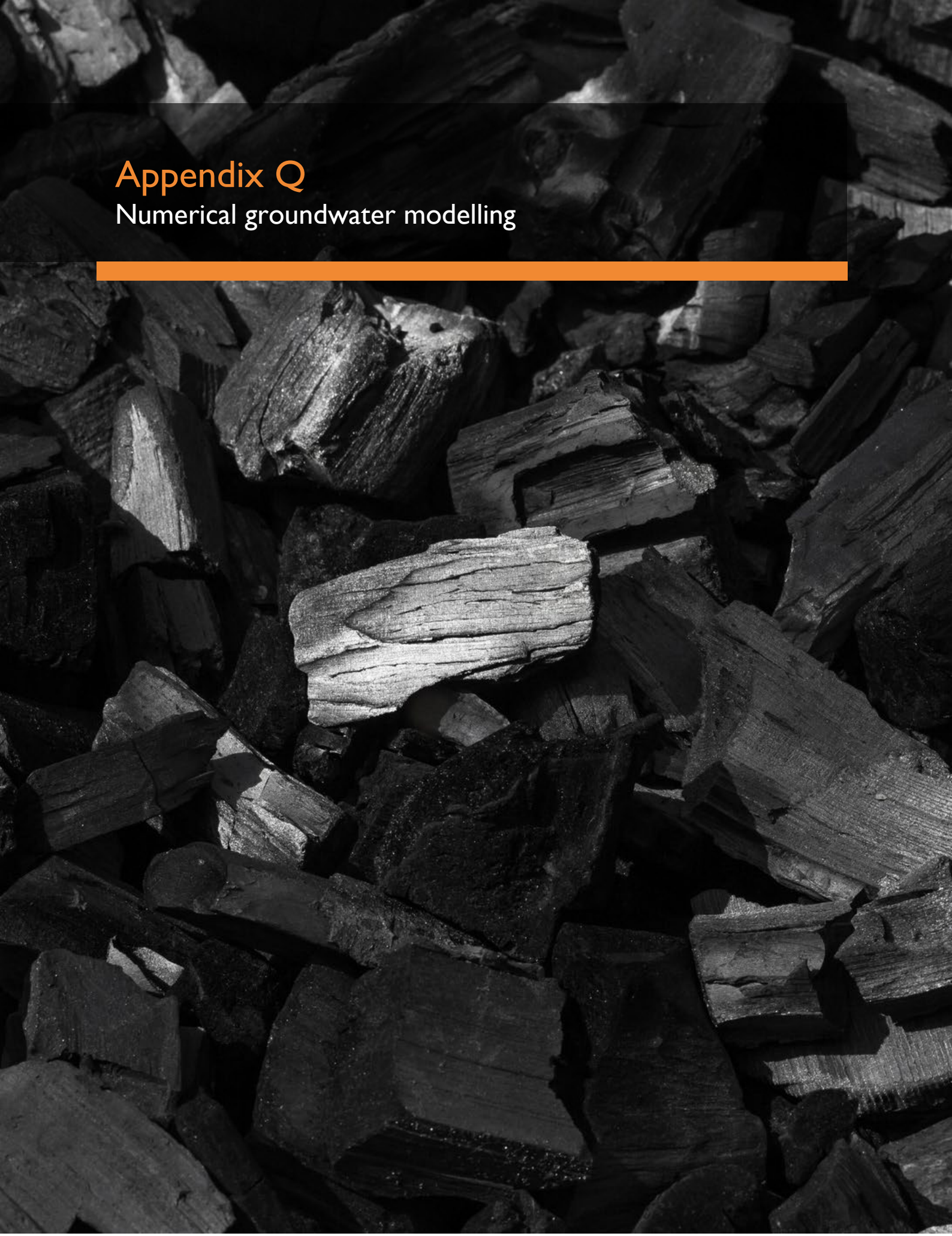
Material Type	Shear Strength		Unit Weight (kN/m3)
	Cohesion (kPa)	Friction (angle)	
Rock Materials			
Tertiary (in situ)	52	30	20
White Sandstone (where weathered)	6	32	20
Fresh Permian	100	45	22
Weathered Coal	0	30	15
Fresh Coal	30	35	15
Spoils			
Spoil (unsaturated) / Category 3-1Std Dev.	35	28	18
Spoil (saturated) / Category 3 - 1 Std Dev	10	22.5	20
Weathered Tertiary Spoil	20	25	18
Fresh Permian Spoil	50	30	18
Weak materials			
Weak or sheared bedding parallel materials	0	16	Not applicable

Jointing is evident in sections of the coal and overburden walls running approximately 10 – 15 degrees off the orientation of the wall and inclined at various angles from 75 degrees into the pit to around 85 degrees into the wall.

Weak bedding parallel materials are generally associated with the coal seams especially with the roof and floor of Seam 3 and Seam 4. With the progression of mining, the strips are advancing in an up dip direction for the highwalls causing a potential for translational sliding along these weak planes. The undercutting of bedding as part of the excavated lowwall development is also a part of this. The materials typically comprise of soft clayey or sheared bands.

Isolated rock or blockfalls are generally associated with the basalt overlying the white sandstone. Generally the upper pass of the highwall consists of basalt and the lower pass of white sandstone. In order to reduce the impact of failure from basalt with its columnar forming characteristics, buffer blasting has been employed.

The white sandstone is weathered and is regarded as extremely weak. It is involved in the majority of failures. Following a few days of exposure, the wall condition in the white sandstone deteriorates often leading to failure. The lower strength of the material compared to other sandstones at site is considered to be related to either blasting impacts, deep weathering or leaching effects from the overlying basalts.



Appendix Q
Numerical groundwater modelling

This page is intentionally blank.

REPORT ON

BLAIR ATHOL

NUMERICAL GROUNDWATER MODELLING REPORT

For: SGM Environmental

Project number: 4158

Date: 08/05/2024

ABN: 50 627 068 866 www.hydrogeologist.com.au info@hydrogeologist.com.au

1/149 Boundary Road, Bardon. QLD. 4065 P.O. Box 108, The Gap. QLD. 4061

Table of Contents

1. Introduction 1
2. Model design 2
   - 2.1. Model code selection 2
   - 2.2. Model domain 2
   - 2.3. Model processing and discretisation 2
   - 2.4. Model layers 3
   - 2.5. Model boundary conditions 4
     - 2.5.1. Rainfall recharge 4
     - 2.5.2. Evapotranspiration 4
     - 2.5.3. Surface drainage 4
     - 2.5.4. Final pit lake 5
     - 2.5.5. Mining 5
   - 2.6. Application of hydraulic properties 5
3. Model calibration 6
   - 3.1. Calibration approach 6
   - 3.2. Calibration targets 6
   - 3.3. Calibration results 7
   - 3.4. Calibrated hydraulic parameters 7
   - 3.5. Calibrated recharge 8
   - 3.6. Calibrated evapotranspiration 9
   - 3.7. Calibrated multiplying factors from pilot points 9
   - 3.8. Calibrated time-varied properties 10
   - 3.9. Calibrated water balance 10
   - 3.10. Overall calibration performance 11
4. Model predictions 12
   - 4.1. Modelling approach 12
   - 4.2. Budgets 13
   - 4.3. Heads 14
5. Conclusions 15
6. References 16

Table of Contents (continued)

Figure list

Figure 1 Model mesh 17
Figure 2 Bottom elevation of Quaternary alluvium (Layer 1) 18
Figure 3 Bottom elevation of Tertiary sediments and basalt (Layer 2) 19
Figure 4 Bottom elevation of Permian overburden (Layer 3) 20
Figure 5 Bottom elevation of Permian coal seams (Layer 4) 21
Figure 6 Bottom elevation of Permian underburden (Layer 5) 22
Figure 7 Bottom elevation of Basement volcanics (Layer 6) 23
Figure 8 Recharge zones 24
Figure 9 Surface drainage and final pit lake 25
Figure 10 Mining progression 26
Figure 11 Location of observation sites 27
Figure 12 Model calibration scatter diagrams – observed and modelled heads 28
Figure 13 Location of pilot points 29
Figure 14 Modelled saturated heads in Layer 1 at the end of calibration 30
Figure 15 Modelled saturated heads in Layer 2 at the end of calibration 31
Figure 16 Modelled saturated heads in Layer 3 at the end of calibration 32
Figure 17 Modelled saturated heads in Layer 4 at the end of calibration 33
Figure 18 Modelled saturated heads in Layer 5 at the end of calibration 34
Figure 19 Modelled saturated heads in Layer 6 at the end of calibration 35
Figure 20 Modelled saturated heads in Layer 1 after 10 years post closure 36
Figure 21 Modelled saturated heads in Layer 2 after 10 years post closure 37
Figure 22 Modelled saturated heads in Layer 3 after 10 years post closure 38
Figure 23 Modelled saturated heads in Layer 4 after 10 years post closure 39
Figure 24 Modelled saturated heads in Layer 5 after 10 years post closure 40
Figure 25 Modelled saturated heads in Layer 6 after 10 years post closure 41
Figure 26 Modelled saturated heads in Layer 1 after 50 years post closure 42
Figure 27 Modelled saturated heads in Layer 2 after 50 years post closure 43
Figure 28 Modelled saturated heads in Layer 3 after 50 years post closure 44
Figure 29 Modelled saturated heads in Layer 4 after 50 years post closure 45
Figure 30 Modelled saturated heads in Layer 5 after 50 years post closure 46
Figure 31 Modelled saturated heads in Layer 6 after 50 years post closure 47
Figure 32 Modelled saturated heads in Layer 1 after 100 years post closure 48
Figure 33 Modelled saturated heads in Layer 2 after 100 years post closure 49
Figure 34 Modelled saturated heads in Layer 3 after 100 years post closure 50

Table of Contents (continued)

Figure 35 Modelled saturated heads in Layer 4 after 100 years post closure 51
Figure 36 Modelled saturated heads in Layer 5 after 100 years post closure 52
Figure 37 Modelled saturated heads in Layer 6 after 100 years post closure 53
Figure 38 Modelled saturated heads in Layer 1 after 500 years post closure 54
Figure 39 Modelled saturated heads in Layer 2 after 500 years post closure 55
Figure 40 Modelled saturated heads in Layer 3 after 500 years post closure 56
Figure 41 Modelled saturated heads in Layer 4 after 500 years post closure 57
Figure 42 Modelled saturated heads in Layer 5 after 500 years post closure 58
Figure 43 Modelled saturated heads in Layer 6 after 500 years post closure 59
Figure 44 Cross section A-A' – groundwater level after 1000 years post closure 60
Figure 45 Cross section B-B' – groundwater level after 1000 years post closure 61

Table list

Table 1 Model temporal discretisation 3
Table 2 Model hydrostratigraphic definition 3
Table 3 Model layer definition 4
Table 4 Summary of model calibration performance – unweighted (head observations only) 7
Table 5 Summary of calibrated horizontal hydraulic conductivity (Kh) values 7
Table 6 Summary of calibrated vertical hydraulic conductivity (Kz) values 8
Table 7 Summary of calibrated specific storage (Ss) values 8
Table 8 Summary of calibrated specific yield (Sy) values 8
Table 9 Summary of calibrated recharge rate for recharge zones 9
Table 10 Summary of evapotranspiration rate and depth of extinction for EVT zones 9
Table 11 Summary of pilot points used in the calibration process 10
Table 12 Calibrated time-varied property values in mining cells 10
Table 13 Summary water balance at end of calibration period 10
Table 14 General head applied in the model of second stage 12
Table 15 Numerical model – water budget summary 13
Table 16 General head applied to represent pit void lake recovery 13

Appendix list

Appendix A Blair Athol Coal Mine – PRCP Groundwater Assessment Prepared for Terracom Ltd. Dated 16 January 2023
Appendix B Calibration hydrographs

Blair Athol - Numerical Groundwater Modelling Report

Prepared for

SGM Environmental

1. Introduction

Blair Athol Coal Mine (BAC) is an open cut coal mine located approximately 20 km northwest of Clermont in central Queensland. BAC open cut pits, overburden emplacement areas, coal stockpiles, a coal handling plant (CHP) and water management infrastructure are located on Mining Lease (ML) 1804.

Terracom Limited (Terracom) operates BAC in accordance with Environmental Authority (EA) EPML00876713.

Mining at BAC commenced in 1978 by Rio Tinto, who operated the mine until it was placed under care and maintenance in 2012. In 2017, BAC was sold to Terracom. Mining activity at BAC recommenced in 2018, with the mine currently producing approximately 2.5 million tonnes (Mt) of thermal coal per year.

hydrogeologist.com.au previously prepared a groundwater assessment for the Blair Athol PRCP in January 2023. This report is provided as Appendix A. This assessment was developed on a conceptual understanding only and was not supported a numerical groundwater flow model. It is understood that the Department of Environment, Science and Innovation (DESI) have since requested the development of a numerical groundwater model to support the PRCP.

hydrogeologist.com.au has developed a 3D numerical groundwater flow model to support the PRCP. The purpose of the groundwater model is to simulate the post closure effects of the BAC on groundwater levels.

With the exception of geological model layers, there has been no additional data provided by Terracom to support the development of the 3D numerical groundwater flow model. On this basis, the conceptual groundwater assessment (Appendix A) previously provided still remains valid.

This report provides a detailed description of the modelling, including model design and construction, calibration and predictions. The report is structured as follows:

- Section 1 – Introduction and overview of the report scope and structure.
- Section 2 – Model design and construction.
- Section 3 – Model calibration.
- Section 4 – Model predictions.
- Section 5 – References.

2. Model design

2.1. Model code selection

The model was developed using the latest version of MODFLOW 6 (Langevin *et al.*, 2017) which is the current core version of the U.S. Geological Survey MODFLOW groundwater modelling code. A 3D numerical model was established using an unstructured quadtree grid. Spatial data management, pre-processing, and map output generation were performed using QGIS, FloPy (Bakker *et al.* 2016) and Python code.

2.2. Model domain

The model domain is shown in Figure 1. The domain covers an area of approximately 500 km^2, extending approximately 25 km east to west and 27 km north to south.

The model domain extents were designed to be large enough to:

- encompass the full extent of depressurisation associated with the Blair Athol mining area;
- encompass the full extent of depressurisation associated with the Clermont mining area, and
- remove significant interaction (i.e., boundary effects) between the depressurisation associated with mining activities and the model boundary conditions.

Natural geological, hydrological and hydrogeological features such as groundwater units, geological structures and watercourses and catchment boundaries were also considered in determining the extents of the model domain, as required.

2.3. Model processing and discretisation

The model mesh was generated using GRIDGEN (Lien *et al.*, 2015), which was implemented in FloPy. The program prepares a three-dimensional base grid with variable row and column widths, as well as spatially variable cell top and bottom elevations. GRIDGEN then refines the mesh based on user-provided features (such as points, lines, and polygons) into smaller cells, continuously refining the grid until the desired level of refinement is achieved.

In this model, the base grid size was set to 600 m, and refinements were applied to specific areas, including the model boundaries (150 m), mining areas (75 m), surface drainage (75 m), boundaries of alluvium and tertiary formations (75 m), and monitoring bores (37.5 m). There are 117,867 active cells in the entire model, distributed in six model layers. The model mesh is shown in Figure 1.

Two models were developed to represent the calibration and predictive periods respectively (Table 1). With the exception of the first stress period in the calibration model (which was steady state), the calibration model utilised yearly stress periods, while the predictive model used stress periods with varied length to simulate the long-term water level recovery in the pit void.

The transient calibration encompassed the period of 1986 to 2023, with annual stress periods applied. To achieve better model convergency during the automatic calibration process, the Adaptive Time Stepping (ATS) package was employed for time steps. This package allows for dynamic adjustment of time steps, enhancing the efficiency and accuracy of the model convergency.

Table 1 Model temporal discretisation

Stress period	Stress period length	Dates	Model	Modelling phase
1	N/A	N/A	Calibration	Steady state, pre-mine development
2 – 40	1 year	01/01/1986 – 31/12/2023		Transient calibration period
1 – 11	1 year	01/01/2024 – 31/12/2034	Prediction	Prediction (mining) period
12	2 years	1/01/2035 – 31/12/2036		
13	5 years	1/01/2037 – 31/12/2041		
14	10 years	1/01/2042 – 31/12/2051		
15	20 years	1/01/2052 – 31/12/2071		
16	50 years	1/01/2072 – 31/12/2121		
17 - 25	100 years	1/01/2122 – 31/12/3021		

2.4. Model layers

The model was constructed with six layers to represent the hydrogeological units. Table 2 summarises the model layers and the corresponding hydrostratigraphic units.

Table 2 Model hydrostratigraphic definition

Model layer	Hydrostratigraphic unit
1	Quaternary alluvium
2	Tertiary sediments and basalt
3	Permian – overburden
4	Permian – coal seams
5	Permian - underburden
6	Basement volcanics - Triassic

The surface elevation of Layer 1 (topography) was based on regional DEM. The thickness of the Quaternary alluvium (Layer 1) was assumed to have a uniform thickness of 5 m due to the lack of such data.

The elevation and thickness of the Tertiary basalt and sediments and Permian coal measures (Layers 2 to 5) was adopted or digitized from (JBT Consulting, 2012). The basement volcanics (Layer 6) was modelled with a uniform thickness (nominally 200 m). Geological data for the coal seam thickness and geometry (Layer 4) was provided by Terracom. This data was incorporated into the model.

The bottom elevation of the Quaternary alluvium (Layer 1), Tertiary sediments and basalt (Layer 2), Permian overburden (Layer 3), Permian coal seams (Layer 4), Permian underburden (Layer 5) and basement volcanics (Layer 6) are presented in Figure 2 to Figure 7.

Table 3 summarises the model layers and the corresponding hydrostratigraphic units, as well as the layer thickness and number of cells per layer.

Table 3 Model layer definition

Model layer	Hydrogeological unit	Average thickness (m)	Maximum thickness (m)	# Cells per layer
1	Quaternary alluvium	5.00	5.00	20,378
2	Tertiary basalts and sediments	23.86	155.01	18,467
3	Permian – overburden	11.68	92.26	14,895
4	Permian – coal seams	10.82	87.36	14,895
5	Permian – underburden	21.51	163.07	14,895
6	Basement volcanics	200.00	200.00	34,337

2.5. Model boundary conditions

Boundary conditions provide a means by which auxiliary groundwater fluxes and stresses can be specified within the model. The following boundary conditions have been adopted in the model.

2.5.1. Rainfall recharge

SILO gridded rainfall data covering the period from 1890 to 2023 was downloaded and processed for the model area. For the steady state model and predictive model, the long-term average daily rainfall was utilised. The historical data was used for the transient periods of the calibration model, with conversion to daily averages.

Recharge was applied in zones based on the extents of outcropping geological units, using the MODFLOW 6 Recharge (RCH) package. Recharge was calculated as a percentage of daily rainfall. The zones are defined by the extents of outcrop, including Zone 1 – Quaternary alluvium, Zone 2 – Tertiary Sediments/Basalt, Zone 3 – Permian coal measures, and Zone 4 – basement. These zoned recharge rates served as a base rate for each zone, and numerous pilot points were employed to fine-tune these rates at a local level during the calibration process. The recharge zones in the model area are shown in Figure 8. The percentage of rainfall that enters the model as recharge in each zone was optimised through manual calibration.

2.5.2. Evapotranspiration

Evapotranspiration was applied to the entire top cells of the model using the MODFLOW 6 Evapotranspiration (EVT) package. The same methodology, including zonation and pilot points, as used in the RCH package, was employed to calibrate both the extinction depth and the maximum rate of evapotranspiration in the EVT package.

2.5.3. Surface drainage

Surface water drainage was implemented using the MODFLOW 6 River (RIV) package. The RIV package was applied to the rivers within the model and along the model boundary in the southeast, as well as minor drainage features and tributaries within the model domain (Figure 9).

The RIV package simulates a head-dependent flux boundary and is an appropriate boundary type to simulate the ephemeral drainage features in the model area. Within the model, these drainage features were set as dry and acted as drains to remove water from the system. The river bottom elevation and the river stage were set to the DEM (model top).

For riverbed properties, vertical hydraulic conductivity for each river cell was obtained from the NPF package. Standardised stream dimensions, including a stream width of 10 metres and a bed thickness of 2 metres, were uniformly assigned to all river cells. Hydraulic conductance was then calculated for each individual cell based on its geometry and steam dimensions. To ensure adequate drainage of groundwater, a minimum conductance of 1 m^2/day was imposed in cases where the calculated conductance fell below this threshold. This adjustment maintained effective groundwater drainage via the rivers.

2.5.4. Final pit lake

There were two stages involved in simulating the long-term behaviour of the final pit lake. In the first stage, the objective was to determine both the long-term groundwater inflow/outflow rate into the pit lake and its final state (whether it acts as a source or sink) within the regional groundwater system. This modelled inflow versus elevation data was then provided to the project surface water consultant to calculate the rise in water level within the pit void. In the second stage, the surface water consultant provided a second iteration of the pit lake filling curve for inclusion in the predictive model.

The updated water levels were assigned to the corresponding stress periods in the groundwater model as general head boundaries using the GHB package. A conductance value of 100 m²/day was assigned to all GHB cells in the final pit lake. The location of the modelled final pit lake is shown in Figure 9.

2.5.5. Mining

Mine dewatering within the model area was simulated using the DRN package, which was solely applied in the calibration model. The drain cells allow for one-way flow of water out of the model. When the modelled head drops below the specified elevation of the drain, the drain cells become inactive. This is standard way of representing mining, with the actual removal of water being via pumping and/or evaporation.

The model represents two opencut mining areas, the Blair Athol Mine and the Clermont Mine in the southeast of the model domain. Large scale open cut mining commenced in 1936 in this region, and detailed information on the historical mining progression (pre-1985) is not available. To maintain temporal consistency and with the limitation of available data (Google Earth Engine timelapse), it was assumed that mining activities commenced at the start of 1986.

For the calibration model, mining polygons were generated for each open cut pit/mining area, utilising a time-lapse analysis of publicly available data. This method provides a representation of the evolving mining footprint over time. The DRN package was deactivated in the predictive model, as the purpose of the predictive model is to model the water level recovery in the pit void.

To simulate the open cut mining, drain cells were applied to all active layers from the surface to the base of the target coal seam (Layer 4) to ensure full depressurisation of the layers above the coal seam.

The conductance values of the drain cells were set as constant value of 100 m^2/day. The mining progression for calibration model from 1986 to 2023 is shown in Figure 10.

2.6. Application of hydraulic properties

Hydraulic properties were determined using a methodology similar to that of recharge. Initially, uniform base property values (horizontal hydraulic conductivity - kh, vertical hydraulic conductivity - kv, specific storage - Ss, and specific yield - Sy) were assigned to each layer. These values were then adjusted by multiplying factors determined through the use of pilot points. Hydraulic properties in MODFLOW 6 models are facilitated through Node Property Flow (NPF) Package (for kh and kv) and Storage (STO) package (for Ss and Sy). The calibrated hydraulic properties are presented in Section 3.4.

It is assumed that after mining, the pit void is generally filled with spoil material, which typically has a higher permeability and increased storage compared to the original formations. Consequently, the hydraulic properties in the mining cells are expected to change post-mining. In this model, the material change was managed using the Time-Varying Hydraulic Conductivity (TVK) Package and Time-Varying Storage (TVS) Package. These are child packages for the NPF and STO packages, respectively.

3. Model calibration

Model calibration was performed to optimise the model parameter values so that the model can better replicate historical observations. The outcome of the calibration process also provides the initial conditions for the transient predictive simulations used to assess post closure groundwater levels.

3.1. Calibration approach

Given the large number of adjustable parameters (15,897) with the use of pilot points, calibration was executed using PESTPP-IES.

PESTPP-IES serves as a powerful tool for calculating samples from the posterior parameter probability distribution, making it adaptable to a range of modelling scenarios. It does not rely on the assumption of linearity, therefore no Jacobian matrix needs to be calculated during the iterations. For models with a substantial number of parameters, PESTPP-IES has better computational efficiency.

PESTPP-IES assimilates calibration data by using an iterative ensemble smoother algorithm. It combines the Bayesian and subspace methods and achieves great computational efficiency. The process starts with the generation of an ensemble of parameter fields characterised by a prior distribution, which are based on pre-calibration parameter uncertainty, combining expert knowledge and available measurements of system properties. The prior distribution is defined by the user, or PESTPP creates it using the parameter data provided in the pest control file. Through successive iterations, PESTPP-IES adjusts these parameter fields to conform with calibration data constraints. The algorithm combines Bayesian principles with subspace methods to efficiently update the parameter realisations.

This approach is different from the conventional calibration-first methodology. Rather than focusing solely on a single 'calibrated' parameter field, PESTPP-IES aims to construct an ensemble that holistically encompasses parameter uncertainty. This approach significantly reduces computational burden, making it suitable for models with a high number of parameters.

By observing how this base realisation changes during the iterations, the user can assess the impact of the ensemble smoother process on a non-random parameter field. Any biases or implausible variations introduced here are likely to extend to the other random parameter fields in the ensemble. This helps assess if the resulting ensemble truly represents the posterior parameter probability distribution. In our case, the 'base realisation' after seven iterations is considered as the 'calibrated' parameter field.

3.2. Calibration targets

A total of 424 individual head observations and 424 temporal head differences from 25 observation sites were used as the target in the calibration process.

Weights are assigned to observation data to reflect their relative importance in the objective function. Initially, these weights were determined using an empirical formula that treats each bore as a group and considers the visibility differences within these groups. Certain observations in boreholes Curtis, GT02, and GW04b were assigned zero weight because they yielded impossible matches due to inconsistencies between the elevations of the model top and those of the boreholes. Following the initial test PEST run, the observation weights were readjusted to ensure equal importance for each bore in the objective function during the subsequent real PEST-IES run. Additionally, it is worth noting that the weights for temporal head difference observations were decreased to 10% of those for head observations in the same bore. This adjustment prioritises matching head observations over temporal head difference observations.

The location of the observation sites is shown in Figure 11.

3.3. Calibration results

A scatter plot of modelled versus observed hydraulic heads is presented in Figure 12.

The statistics from the calibrated model are reported in Table 4, the observations with zero weights have been removed from these statistics.

Table 4 provides a summary of the monitoring bores including the assigned model layer and the calibrated residuals.

Table 4 Summary of model calibration performance – unweighted (head observations only)

Statistical measure		Unit	Value
Number of observations	n	-	423
Range of measured heads	-	m	55.21
Sum of squared residuals	SSQ, Φ	m^2	18,145.46
Residual mean	MSR	m	4.37
Scaled absolute residual mean	SMSR	%	7.93
Root mean square error	RMS	m	6.55
Scaled root mean squared error	SRMS	%	11.86

The transient calibration resulted in a root mean squared error (RMS) of 6.55 m and a scaled root mean squared error (SRMS) of 11.86%, calculated by non-weighted head observations only. The SRMS exceeds the 10% threshold recommended by the Australia Groundwater Modelling Guidelines (Barnett *et al.*, 2012). An improved calibration could not be achieved, and this is attributed to the lack of data or uncertainty associated with geological layering and historical mining.

The calibration hydrographs are provided as Appendix B.

3.4. Calibrated hydraulic parameters

Table 5 to Table 8 presents the calibrated hydraulic conductivity values and the calibrated storage parameters for each model layer. In Table 6, the vertical hydraulic conductivity was calibrated as a factor of horizontal hydraulic conductivity. The term "Layer base" in these tables refers to the base layer value of the hydraulic property for that respective layer, which is then modified by multiplying factors (ranging from 0.1 to 10 for Kh and Kz factor, and 0.3 to 3 for Sy and Ss) obtained from pilot points. The columns labelled Min, Max and Mean in the table provide statistical summaries of the final values within each layer.

Table 5 Summary of calibrated horizontal hydraulic conductivity (Kh) values

Model layer	Geological unit	Kh (m/d)			
		Layer base	Min	Max	Mean
1	Quaternary alluvium	9.95E-01	3.18E-01	5.00E+00	1.28E+00
2	Tertiary sediments and basalts	1.45E-01	3.13E-02	8.69E-01	1.60E-01
3	Permian overburden	1.00E-03	1.91E-04	6.62E-03	1.05E-03
4	Permian coal seams	2.10E-03	2.33E-04	1.32E-02	2.47E-03
5	Permian underburden	5.77E-02	9.78E-03	3.46E-01	7.20E-02
6	Basement volcanics	8.92E-02	1.09E-02	8.35E-01	1.49E-01

Table 6 Summary of calibrated vertical hydraulic conductivity (Kz) values

Model layer	Geological unit	Kz factor	Kz (m/day)			
			layer base	Min	Max	Mean
1	Quaternary alluvium	1.85E-01	1.84E-01	1.66E-02	1.46E+00	3.21E-01
2	Tertiary sediments and basalts	1.47E-01	2.13E-02	2.01E-03	2.80E-01	2.18E-02
3	Permian overburden	2.63E-02	2.63E-05	1.95E-06	4.27E-04	2.84E-05
4	Permian coal seams	1.39E-01	2.92E-04	1.52E-05	6.51E-03	3.93E-04
5	Permian underburden	2.79E-01	1.61E-02	1.28E-03	1.86E-01	2.54E-02
6	Basement volcanics	7.88E-02	7.03E-03	1.36E-04	8.70E-02	1.24E-02

Table 7 Summary of calibrated specific storage (Ss) values

Model layer	Geological unit	Specific storage (m^{-1})			
		Layer base	Min	Max	Mean
1	Quaternary alluvium	7.91E-05	3.39E-05	1.00E-04	7.78E-05
2	Tertiary sediments and basalts	6.48E-04	1.00E-04	1.00E-04	1.00E-04
3	Permian overburden	9.67E-07	4.14E-07	2.19E-06	1.05E-06
4	Permian coal seams	2.09E-05	8.28E-06	5.39E-05	2.43E-05
5	Permian underburden	1.56E-06	5.29E-07	3.38E-06	1.57E-06
6	Basement volcanics	1.18E-05	4.44E-06	3.31E-05	1.33E-05

Table 8 Summary of calibrated specific yield (Sy) values

Model layer	Geological unit	Specific yield (-)			
		Layer base	Min	Max	Mean
1	Quaternary alluvium	4.74E-02	2.04E-02	1.34E-01	4.76E-02
2	Tertiary sediments and basalts	3.31E-04	1.08E-04	8.39E-04	3.50E-04
3	Permian overburden	5.02E-04	2.22E-04	1.17E-03	5.32E-04
4	Permian coal seams	2.26E-04	1.00E-04	4.90E-04	2.06E-04
5	Permian underburden	3.34E-04	1.43E-04	7.09E-04	3.45E-04
6	Basement volcanics	2.91E-04	1.00E-04	7.96E-04	2.81E-04

3.5. Calibrated recharge

Recharge was calibrated against the recorded annual rainfall within the model domain for each stress period of the calibration model. The percentage of average annual rainfall that converts to recharge was estimated during calibration and is shown below in Table 9.

According to the model structure, no recharge parameters were applied to the Permian coal seams and Permian underburden (Layer 4 and 5) as they are not exposed at the model top.

It is important to note that these values are not the final recharge percentages and will be further adjusted by multiplying factors (ranging from 0.1 to 10) derived from the pilot points.

Table 9 Summary of calibrated recharge rate for recharge zones

Modelled recharge zone	Recharge as a % of average annual rainfall
1 – Quaternary alluvium	2.1%
2 – Tertiary	0.28%
3 – Permian overburden	1.84%
4 – Permian coal seams	N/A
5 – Permian underburden	N/A
6 – Basement	0.07%

3.6. Calibrated evapotranspiration

Maximum evapotranspiration rate was calibrated against the recorded annual evapotranspiration within the model domain for each stress period of the calibration model. The percentage of average annual evapotranspiration were estimated during calibration and are shown below in Table 10.

In line with the model structure, evapotranspiration parameters were not applied to the Permian coal seams and Permian underburden (Layer 4 and 5) as they are not exposed at the model top.

It is important to note that these values are preliminary and will be further adjusted using multiplying factors (ranging from 0.1 to 10 for EVT rate and 0.2 to 5 for depth of extinction) derived from the pilot points. Additionally, the final values for each parameter will be constrained within prescribed minimum and maximum values.

Table 10 Summary of evapotranspiration rate and depth of extinction for EVT zones

Modelled EVT zone	Max EVT rate as a % of average annual evapotranspiration	Depth of extinction (m)
1 – Quaternary alluvium	27.76%	1.97
2 – Tertiary	28.22%	1.64
3 – Permian overburden	19.29%	1.99
4 – Permian coal seams	N/A	N/A
5 – Permian underburden	N/A	N/A
6 – Basement	19.71%	1.54

3.7. Calibrated multiplying factors from pilot points

As detailed in preceding sections, numerous pilot points were employed to enhance the representation of parameter fields and achieve more precise history matching. A total of 2262 pilot points were allocated to each layer, sharing identical spatial positions. To simplify data processing, points outside the model domain were not removed, as they will be automatically excluded when interpolating values to model cells. The typical distance between pilot points is 1000 metres, with denser placement near observation bores to better utilise available information during the calibration process. Pilot points near model boundaries were also adjusted or shifted to align with the boundary line. The location of these pilot points are shown in Figure 13.

To maximize the benefits of pilot points, many spatial parameters underwent further adjustments by applying multiplying factors carried by them. These parameters include horizontal hydraulic conductivity (kh), vertical hydraulic conductivity factor (kzf), specific storage (ss), specific yield (sy), recharge rate (rch), evapotranspiration rate (evt), and depth of extinction (exdp). Table 11 lists these spatial parameters that were adjusted by pilot points along with their initial factor, minimum factor, maximum factor, and calibrated ranges for each parameter.

Table 11 Summary of pilot points used in the calibration process

Spatial parameter	Initial factor	Min factor	Max factor	Calibrated range
kh	1	0.1	10	0.1 – 10
kvf	1	0.1	10	0.106 – 8.31
Ss	1	0.3	3	0.3 – 3
Sy	1	0.3	3	0.3 – 3
rch	1	0.1	10	0.105 – 8.12
evt	1	0.1	10	0.119 – 5.494
exdp	1	0.2	5	0.237 – 5

3.8. Calibrated time-varied properties

As stated in Section 2.6, time-varying properties were implemented for the mined cells, along with adjustments made to the recharge rate and evapotranspiration rate within these cells during the calibration process. Table 12 summarises the calibrated values for these time-varying properties.

Table 12 Calibrated time-varied property values in mining cells

Time - varied property	Calibrated value
kh (m/day)	5.17E+00
kvf (-)	3.00E-02
Ss (m^{-1})	2.40E-04
Sy (-)	2.20E-03
rch (-)	0.59%
evt (-)	23.93%

3.9. Calibrated water balance

The mass balance error of the transient calibration model is the difference between model inflows and model outflows throughout the calibration period. An error of approximately 1% is considered acceptable. The water budget error for the final stress period in the transient calibration model is presented in Table 13. The water balance error is zero, indicating that the model is numerically stable and has achieved an accurate numerical solution.

Table 13 Summary water balance at end of calibration period

Water budget item	Inflow (m^3/d)	Outflow (m^3/d)
Drains (mine inflow)	-	14,084.44
Recharge	10,511.24	-
River	-	1.72
Evapotranspiration	-	5,213.45
Storage	9,764.82	976.44
Total	20,276.06	20,276.05
Mass balance error	**0.00%**	

3.10. Overall calibration performance

The model has been appropriately calibrated to transient conditions so far as the available data and model assumptions will allow. Whilst the quantitative calibration metrics (e.g., SRMS) are not within guideline-recommended ranges the conceptual model for groundwater flow has been honoured by the calibration. Further, the relative contributions of recharge/discharge processes in the model water balance are within the ranges expected.

The calibrated model is therefore deemed to be a suitable tool for predicting post closure groundwater levels. The predictive scenarios based on the calibrated model are presented in Section 4.

The calibrated groundwater levels for each model layer are presented in Figure 14 to Figure 19. These contours represent groundwater levels at the end of 2023. The direction of groundwater flow surrounding the mine is also shown on these figures.

4. Model predictions

4.1. Modelling approach

The transient model used for predictive scenarios served as an extension of the transient calibration model. It comprised 11 yearly stress period from 1/1/2024 to 31/12/2034, followed by 14 stress periods with varied lengths from 2 years to 100 years from 1/2/2035 to 31/12/3021, simulating the final void pit lake recovery and the aquifer response over approximately 1000 years. The pit lake recovery curve was defined in an interactive approach with the PRCP surface water consultant.

The final pit lake was modelled using GHB cells, with details provided in Section 2.5.4. Several scenarios were tested, involving setting the final pit lake water level from 250 mAHD to 310 mAHD, to assess the behaviour of the pit lake on the groundwater system. It was assessed that the pit lake transitions from a sink to a source between an elevation of 300 mAHD to 310 mAHD. Further scenarios were tested to assess the level at which the lake has a near-zero net exchange with the surrounding groundwater system. This level was assessed to be 304.5 mAHD. It is also assessed that in each scenario, the groundwater model reaches quasi-steady state (or a long-term equilibrium) by SP 18 or the end of year 2321.

Table 14 summarises the general head boundary parameters applied to simulate the pit lake recovery and long term equilibrium level.

Table 14 General head applied in the model of second stage

SP	Date from	Date to	Num of years	General head applied
1	1/01/2024	31/12/2024	1	261.555
2	1/01/2025	31/12/2025	1	267.966
3	1/01/2026	31/12/2026	1	271.6
4	1/01/2027	31/12/2027	1	272.086
5	1/01/2028	31/12/2028	1	272.607
6	1/01/2029	31/12/2029	1	273.344
7	1/01/2030	31/12/2030	1	273.962
8	1/01/2031	31/12/2031	1	276.707
9	1/01/2032	31/12/2032	1	277.324
10	1/01/2033	31/12/2033	1	278.486
11	1/01/2034	31/12/2034	1	278.439
12	1/01/2035	31/12/2036	2	277.559
13	1/01/2037	31/12/2041	5	277.132
14	1/01/2042	31/12/2051	10	280.668
15	1/01/2052	31/12/2071	20	277.615
16	1/01/2072	31/12/2121	50	281.89
17	1/01/2122	31/12/2221	100	278.92
18	1/01/2222	31/12/2321	100	281.261
19	1/01/2322	31/12/2421	100	278.357
20	1/01/2422	31/12/2521	100	281.356
21	1/01/2522	31/12/2621	100	284
22	1/01/2622	31/12/2721	100	284
23	1/01/2722	31/12/2821	100	284
24	1/01/2822	31/12/2921	100	284
25	1/01/2922	31/12/3021	100	284

4.2. Budgets

The water budget (or water balance) of the numerical model reflects and quantifies flows entering and leaving the model domain. The inflows into the model domain are through diffuse aerial recharge (RCH boundary condition) and lateral groundwater recharge via pit lake (GHB boundary condition) during the prediction/recovery period. The outflows from the model domain are via surface drainage (RIV boundary condition), evapotranspiration (EVT boundary conditions), water removal through mining (DRN boundary condition) during the transient calibration period, and lateral groundwater discharge via pit lake (GHB boundary condition) during the prediction/recovery period.

The flow rates and volumes across individual boundaries are summarised in Table 15.

Table 15 Numerical model – water budget summary

Boundary condition		Steady state flow rate (m^3/day)	Transient - calibration		Transient - prediction	
			Cumulative volume (m^3)	Average flow rate (m^3/day)	Cumulative volume (m^3)	Average flow rate (m^3/day)
	number of days	-	13879		364512	
in	recharge (RCH)	9,581.69	130,349,299.27	9,391.84	3,492,469,770.98	9,581.22
	surface drainage (RIV)	-	-	-	-	-
	head dependant boundary (GHB)	-	-	-	6,722,514,438.33	18,442.51
out	surface drainage (RIV)	14.65	119,904.74	8.64	924,409.83	2.54
	head dependant boundary (GHB)	-	-	-	7,360,476,163.65	20,192.69
	evapotranspiration (EVT)	9,566.70	104,075,812.11	7,498.80	2,705,061,155.45	7,421.05
	mining / pit lake (DRN)	-	42,324,478.32	3,049.53	113,607,164.30	311.67

Table 16 summarises the GHB elevation applied to simulate the recovery of the pit lake during post closure.

Table 16 General head applied to represent pit void lake recovery

SP	Date from	Date to	No. of years	General head applied
1	1/01/2024	31/12/2024	1	261.555
2	1/01/2025	31/12/2025	1	267.966
3	1/01/2026	31/12/2026	1	271.6
4	1/01/2027	31/12/2027	1	272.086
5	1/01/2028	31/12/2028	1	272.607
6	1/01/2029	31/12/2029	1	273.344
7	1/01/2030	31/12/2030	1	273.962
8	1/01/2031	31/12/2031	1	276.707
9	1/01/2032	31/12/2032	1	277.324
10	1/01/2033	31/12/2033	1	278.486
11	1/01/2034	31/12/2034	1	278.439
12	1/01/2035	31/12/2036	2	277.559
13	1/01/2037	31/12/2041	5	277.132
14	1/01/2042	31/12/2051	10	280.668
15	1/01/2052	31/12/2071	20	277.615

SP	Date from	Date to	No. of years	General head applied
16	1/01/2072	31/12/2121	50	281.89
17	1/01/2122	31/12/2221	100	278.92
18	1/01/2222	31/12/2321	100	281.261
19	1/01/2322	31/12/2421	100	278.357
20	1/01/2422	31/12/2521	100	281.356
21	1/01/2522	31/12/2621	100	284
22	1/01/2622	31/12/2721	100	284
23	1/01/2722	31/12/2821	100	284
24	1/01/2822	31/12/2921	100	284
25	1/01/2922	31/12/3021	100	284

4.3. Heads

The saturated modelled heads after 10 years post closure are shown from Figure 20 to Figure 25 for the Quaternary alluvium (Layer 1), Tertiary basalt and sediments (Layer 2), Permian overburden (Layer 3), Permian coal seams (Layer 4), Permian underburden (Layer 5) and Basement volcanics (Layer 6).

The saturated modelled heads after 50 years post closure are shown from Figure 26 to Figure 31 for the Quaternary alluvium (Layer 1), Tertiary basalt and sediments (Layer 2), Permian overburden (Layer 3), Permian coal seams (Layer 4), Permian underburden (Layer 5) and Basement volcanics (Layer 6).

The saturated modelled heads after 100 years post closure are shown from Figure 32 to Figure 37 for the Quaternary alluvium (Layer 1), Tertiary basalt and sediments (Layer 2), Permian overburden (Layer 3), Permian coal seams (Layer 4), Permian underburden (Layer 5) and Basement volcanics (Layer 6).

The saturated modelled heads after 500 years post closure are shown from Figure 38 to Figure 43 for the Quaternary alluvium (Layer 1), Tertiary basalt and sediments (Layer 2), Permian overburden (Layer 3), Permian coal seams (Layer 4), Permian underburden (Layer 5) and Basement volcanics (Layer 6).

The predicted groundwater levels at different timeframes demonstrate that the final pit void lake will remain a sink into perpetuity.

Two cross sections have been generated to demonstrate the relationship of the post closure groundwater levels. Figure 44 is a north-south cross section through the Blair Athol Coal Mine and Figure 45 is an east-west cross section through the Blair Athol Coal Mine. The cross sections demonstrate that the final pit void lake will remain a sink into perpetuity.

5. Conclusions

A groundwater flow model has been developed to support the BAC PRCP and key outputs from the model are provided in this report to address the information requested from DESI.

The groundwater flow model predictions confirm the conclusions from the previous conceptual assessment that the final void at BAC is predicted to act as a groundwater sink.

6. References

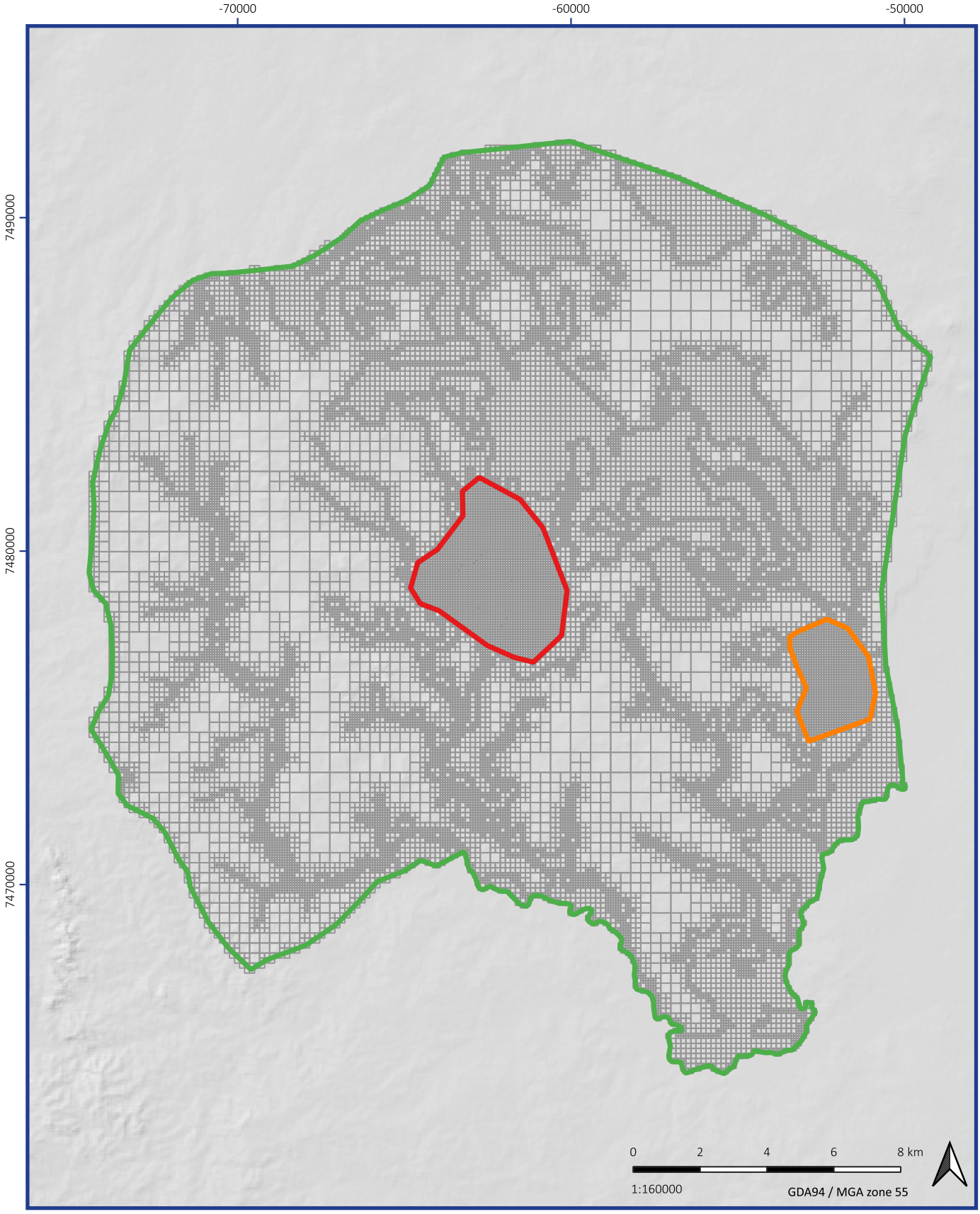
Bakker, M., V. Post, C. D. Langevin, J. D. Hughes, J. T. White, J. J. Starn, and M. N. Fienen. 2016. 'Scripting MODFLOW Model Development Using Python and FloPy'. Groundwater 54(5):733–39. doi: 10.1111/gwat.12413.

Barnett, B., Hunt, R.J., Townley, L.R., Peeters, L., 2012. Australian groundwater modelling guidelines (No. Waterlines Report Series No. 82). National Water Commission, Canberra, ACT, Australia.

JBT Consulting. (2012). *Blair Athol Mine Closure Groundwater Investigation.*

Langevin, C. D., J. D. Hughes, E. R. Banta, A. M. Provost, R. G. Niswonger, and Sorab Panday. 2017. MODFLOW 6 Modular Hydrologic Model: U.S. Geological Survey Software.

Lien, Jyh-Ming, Gaisheng Liu, and C. Langevin. 2015. 'GRIDGEN Version 1.0: A Computer Program for Generating Unstructured Finite-Volume Grids'. Undefined.



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol\4158_Figure 1_model_mesh.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

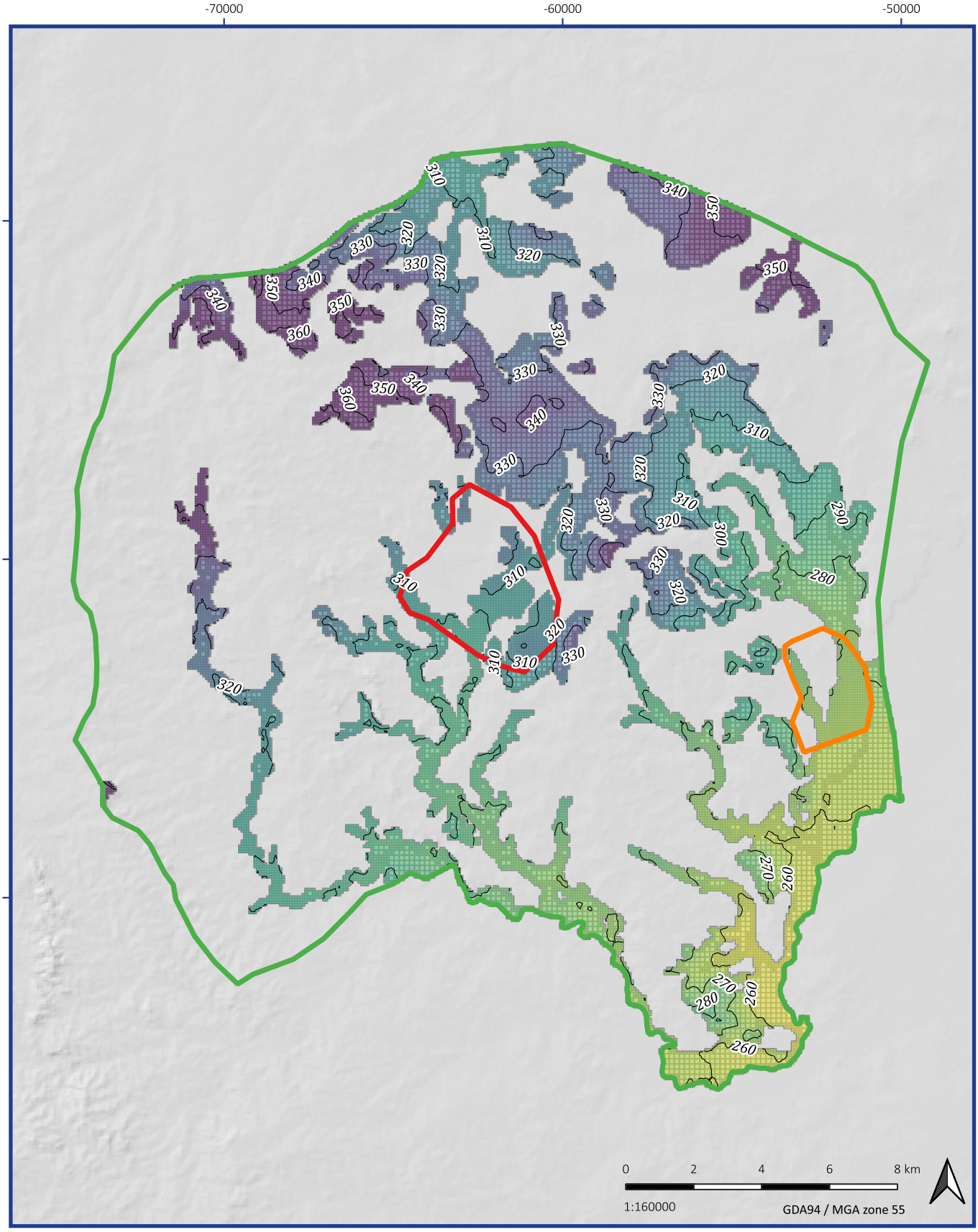
Model mesh

(4158) Blair Athol model

Figure 1

02/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol\4158_Figure 2_bot_layer_1.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

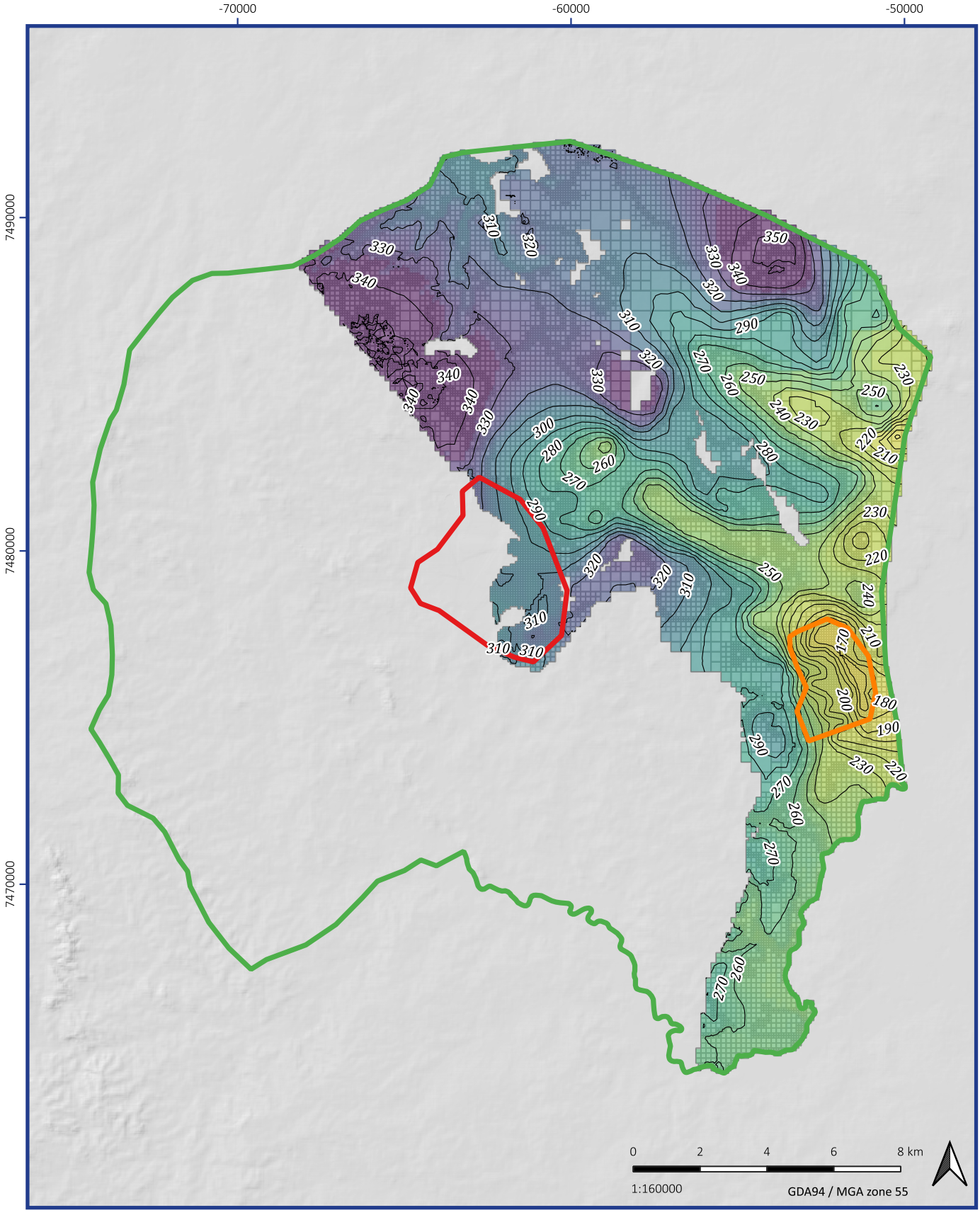
Bottom elevation of Quaternary alluvium (Layer 1)

(4158) Blair Athol model

Figure 2

02/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol\4158_Figure 3_bot_layer_2.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

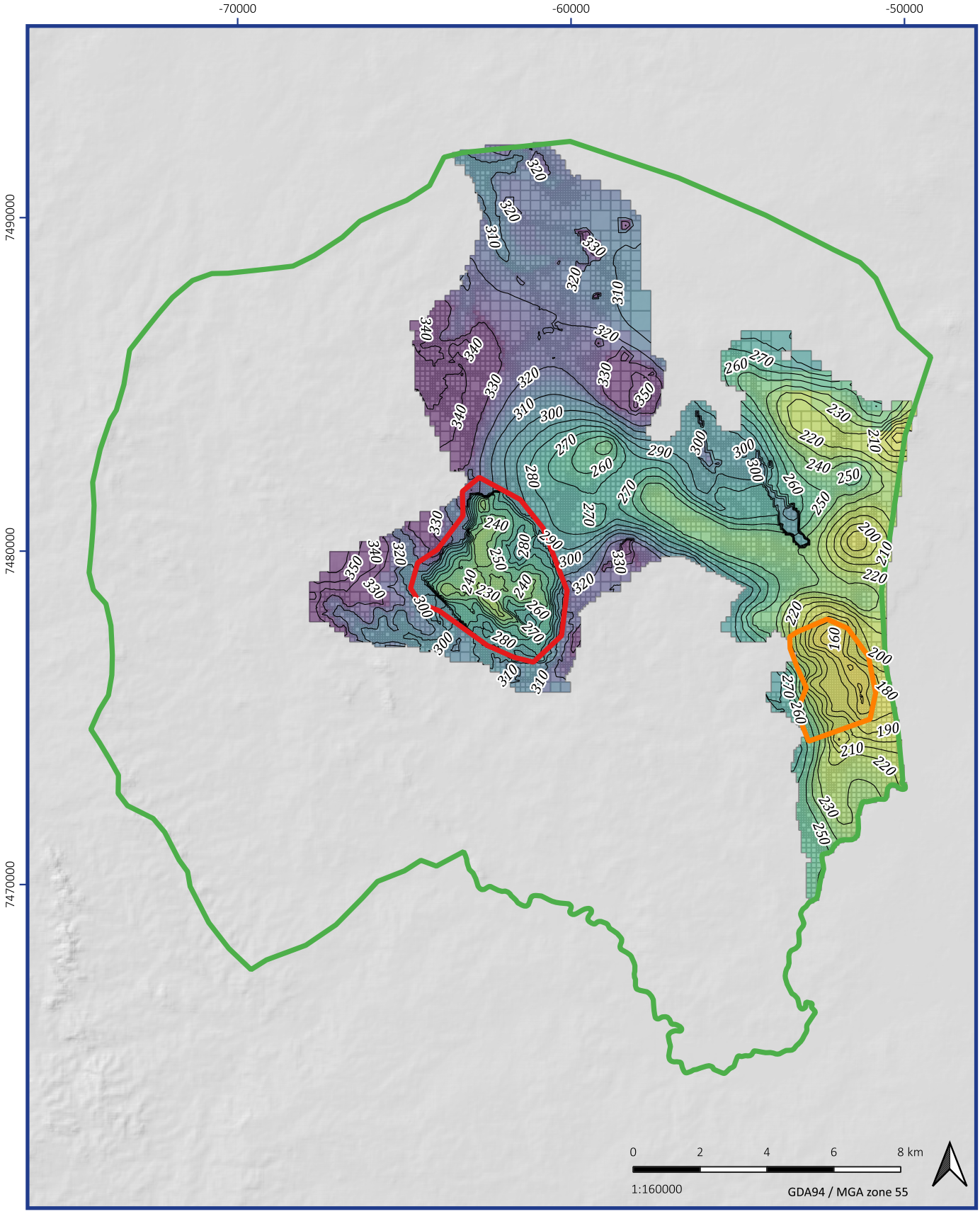
Bottom elevation of Tertiary sediments and basalt (Layer 2)

(4158) Blair Athol model

Figure 3

02/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol\4158_Figure 4_bot_layer_3.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

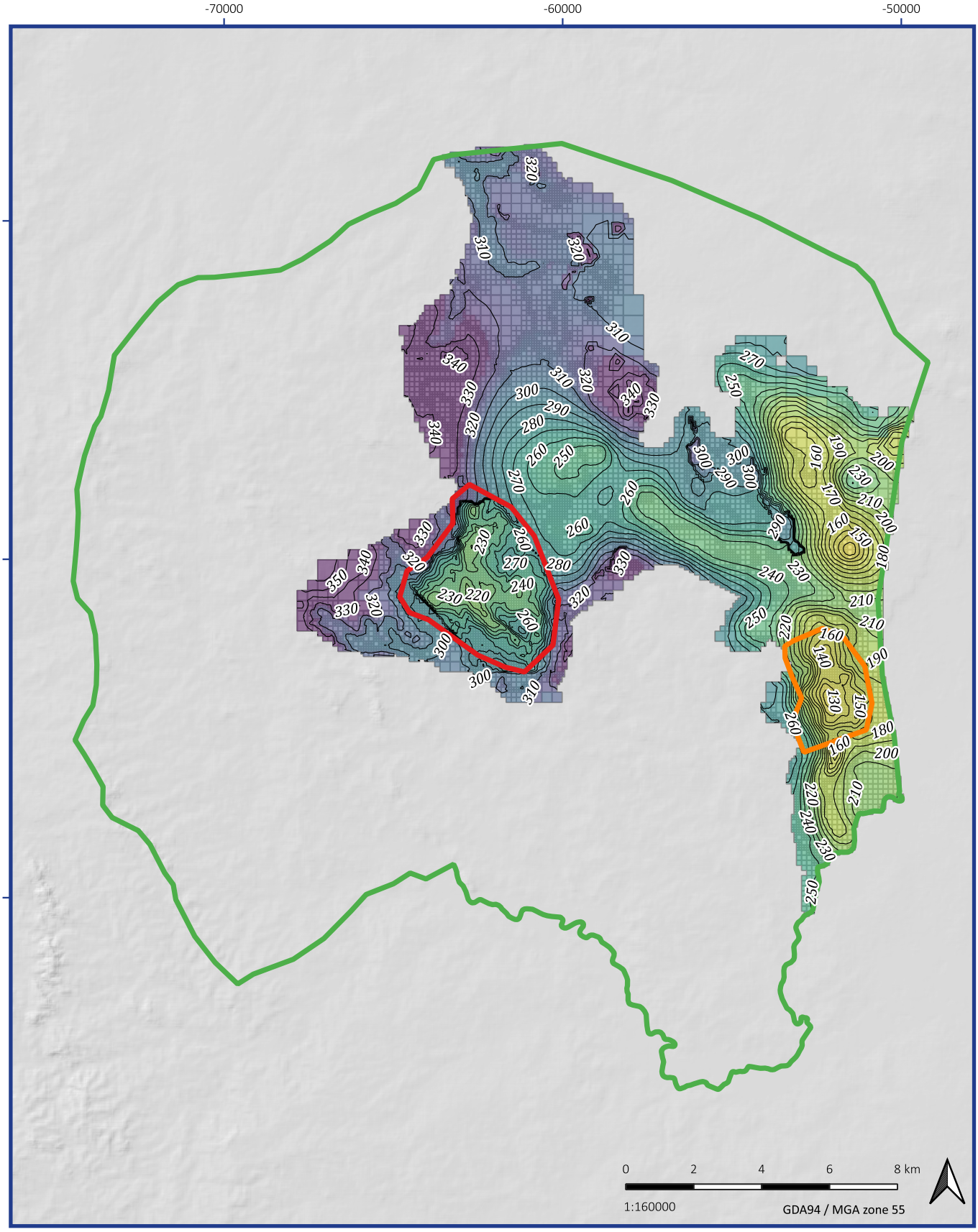
Bottom elevation of Permian overburden (Layer 3)

(4158) Blair Athol model

Figure 4

02/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol\4158_Figure 5_bot_layer_4.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

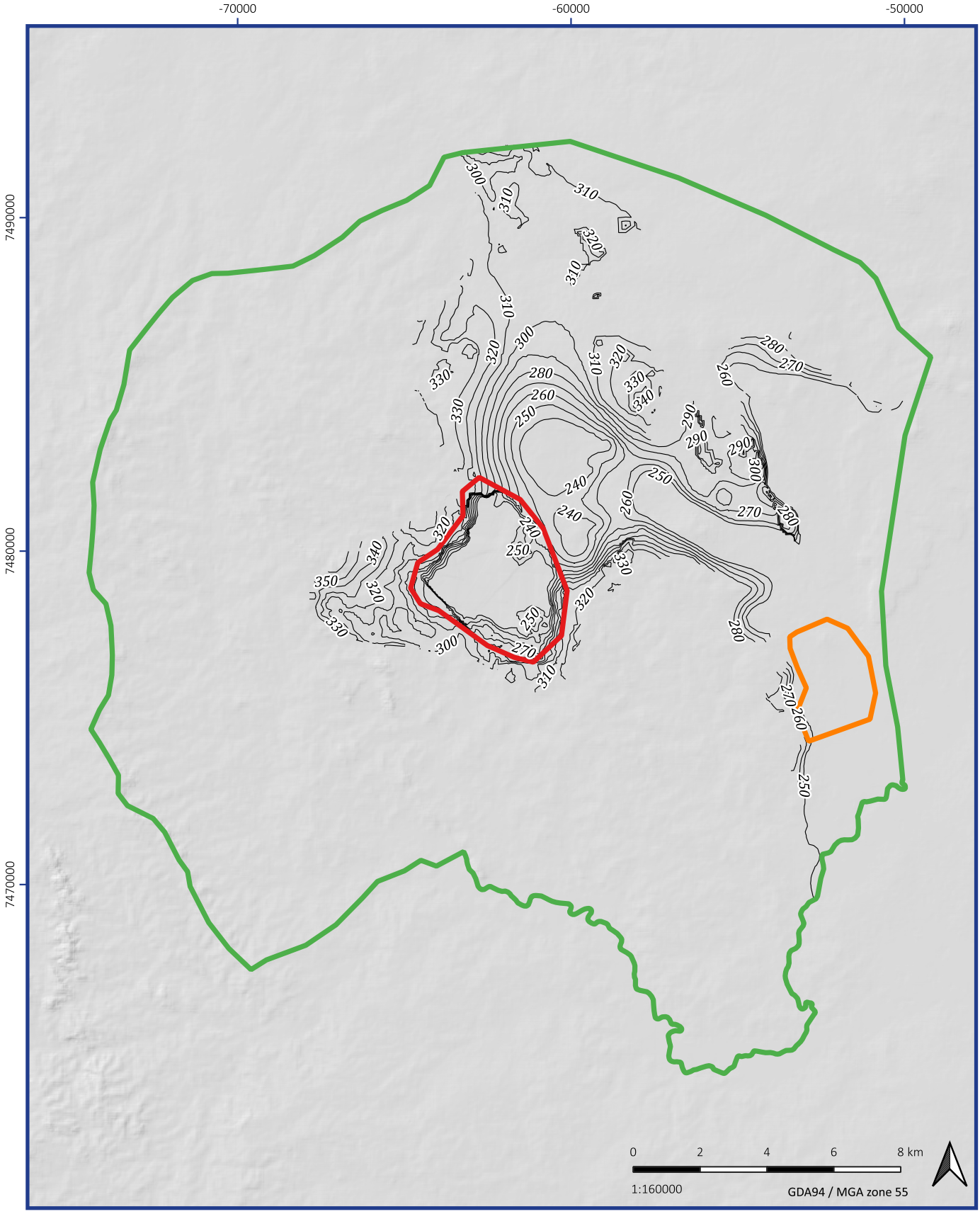
Bottom elevation of Permian coal seams (Layer 4)

(4158) Blair Athol model

Figure 5

02/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol\4158_Figure 5_bot_layer_4.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

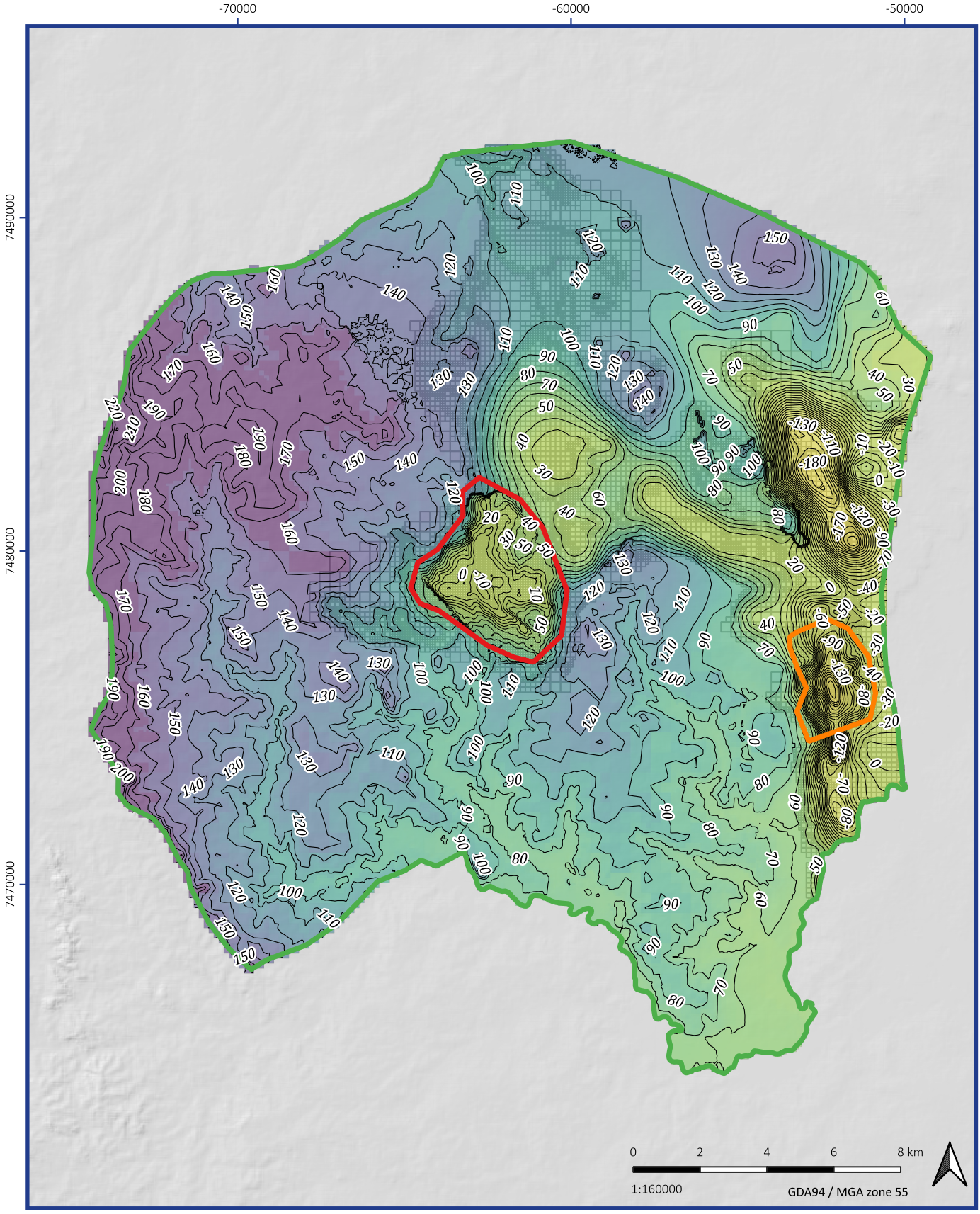
Bottom elevation of Permian underburden (Layer 5)

(4158) Blair Athol model

Figure 6

02/05/2024

hydrogeologist .com.au



Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

Bottom elevation of Basement volcanics (Layer 6)

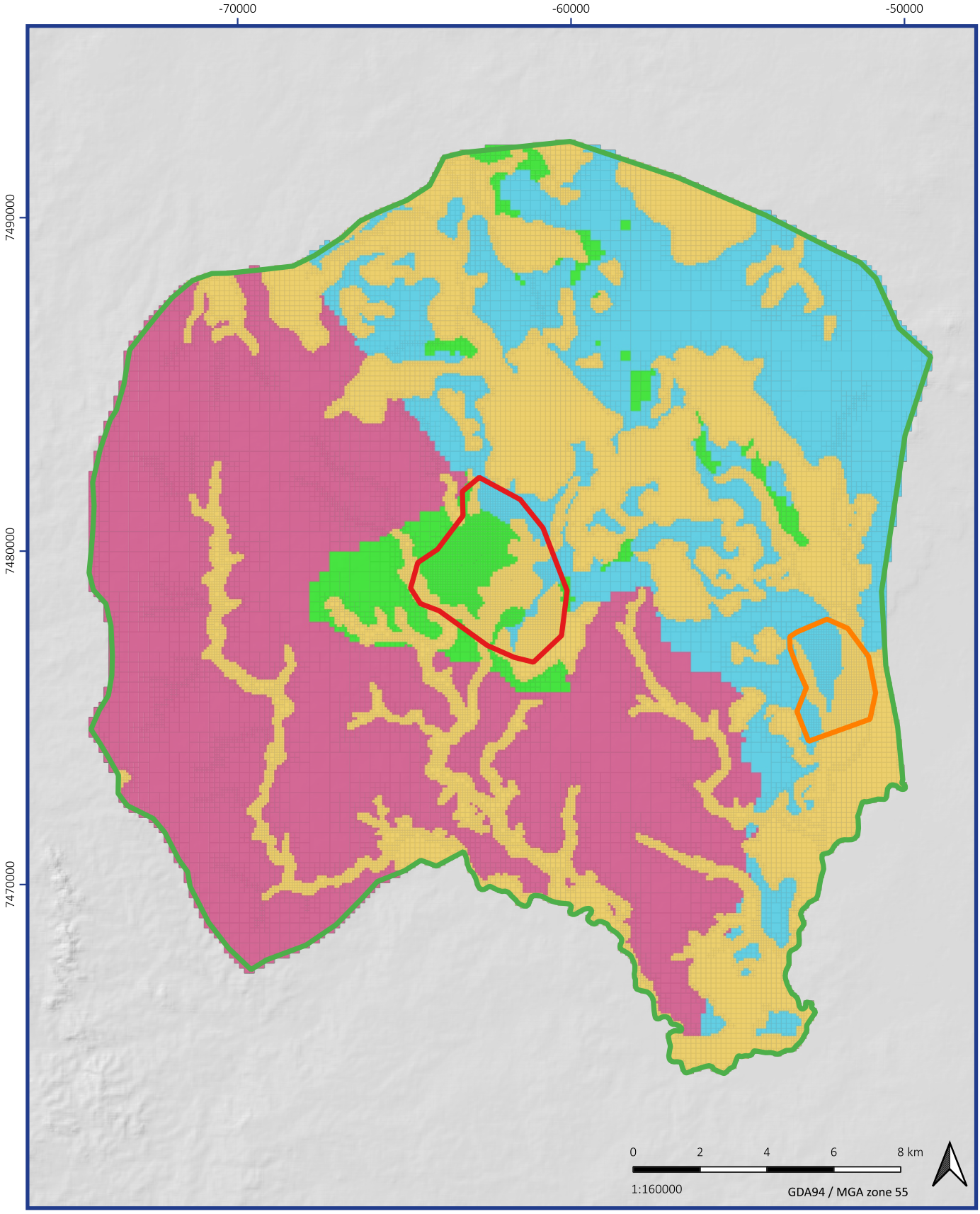
(4158) Blair Athol model

Figure 7

02/05/2024

hydrogeologist.com.au

©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol\4158_Figure 7_bot_layer_6.qgz



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol\4158_Figure 8_recharge_zone.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh
- 1 - Quaternary alluvium
- 2 - Tertiary sediments and basalt
- 3 - Permian overburden
- 6 - Basement volcanic

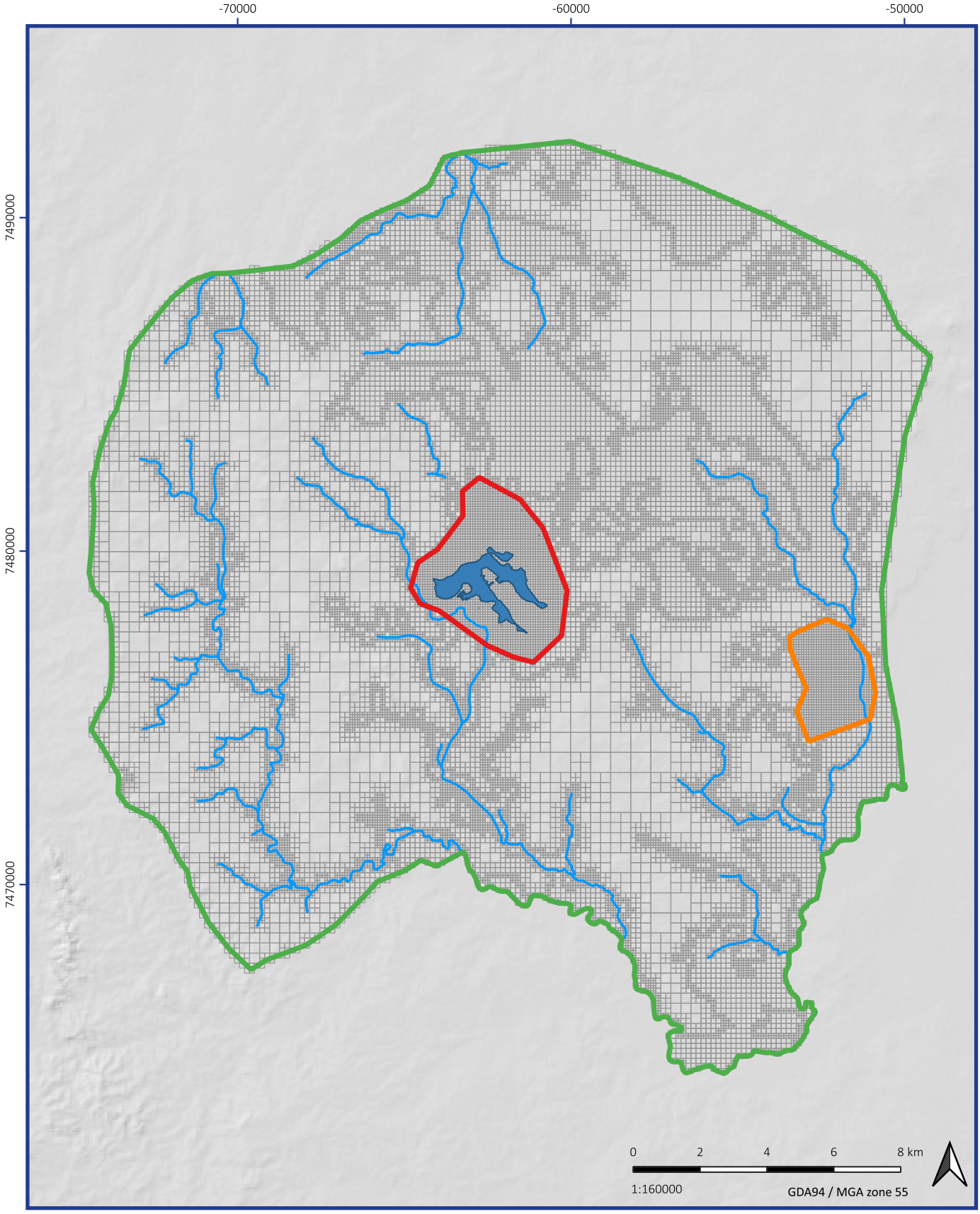
Recharge zones

(4158) Blair Athol model

Figure 8

02/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol\4158_Figure 9_surface_drainage_final_pit.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh
- Surface drainage
- Final pit lake

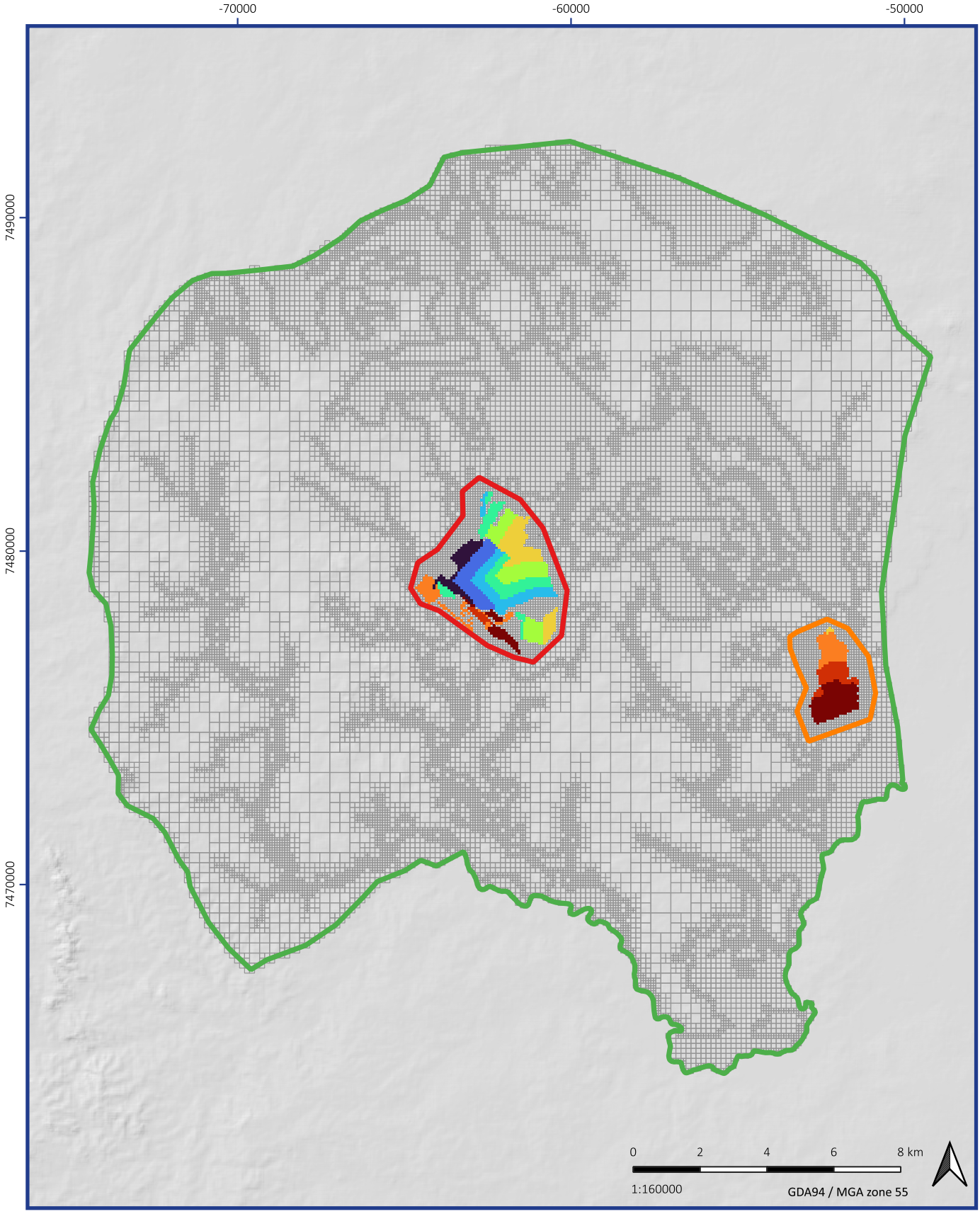
Surface drainage and final pit lake

(4158) Blair Athol model

Figure 9

02/05/2024

hydrogeologist .com.au



Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh
- 1986 - 1990
- 1990 - 1994
- 1994 - 1998
- 1998 - 2002
- 2002 - 2006
- 2006 - 2010
- 2010 - 2014
- 2014 - 2018
- 2018 - 2022

Mining progression

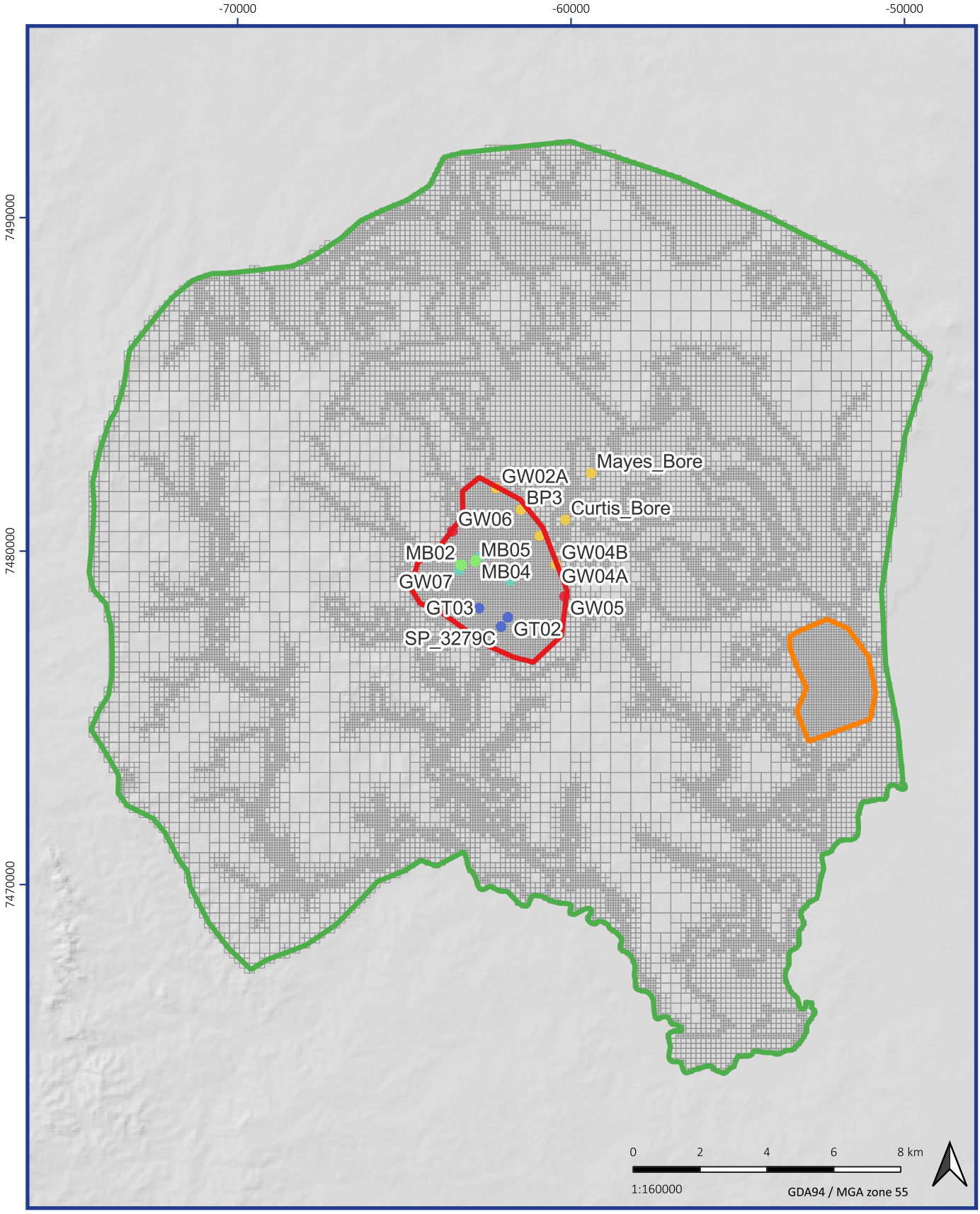
(4158) Blair Athol model

Figure 10

02/05/2024

hydrogeologist .com.au

©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.au|Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006|Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol\4158_Figure 10_mining_progression.qgz



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol\4158_Figure 11_bore_location.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh
- Bores targeted in Layer 1
- Bores targeted in Layer 2
- Bores targeted in Layer 3
- Bores targeted in Layer 4
- Bores targeted in Layer 5

Location of observation sites

(4158) Blair Athol model

Figure 11

02/05/2024

hydrogeologist.com.au

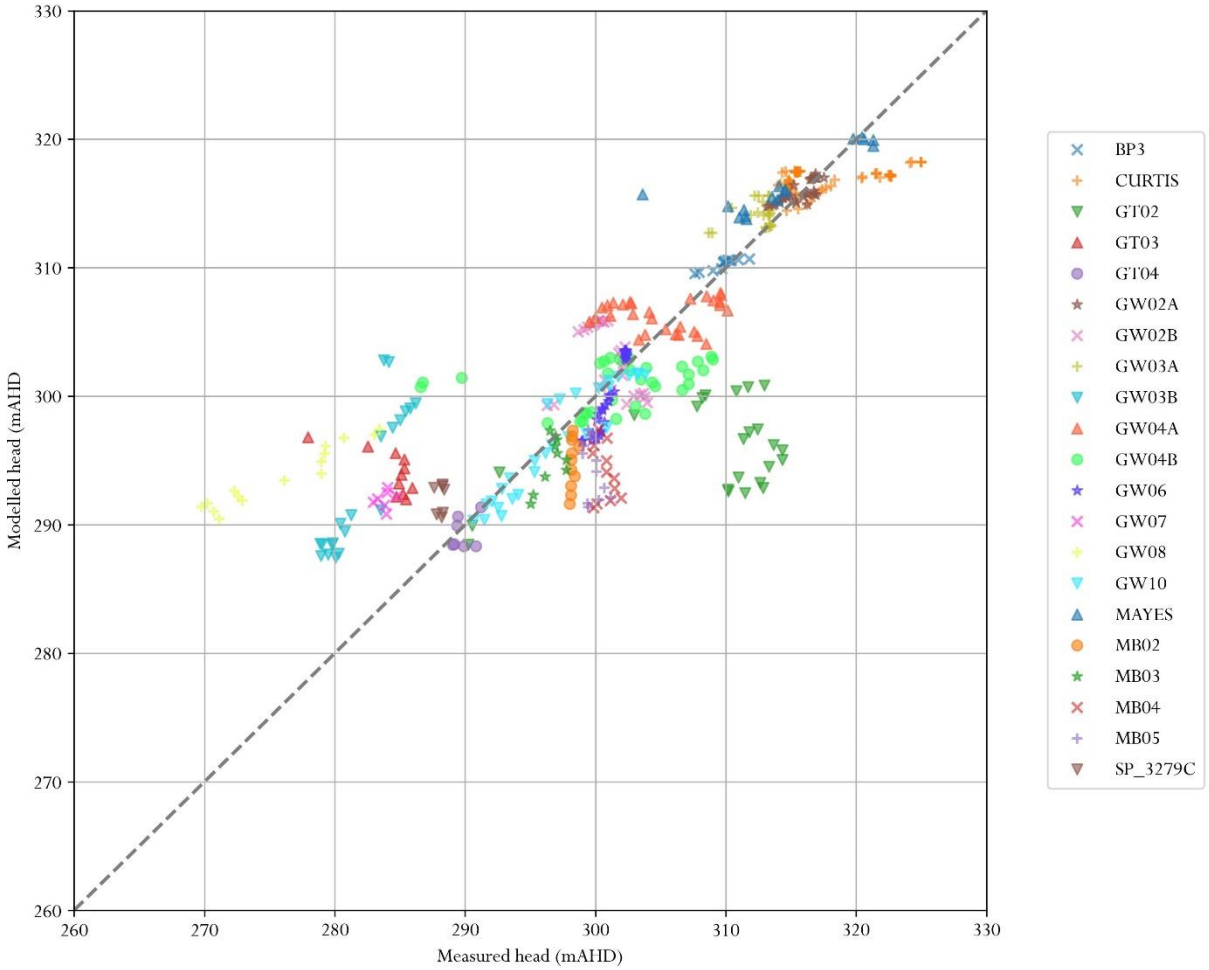
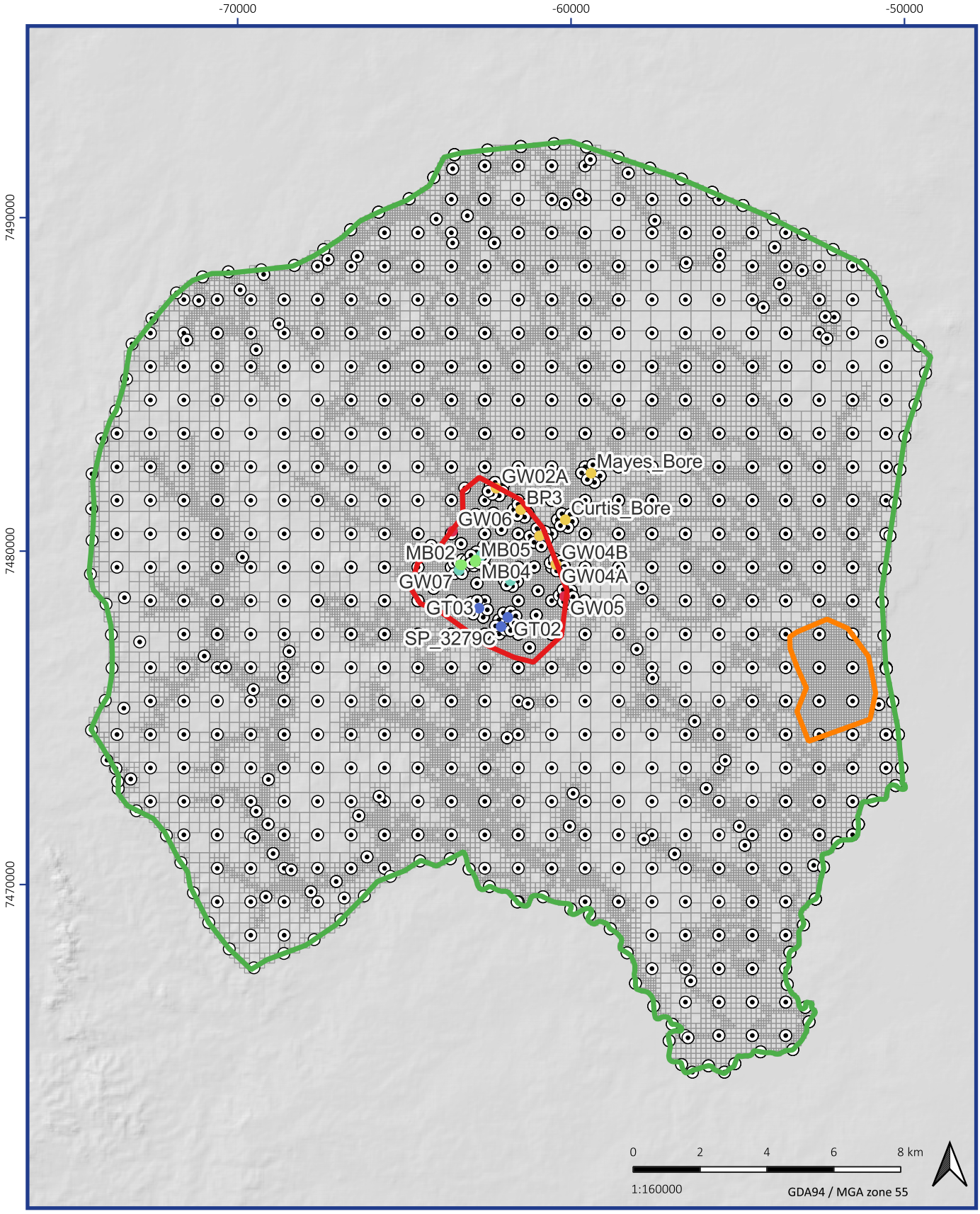


Figure 12 Model calibration scatter diagrams – observed and modelled heads



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol\4158_Figure 12_pilot_points.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh
- Pilot points

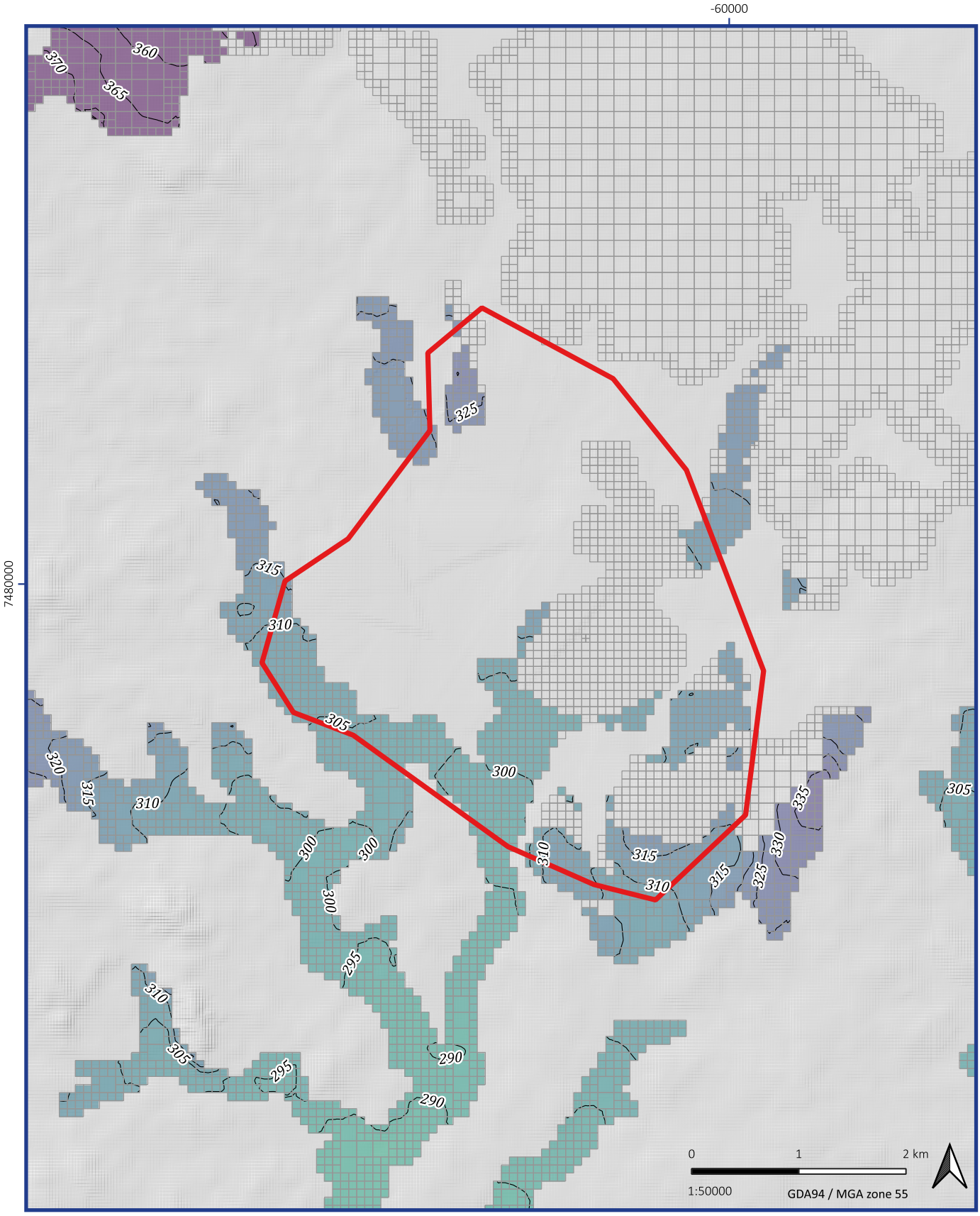
Location of pilot points

(4158) Blair Athol model

Figure 13

02/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 14_cal_sat_heads_layer_1.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

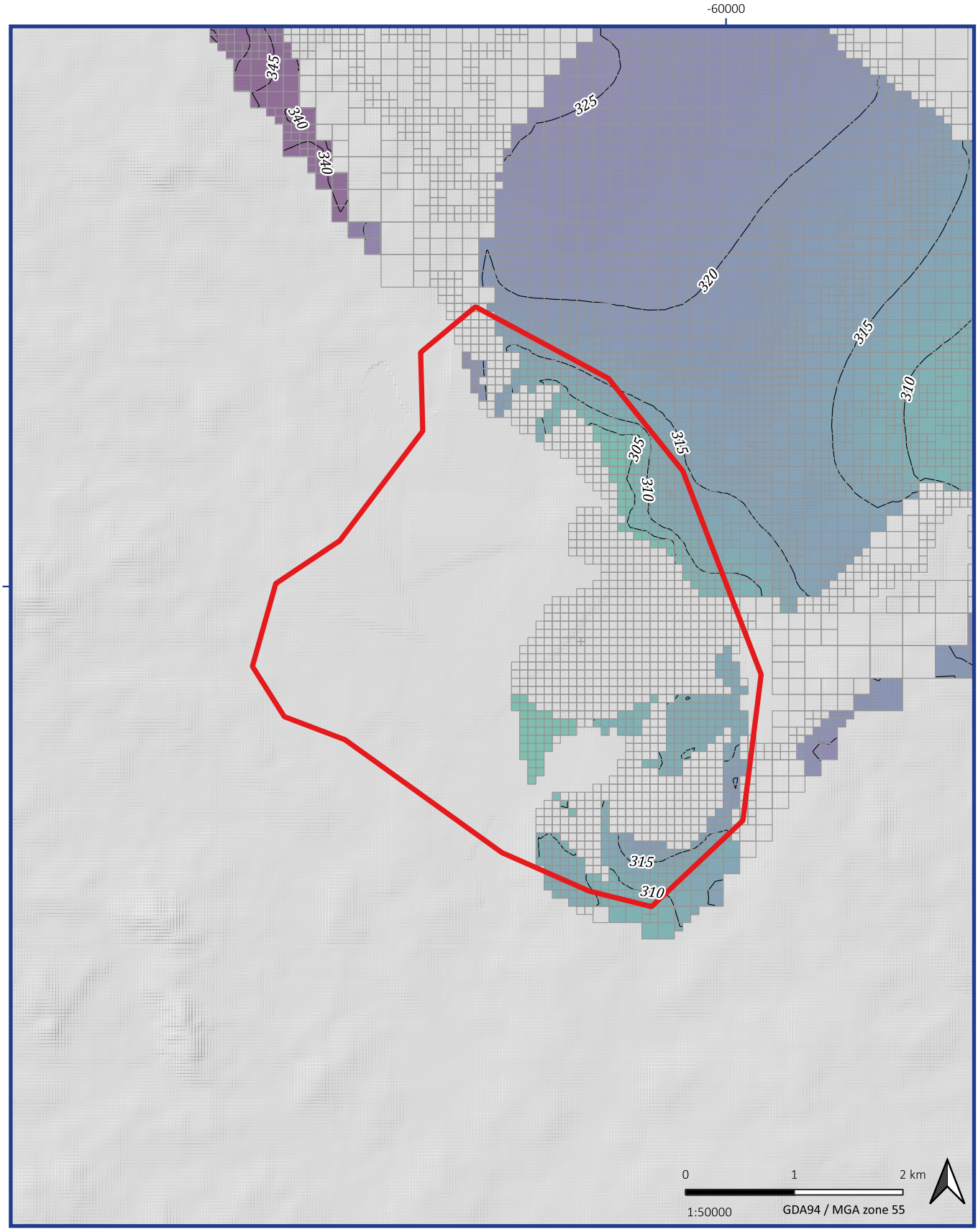
Modelled saturated heads in Layer 1 at the end of calibration

(4158) Blair Athol model

Figure 14

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 15_cal_sat_heads_layer_2.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

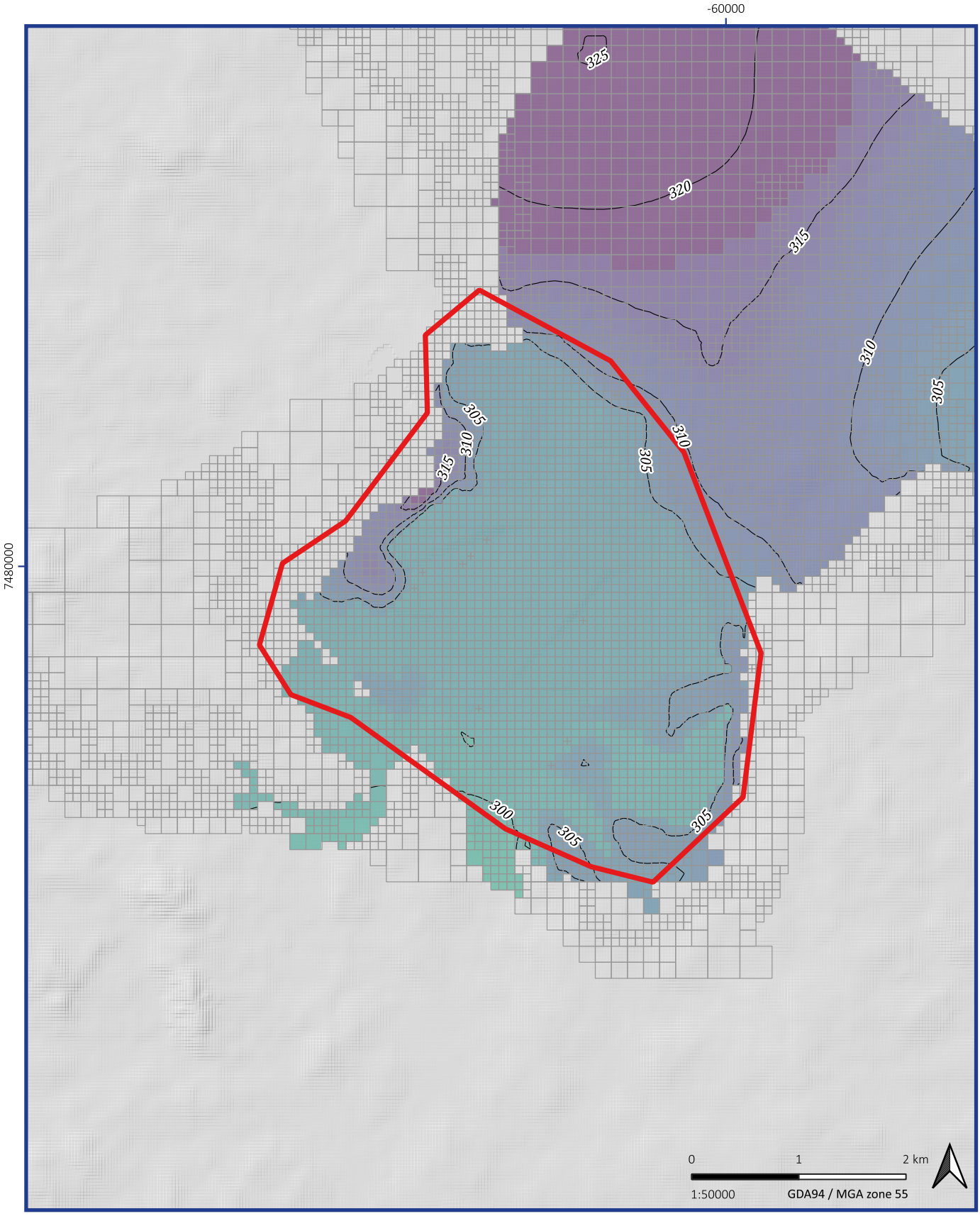
Modelled saturated heads in Layer 2 at the end of calibration

(4158) Blair Athol model

Figure 15

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moonvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 16_cal_sat_heads_layer_3.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

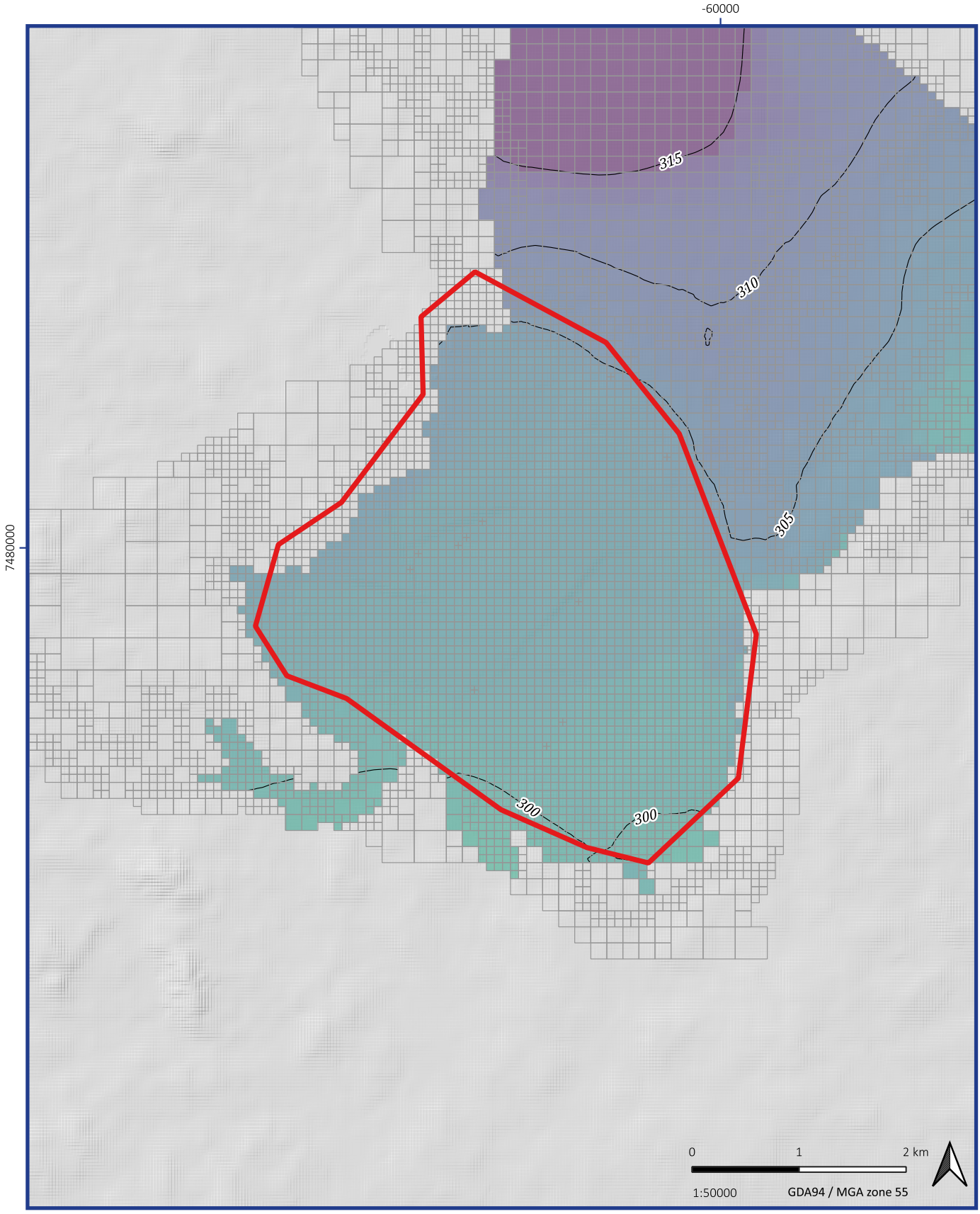
Modelled saturated heads in Layer 3 at the end of calibration

(4158) Blair Athol model

Figure 16

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 17_cal_sat_heads_layer_4.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

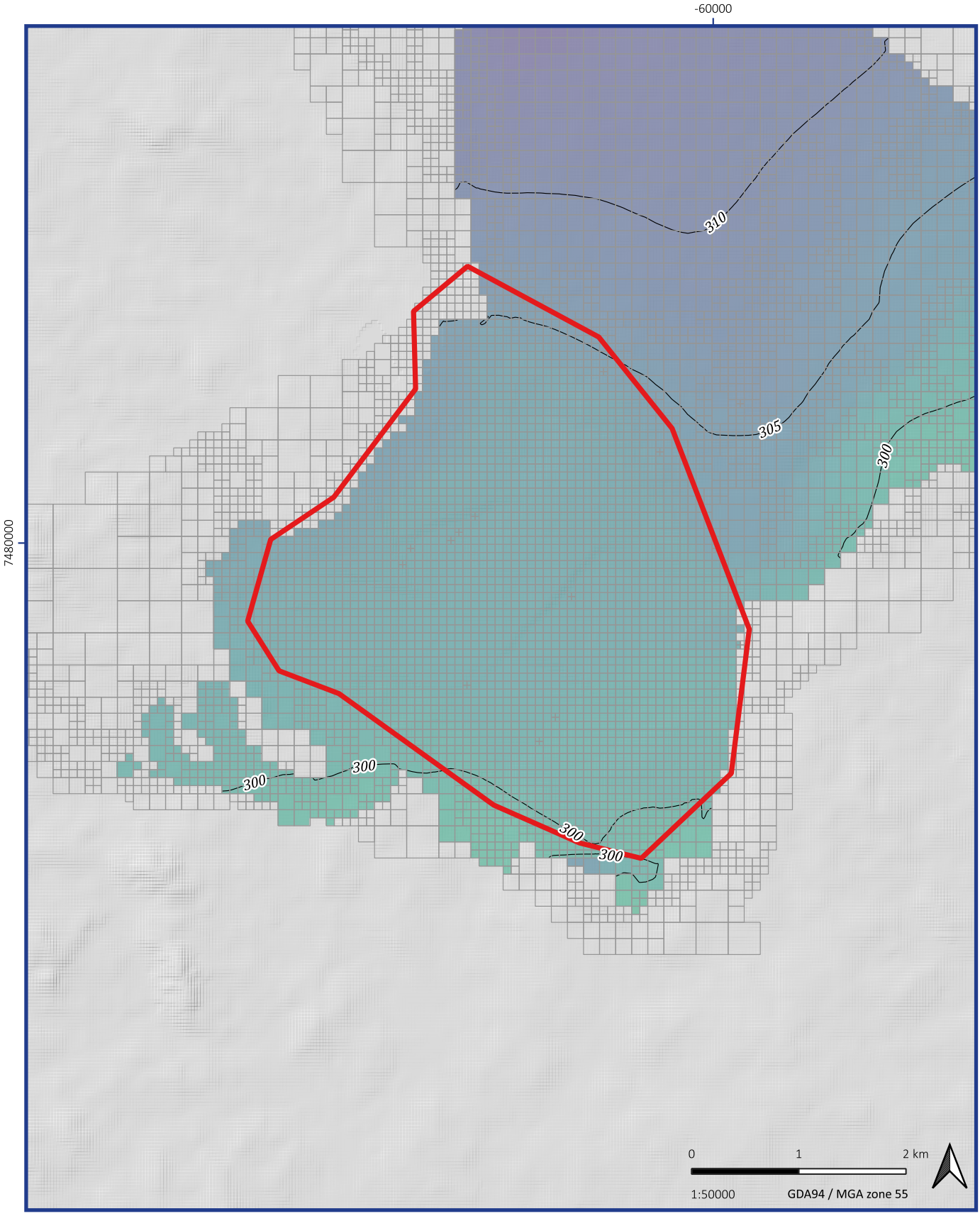
Modelled saturated heads in Layer 4 at the end of calibration

(4158) Blair Athol model

Figure 17

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 18_cal_sat_heads_layer_5.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

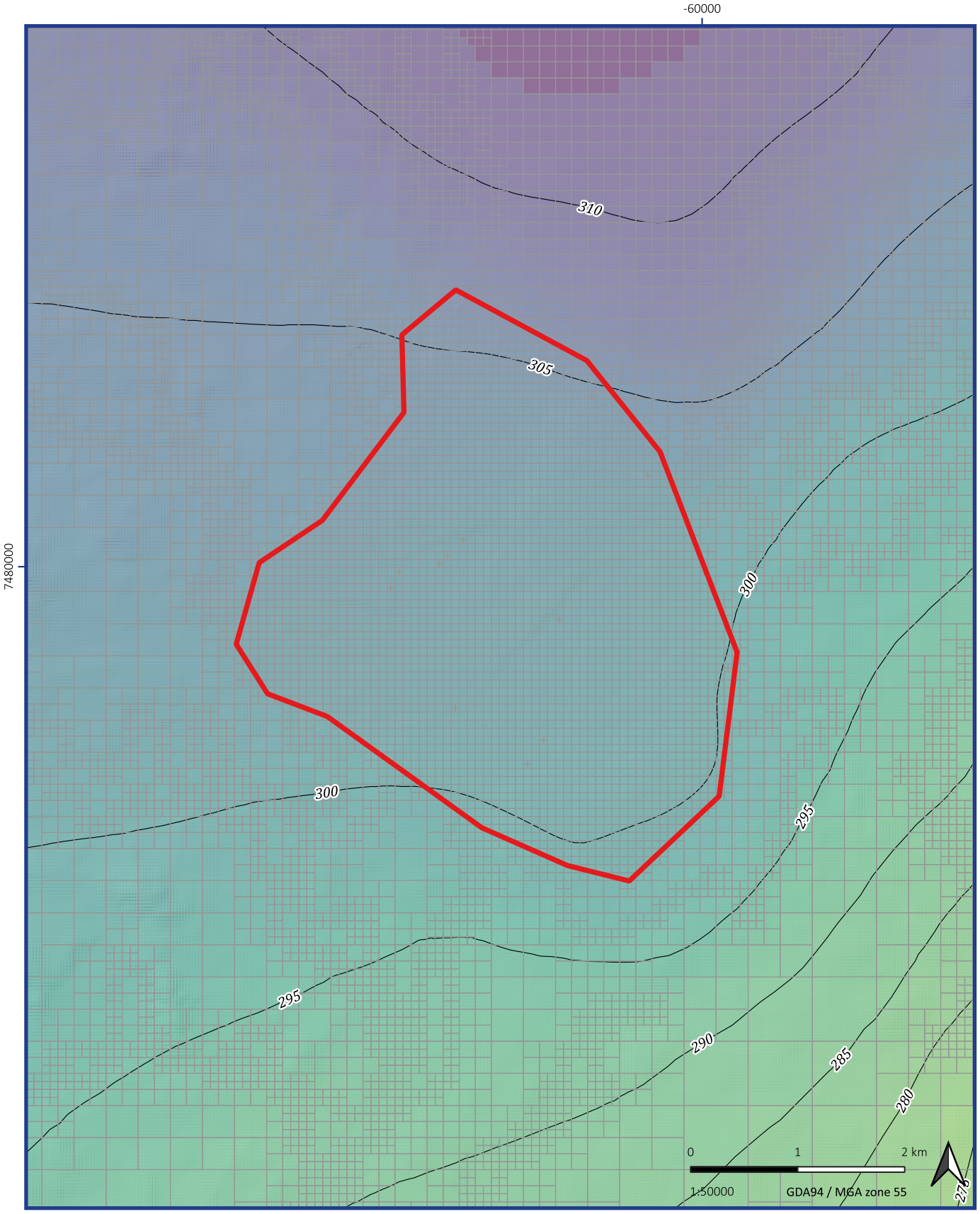
Modelled saturated heads in Layer 5 at the end of calibration

(4158) Blair Athol model

Figure 18

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 19_cal_sat_heads_layer_6.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

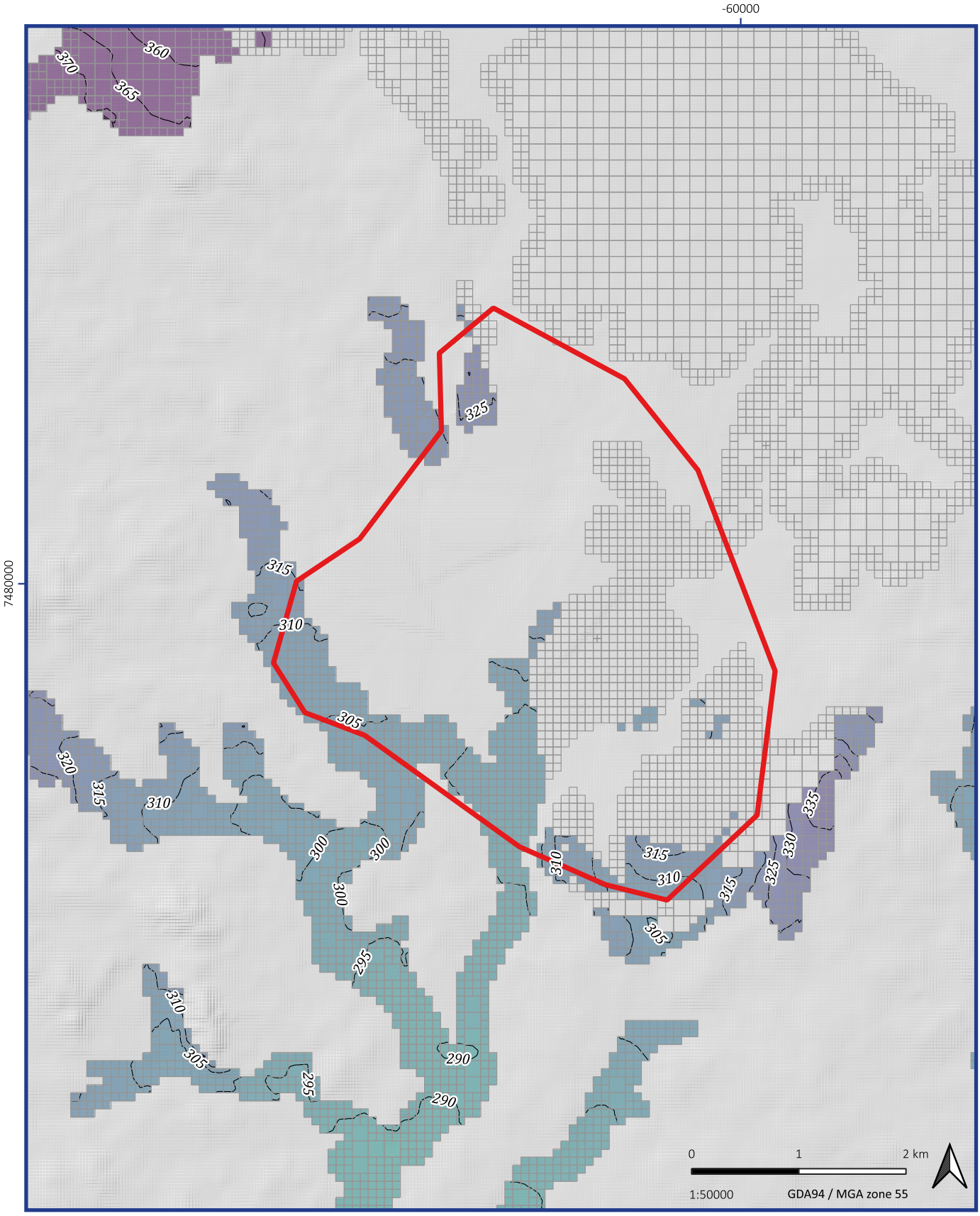
Modelled saturated heads in Layer 6 at the end of calibration

(4158) Blair Athol model

Figure 19

08/05/2024

hydrogeologist.com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006:Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moonvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 20_pred_10y_sat_heads_layer_1.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

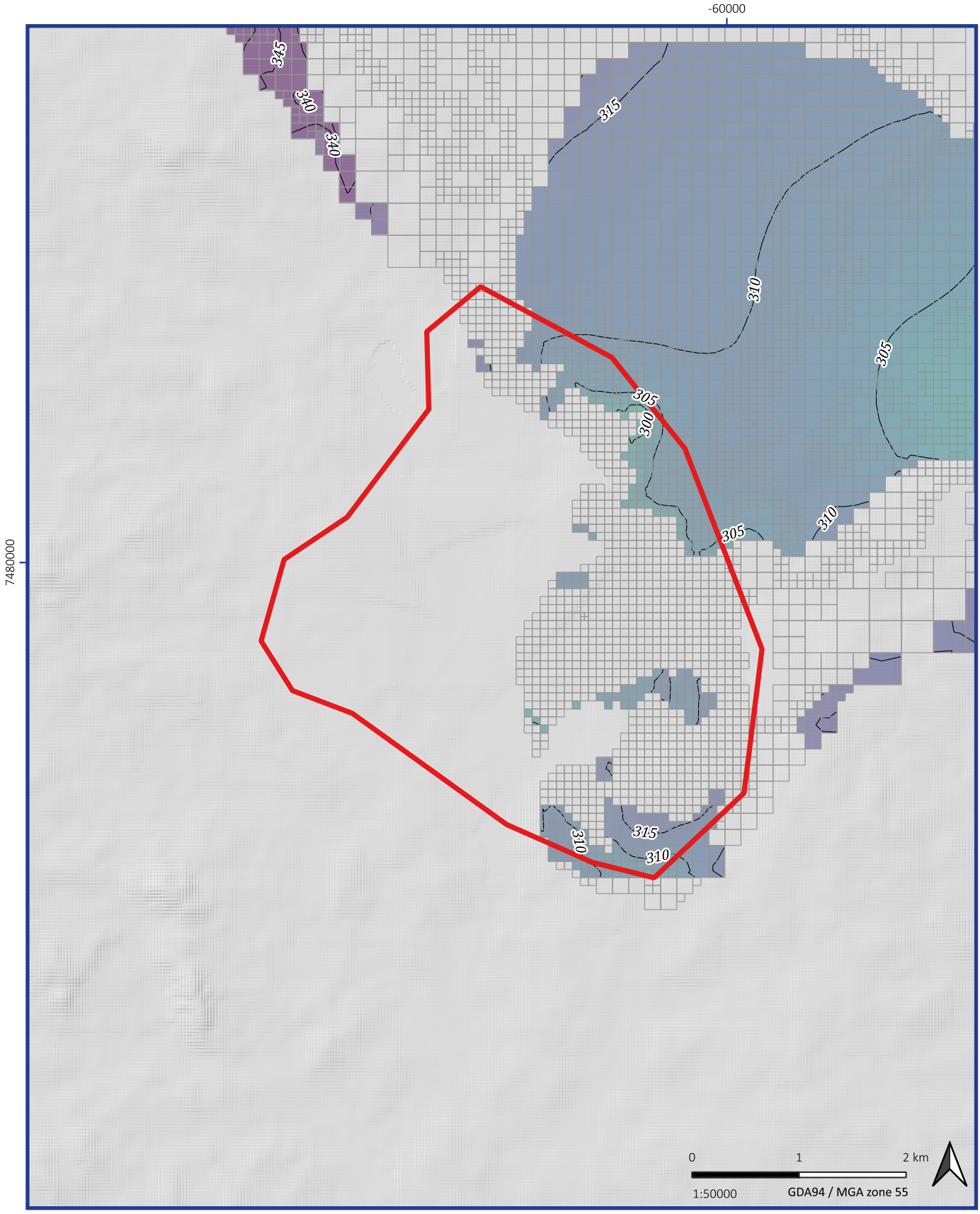
Modelled saturated heads in Layer 1 after 10 years post closure

(4158) Blair Athol model

Figure 20

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 21_pred_10y_sat_heads_layer_2.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

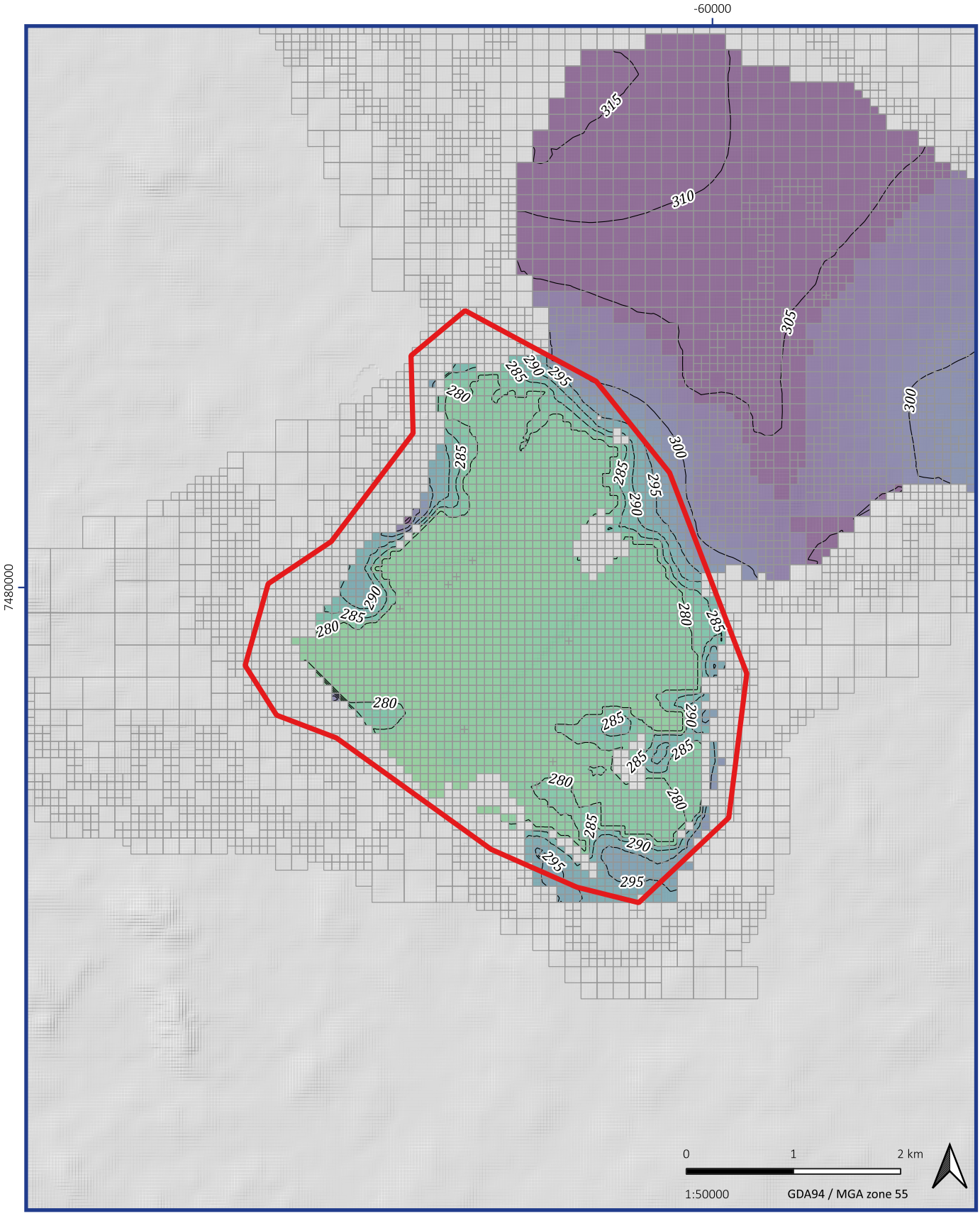
Modelled saturated heads in Layer 2 after 10 years post closure

(4158) Blair Athol model

Figure 21

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006:Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 22_pred_10y_sat_heads_layer_3.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

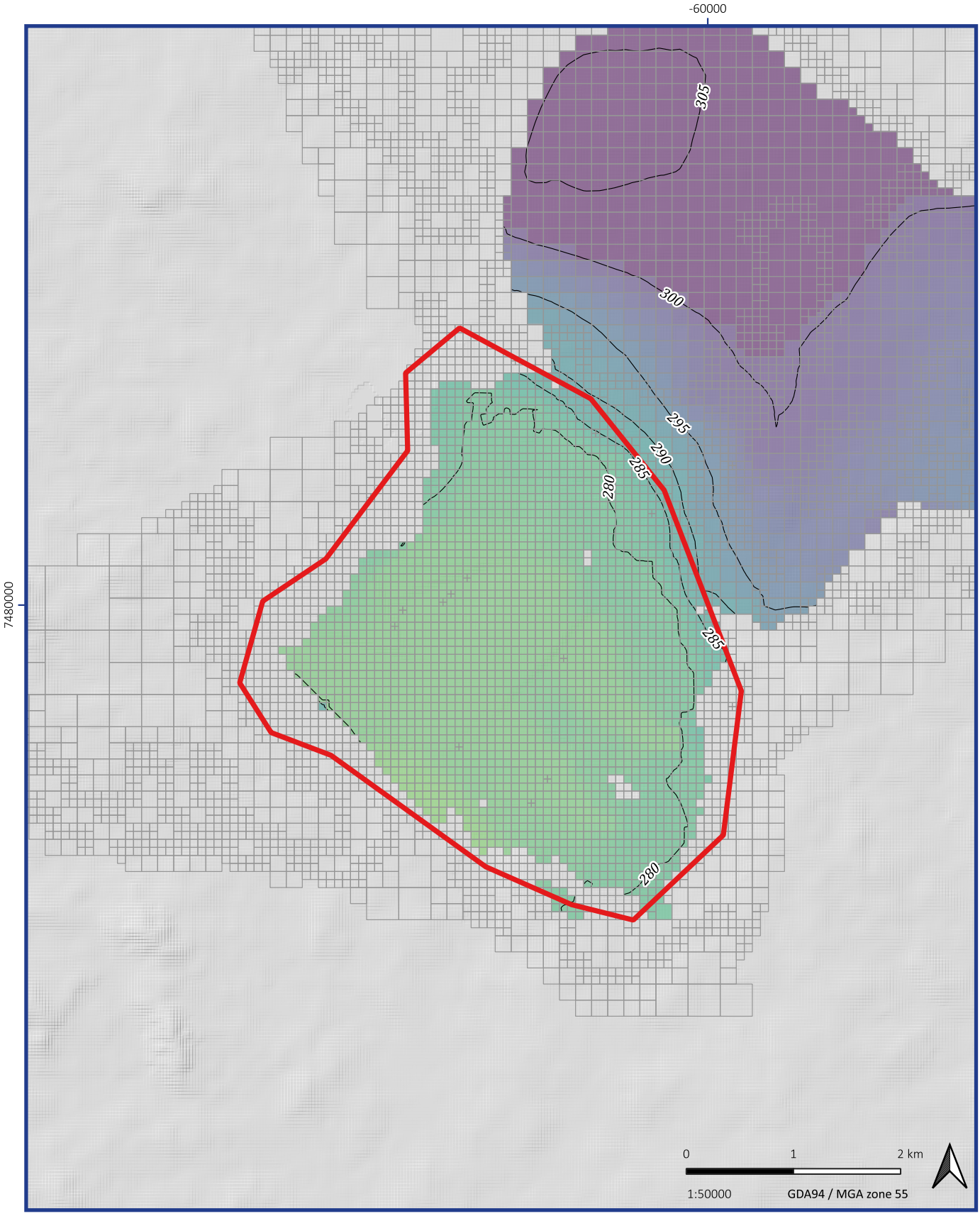
Modelled saturated heads in Layer 3 after 10 years post closure

(4158) Blair Athol model

Figure 22

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006:Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 23_pred_10y_sat_heads_layer_4.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

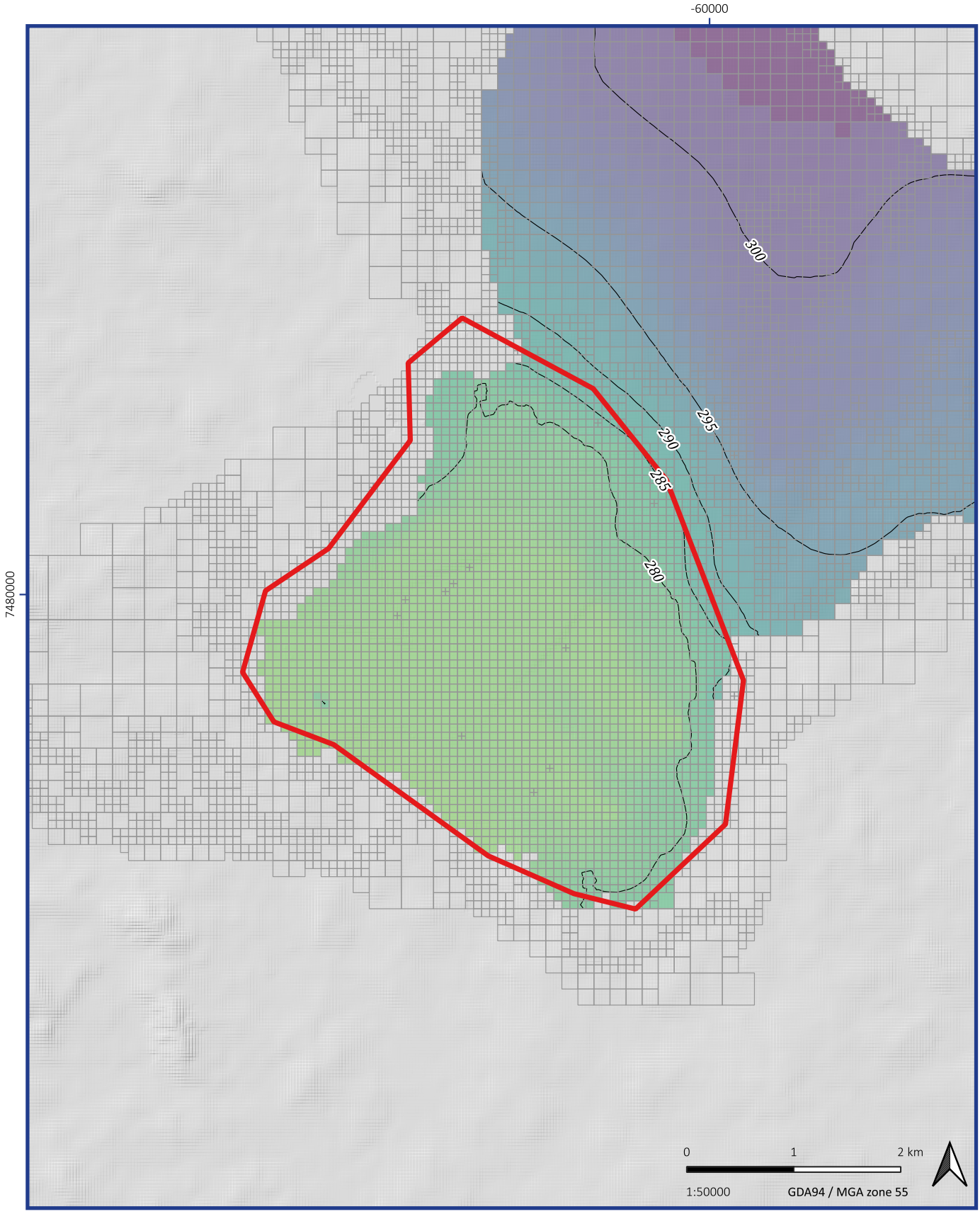
Modelled saturated heads in Layer 4 after 10 years post closure

(4158) Blair Athol model

Figure 23

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 24_pred_10y_sat_heads_layer_5.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

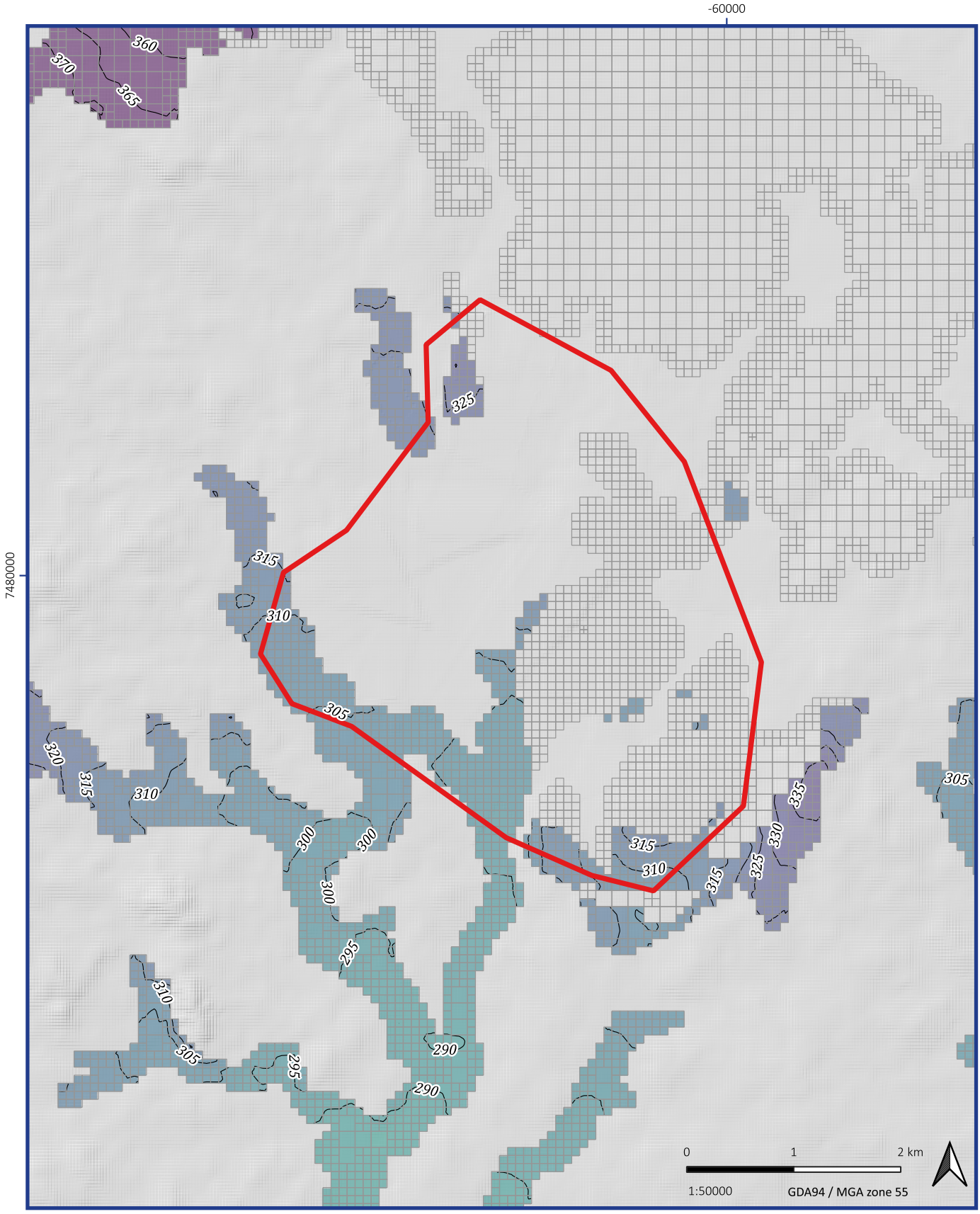
Modelled saturated heads in Layer 5 after 10 years post closure

(4158) Blair Athol model

Figure 24

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moonvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 26_pred_50y_sat_heads_layer_1.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

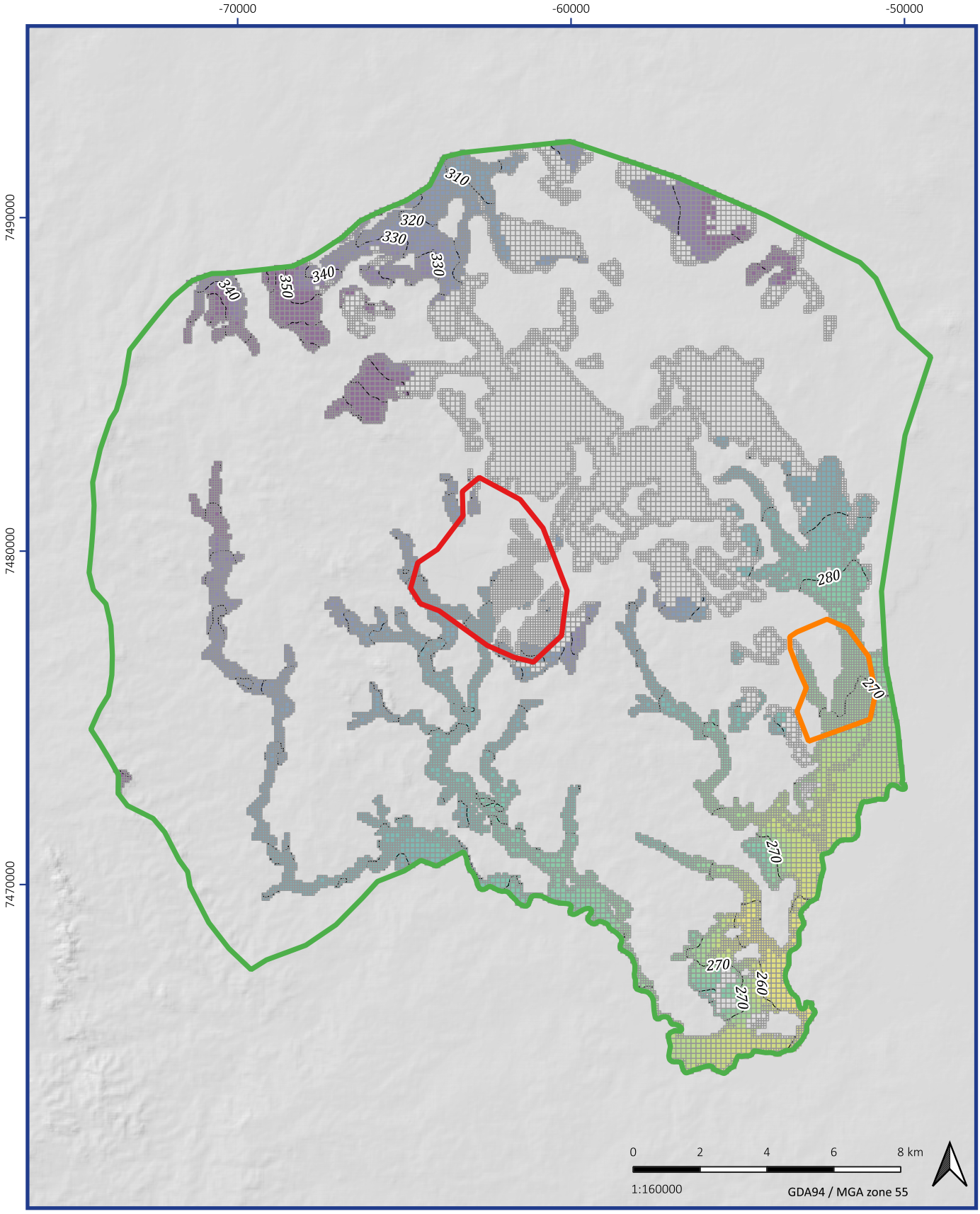
Modelled saturated heads in Layer 6 after 10 years post closure

(4158) Blair Athol model

Figure 25

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 26_pred_50y_sat_heads_layer_1.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

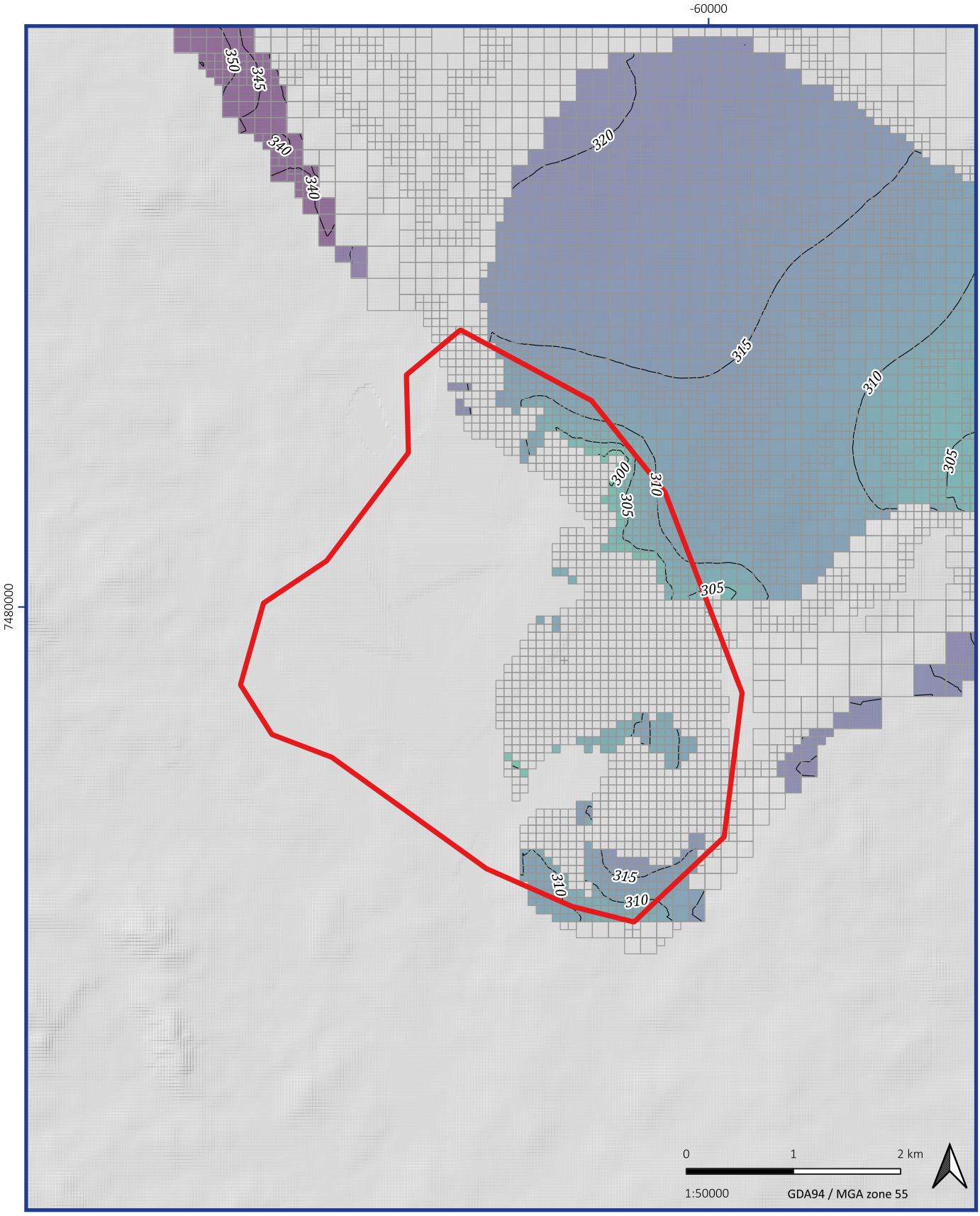
Modelled saturated heads in Layer 1 after 50 years post closure

(4158) Blair Athol model

Figure 26

07/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 27_pred_50y_sat_heads_layer_2.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

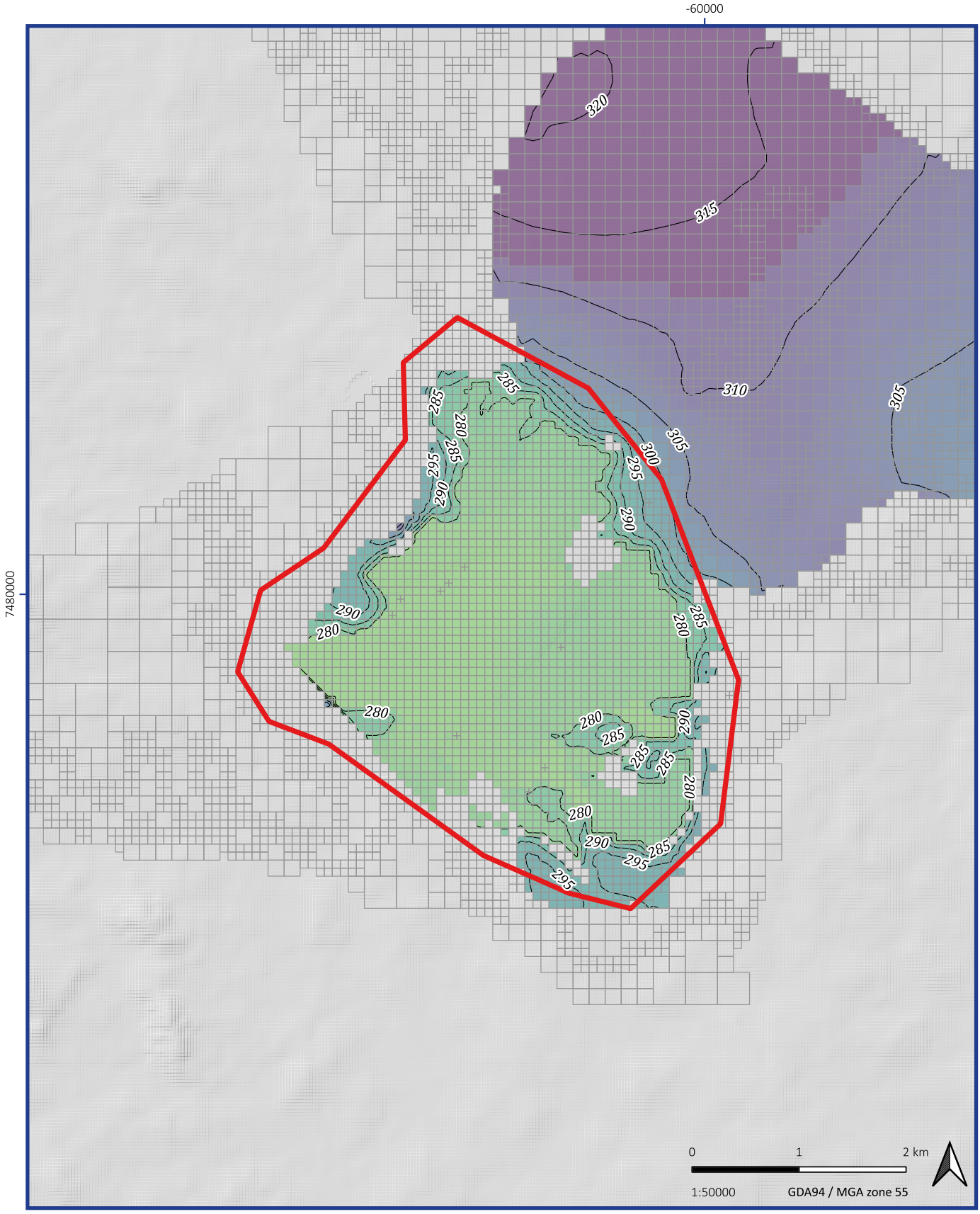
Modelled saturated heads in Layer 2 after 50 years post closure

(4158) Blair Athol model

Figure 27

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 28_pred_50y_sat_heads_layer_3.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

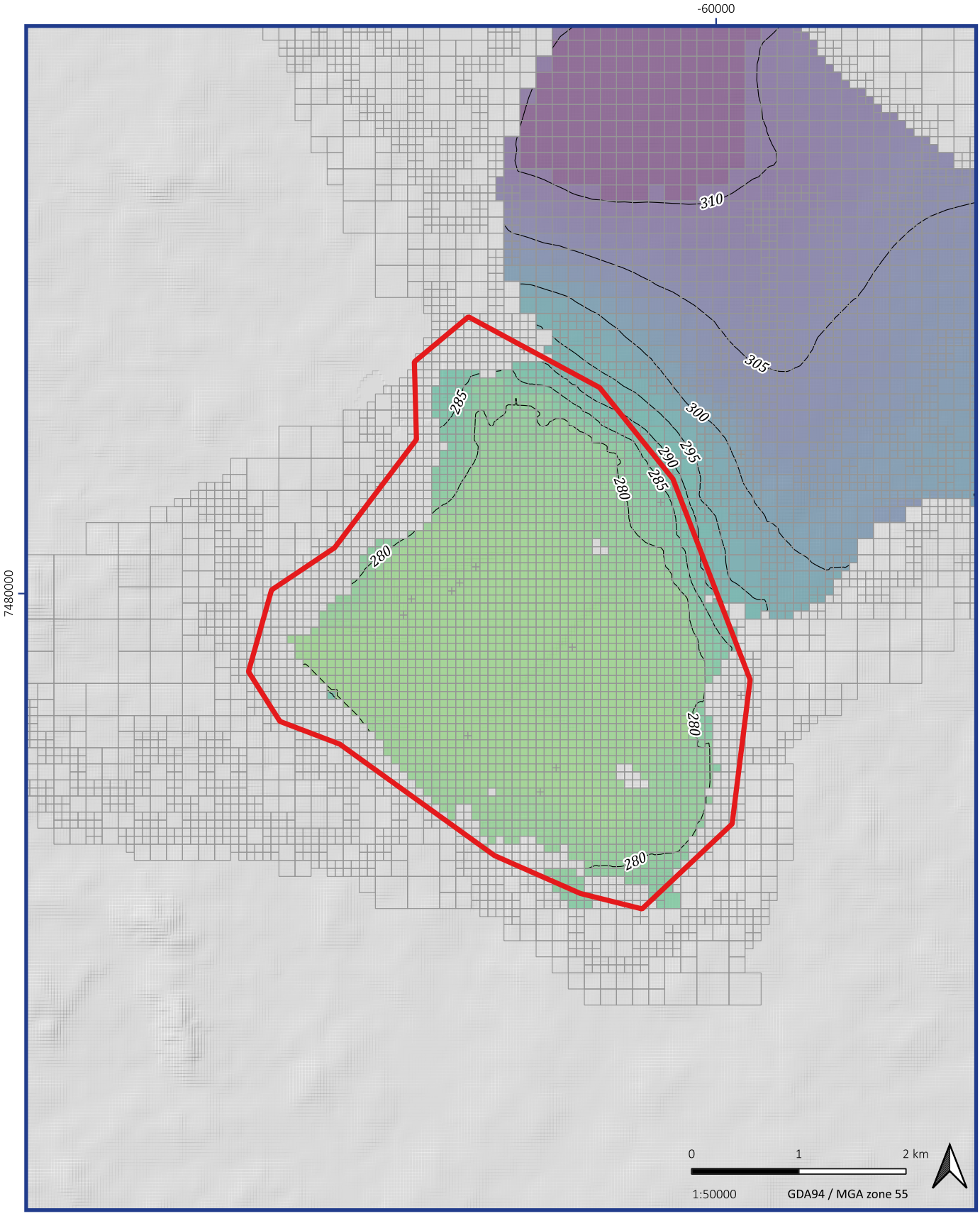
Modelled saturated heads in Layer 3 after 50 years post closure

(4158) Blair Athol model

Figure 28

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 29_pred_50y_sat_heads_layer_4.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

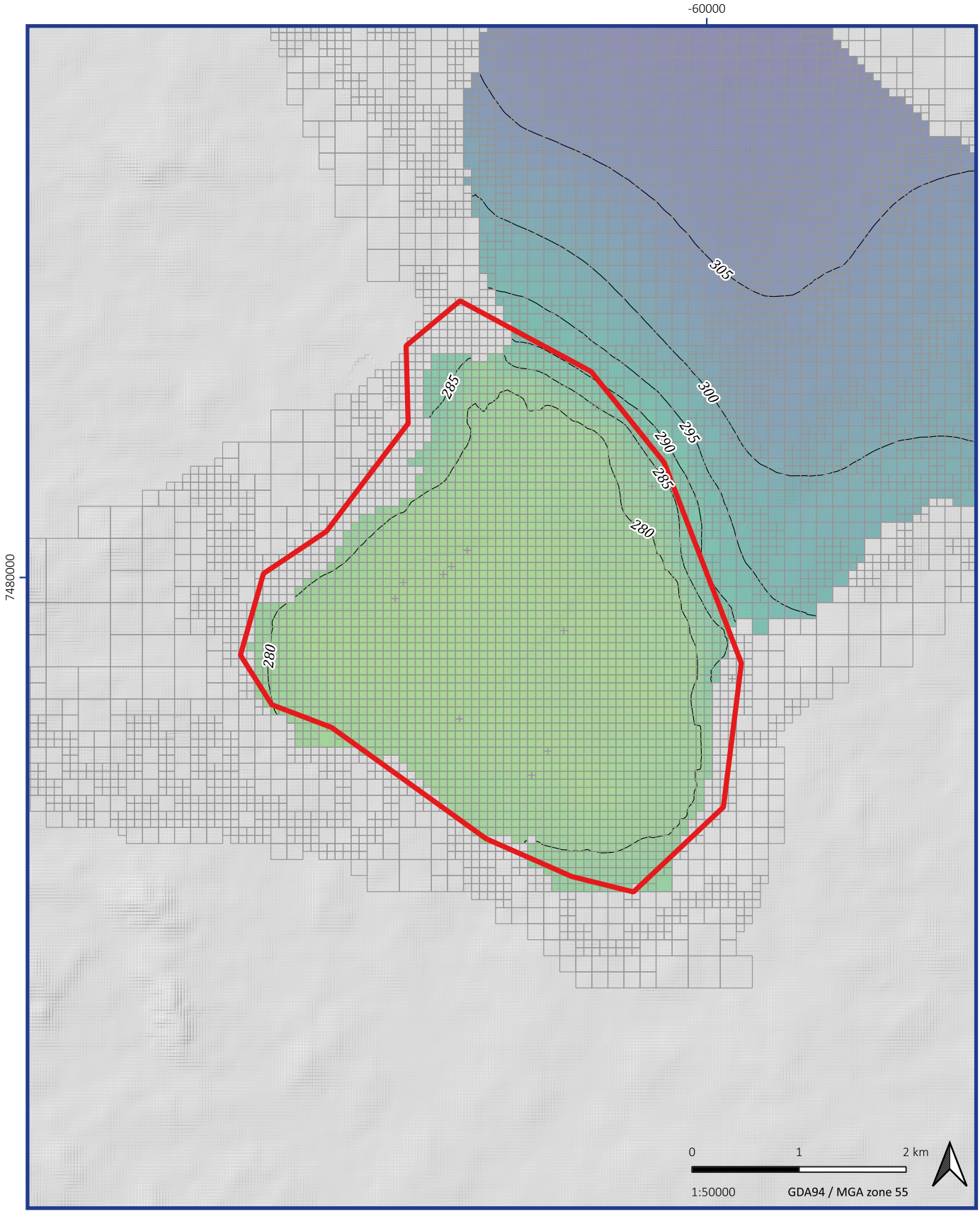
Modelled saturated heads in Layer 4 after 50 years post closure

(4158) Blair Athol model

Figure 29

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 30_pred_50y_sat_heads_layer_5.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

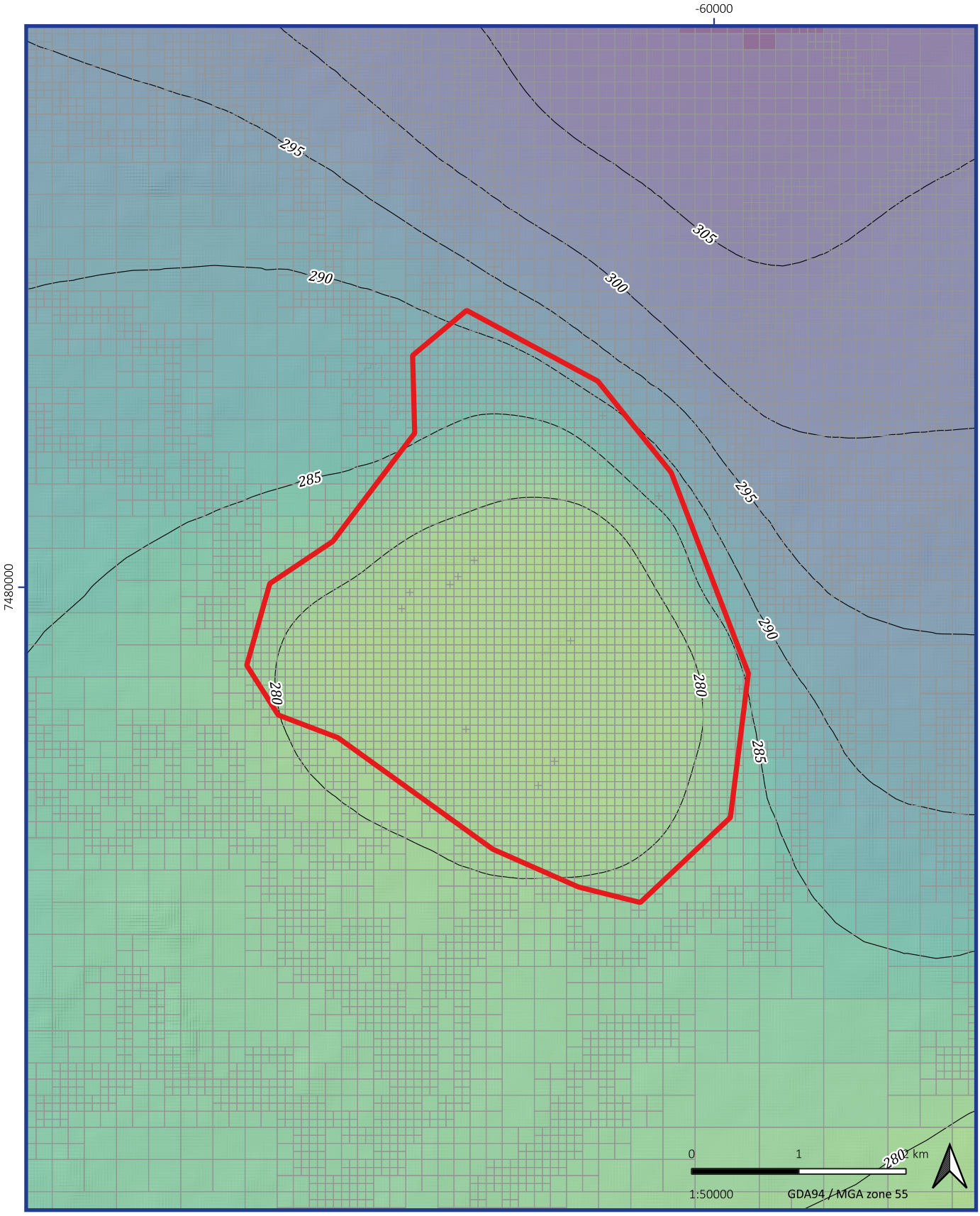
Modelled saturated heads in Layer 5 after 50 years post closure

(4158) Blair Athol model

Figure 30

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 31_pred_50y_sat_heads_layer_6.ogz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

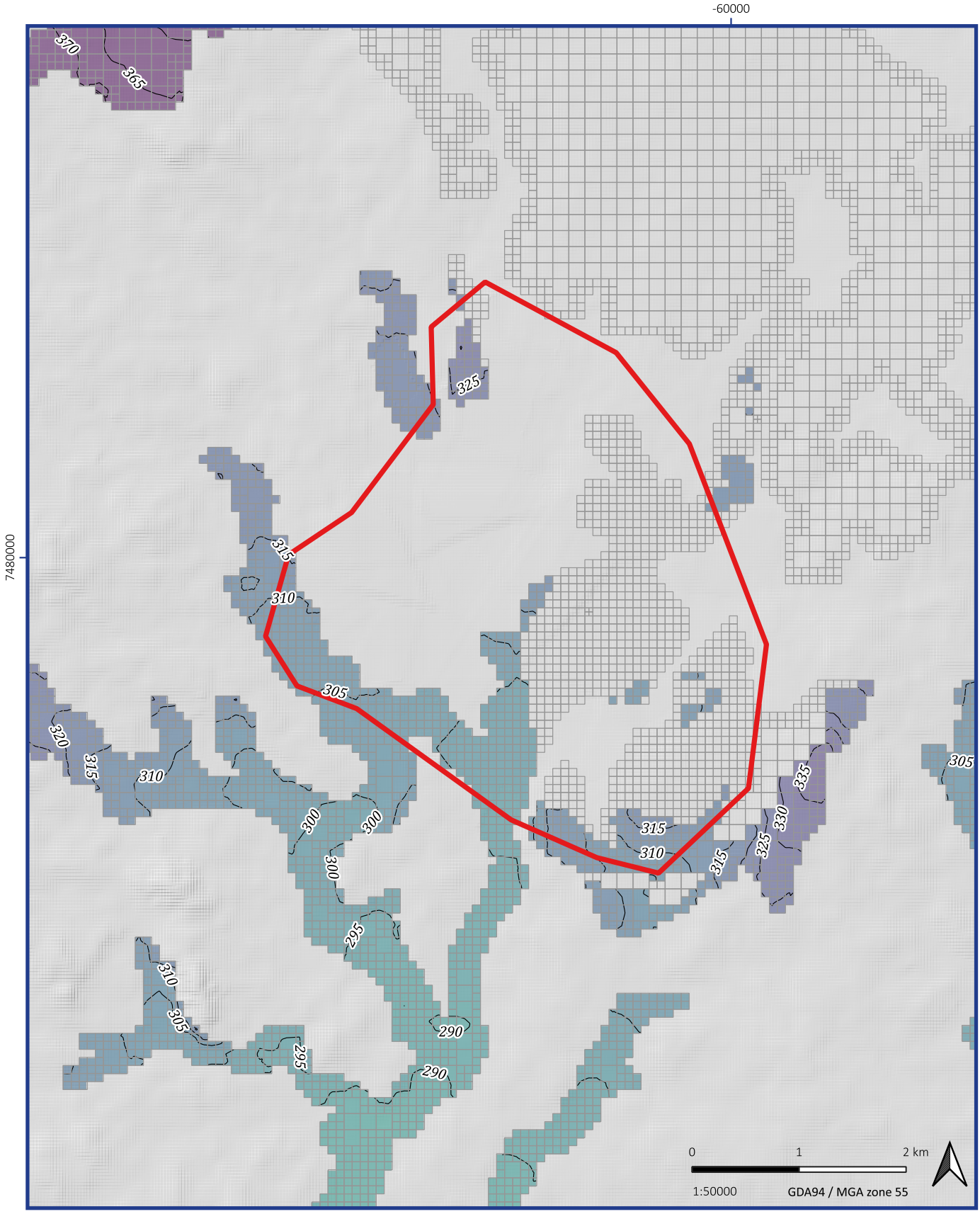
Modelled saturated heads in Layer 6 after 50 years post closure

(4158) Blair Athol model

Figure 31

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 32_pred_100y_sat_heads_layer_1.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

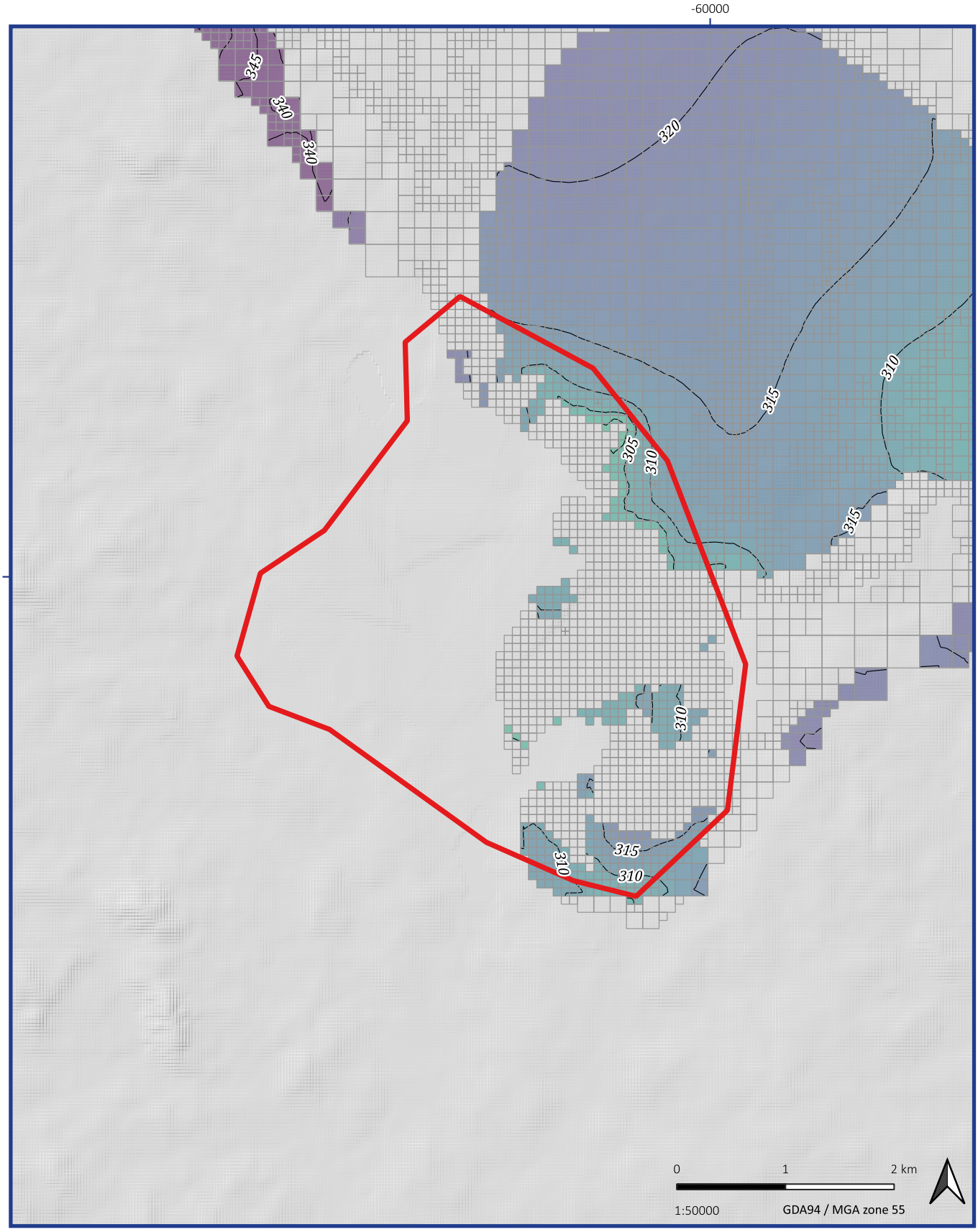
Modelled saturated heads in Layer 1 after 100 years post closure

(4158) Blair Athol model

Figure 32

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moonvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 33_pred_100y_sat_heads_layer_2.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

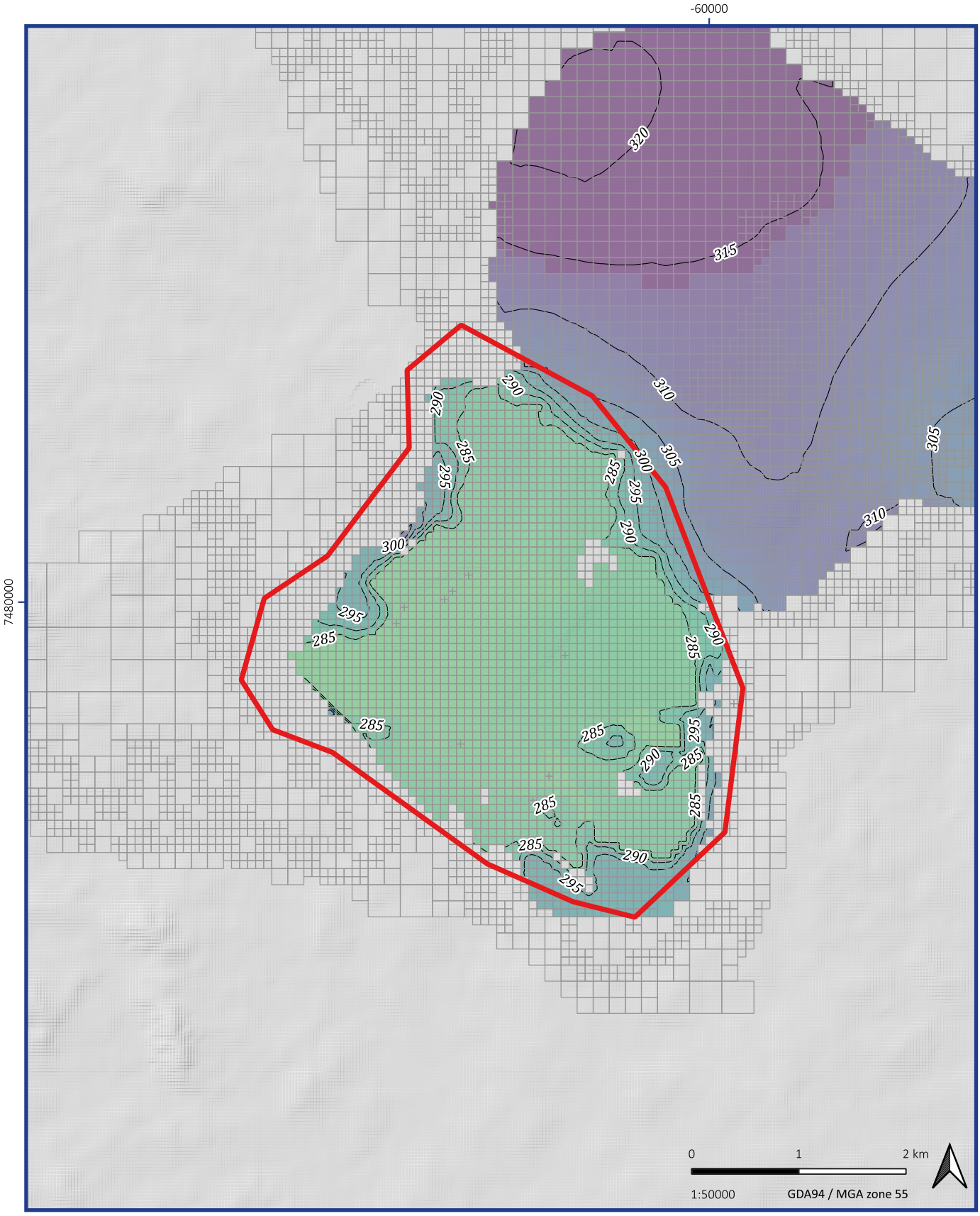
Modelled saturated heads in Layer 2 after 100 years post closure

(4158) Blair Athol model

Figure 33

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moonvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 34_pred_100y_sat_heads_layer_3.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

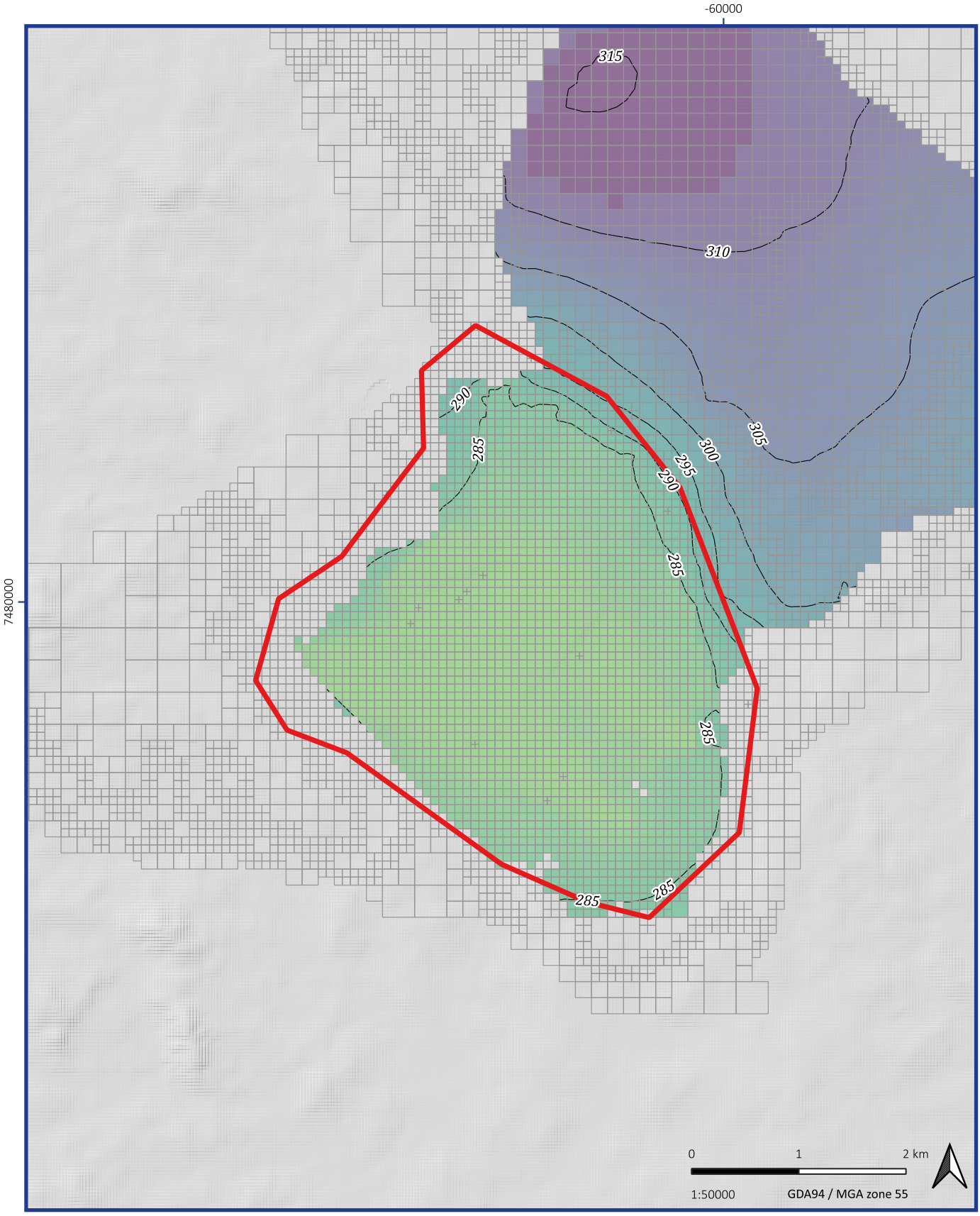
Modelled saturated heads in Layer 3 after 100 years post closure

(4158) Blair Athol model

Figure 34

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 35_pred_100y_sat_heads_layer_4.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

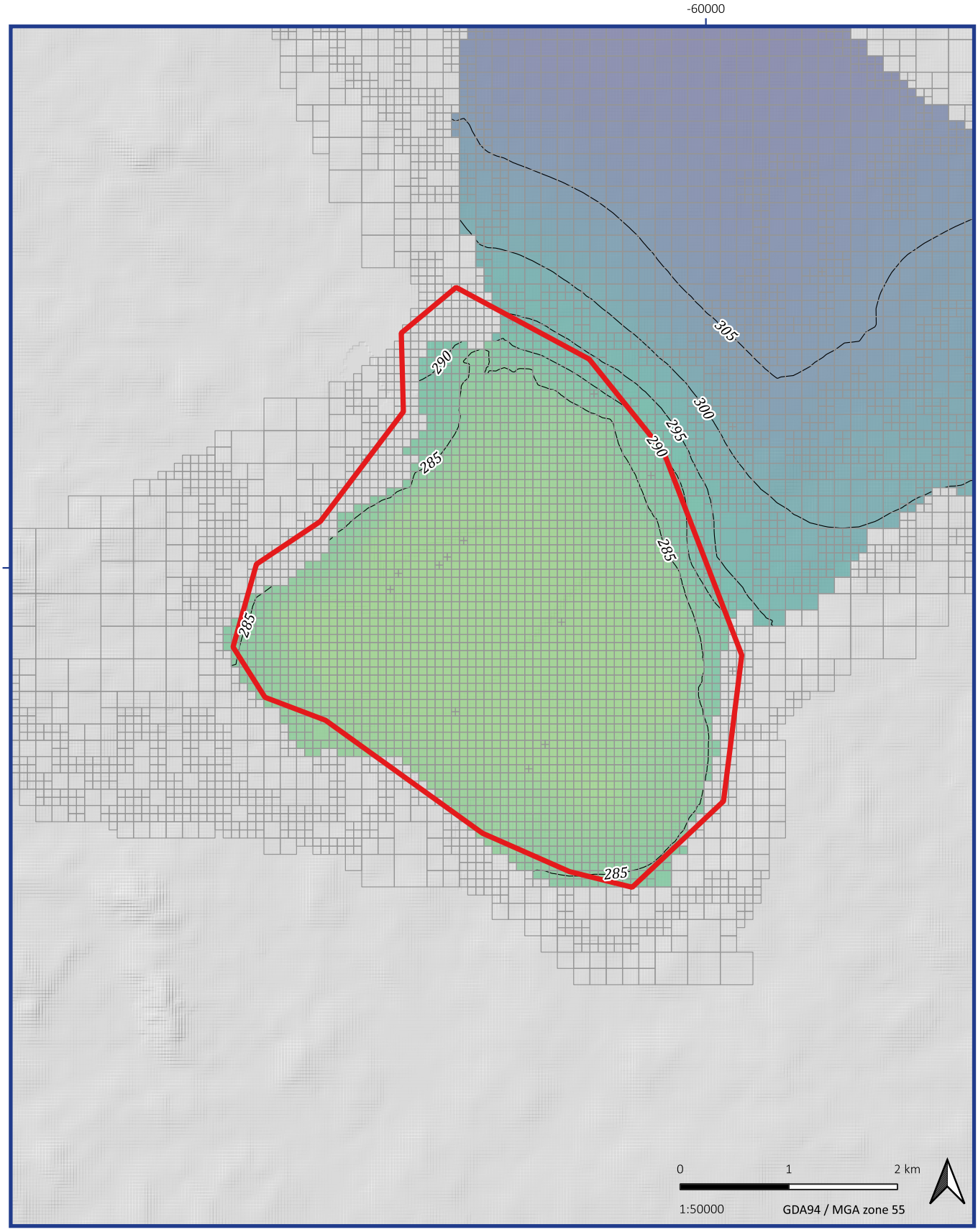
Modelled saturated heads in Layer 4 after 100 years post closure

(4158) Blair Athol model

Figure 35

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 36_pred_100y_sat_heads_layer_5.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

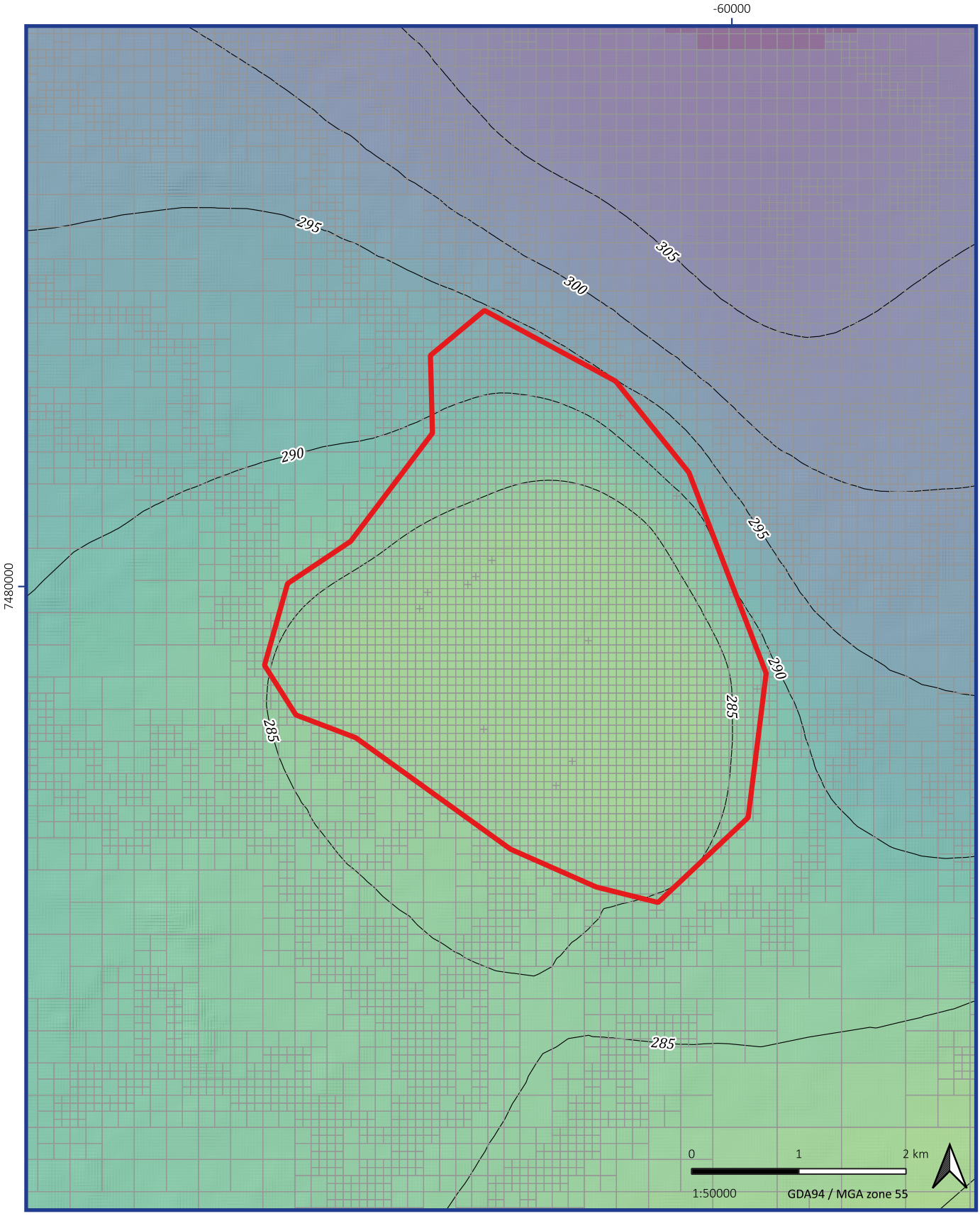
Modelled saturated heads in Layer 5 after 100 years post closure

(4158) Blair Athol model

Figure 36

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 37_pred_100y_sat_heads_layer_6.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

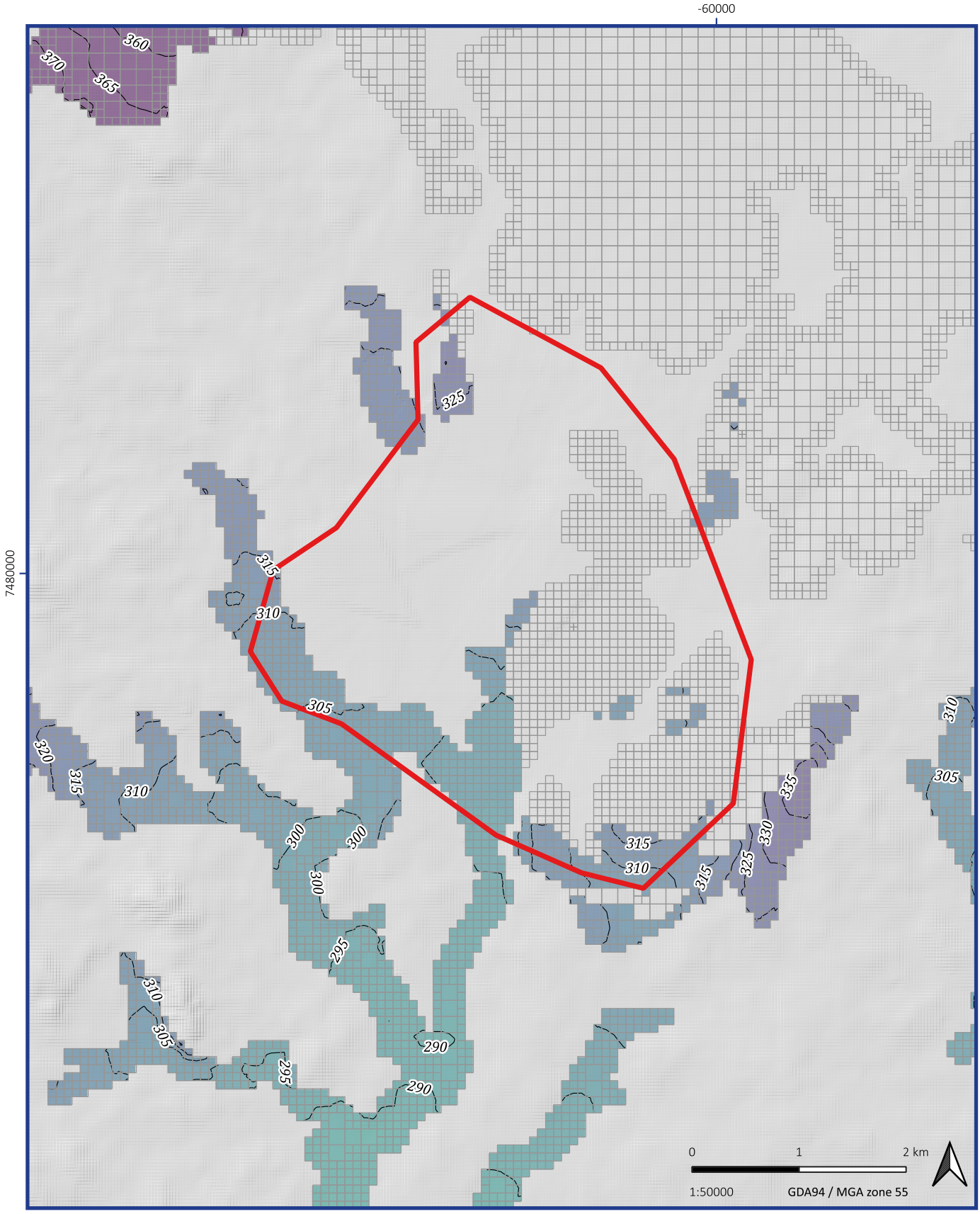
Modelled saturated heads in Layer 6 after 100 years post closure

(4158) Blair Athol model

Figure 37

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moonvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 38_pred_500y_sat_heads_layer_1.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

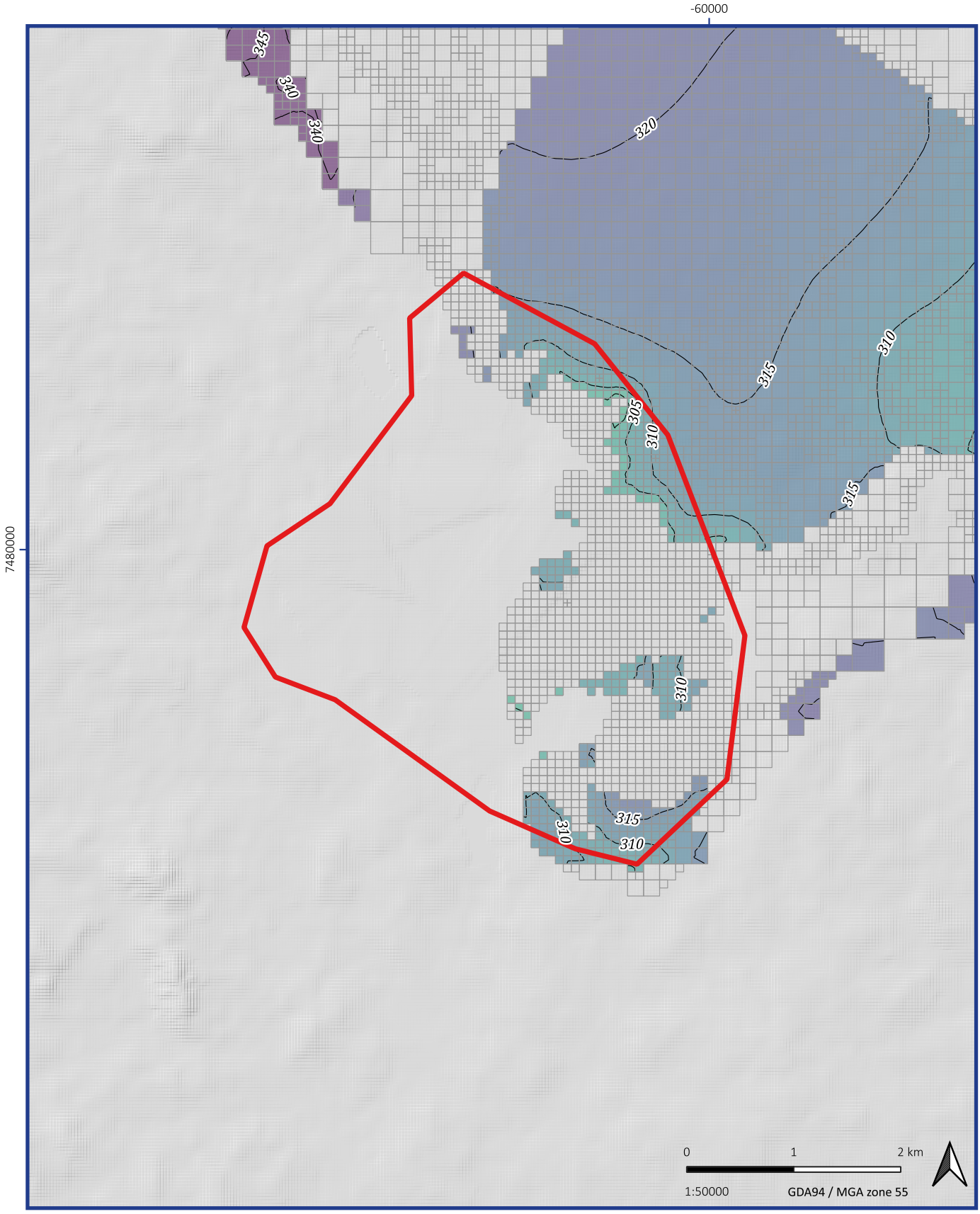
Modelled saturated heads in Layer 1 after 500 years post closure

(4158) Blair Athol model

Figure 38

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 39_pred_500y_sat_heads_layer_2.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

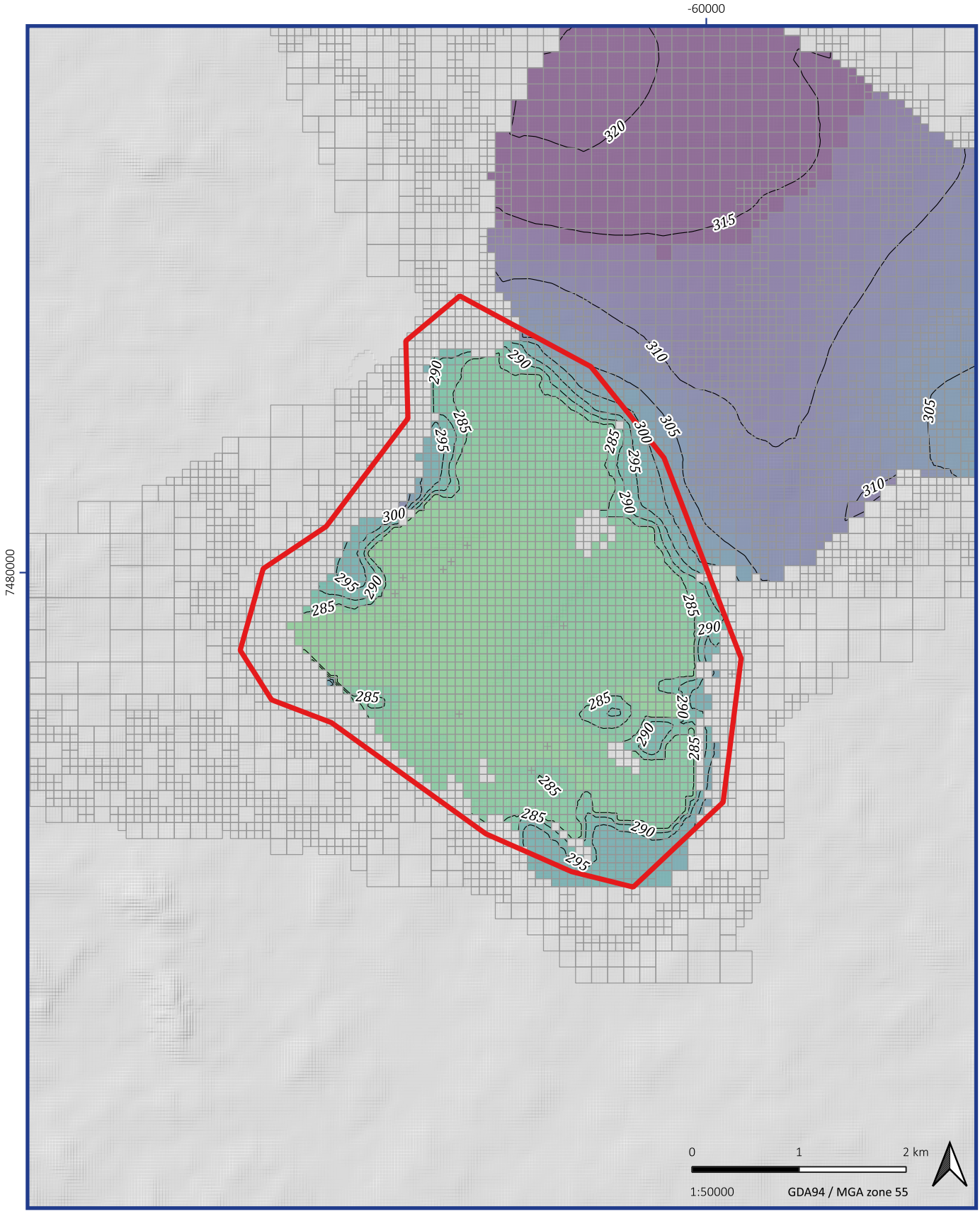
Modelled saturated heads in Layer 2 after 500 years post closure

(4158) Blair Athol model

Figure 39

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 40_pred_500y_sat_heads_layer_3.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

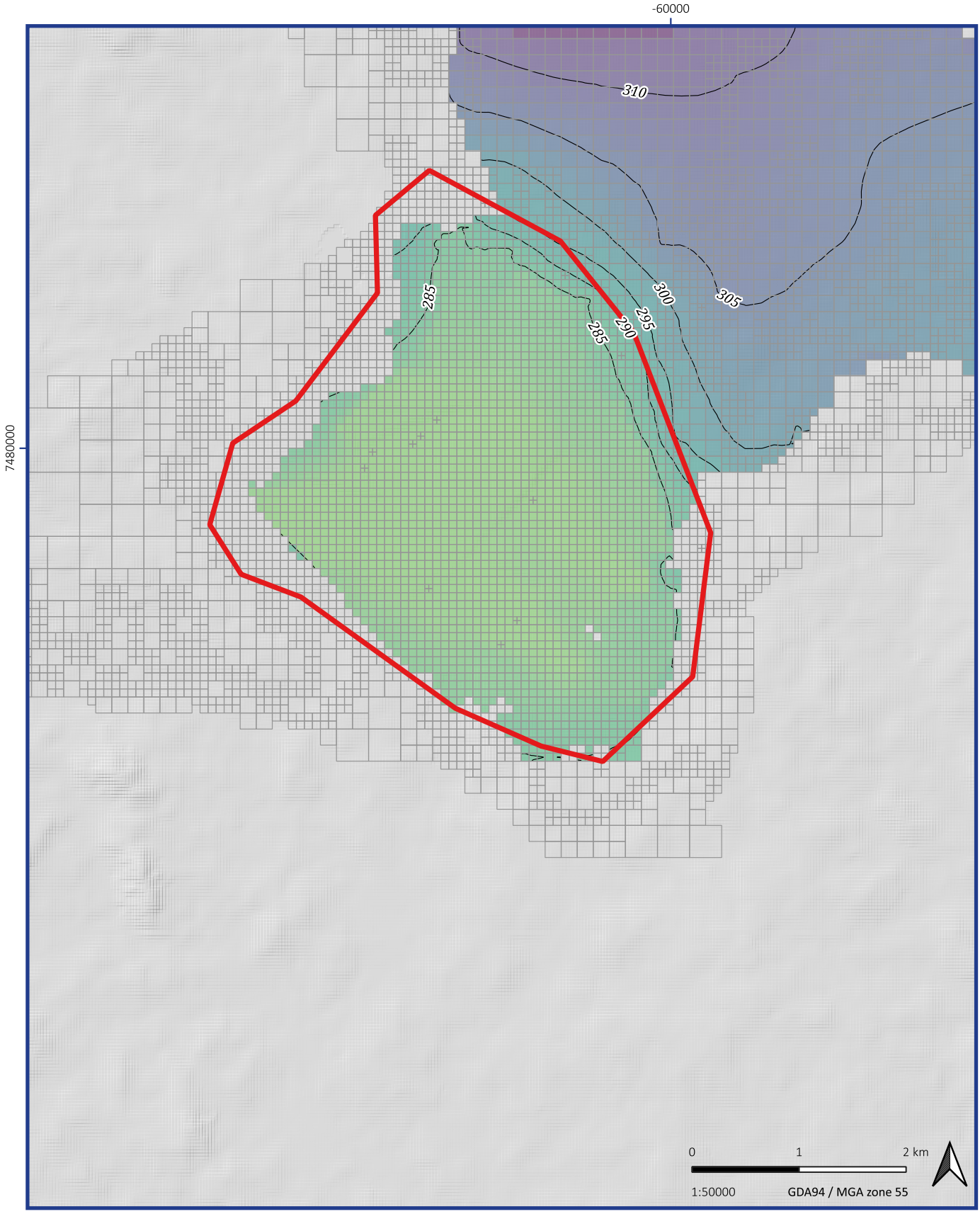
Modelled saturated heads in Layer 3 after 500 years post closure

(4158) Blair Athol model

Figure 40

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 41_pred_500y_sat_heads_layer_4.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

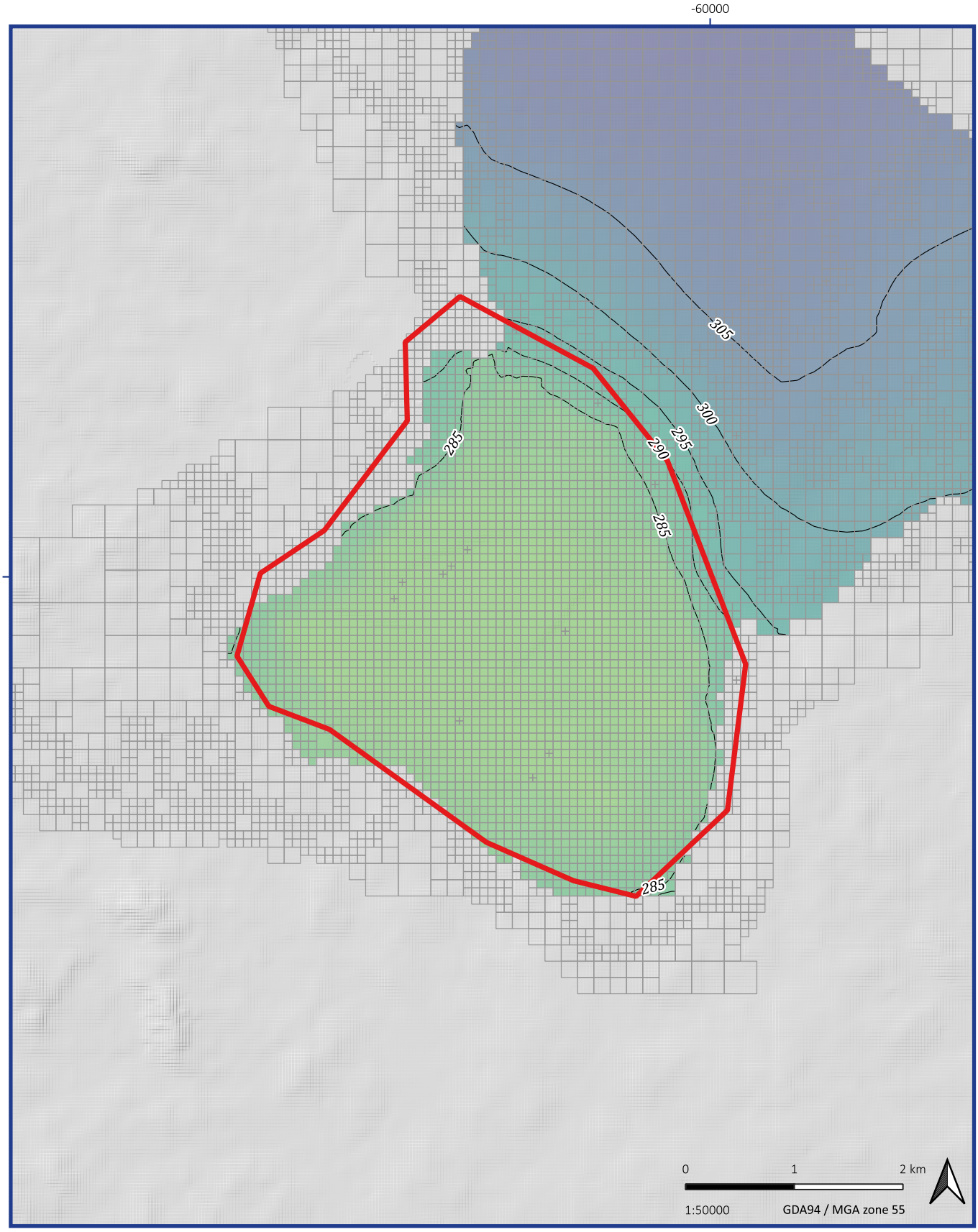
Modelled saturated heads in Layer 4 after 500 years post closure

(4158) Blair Athol model

Figure 41

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 42_pred_500y_sat_heads_layer_5.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

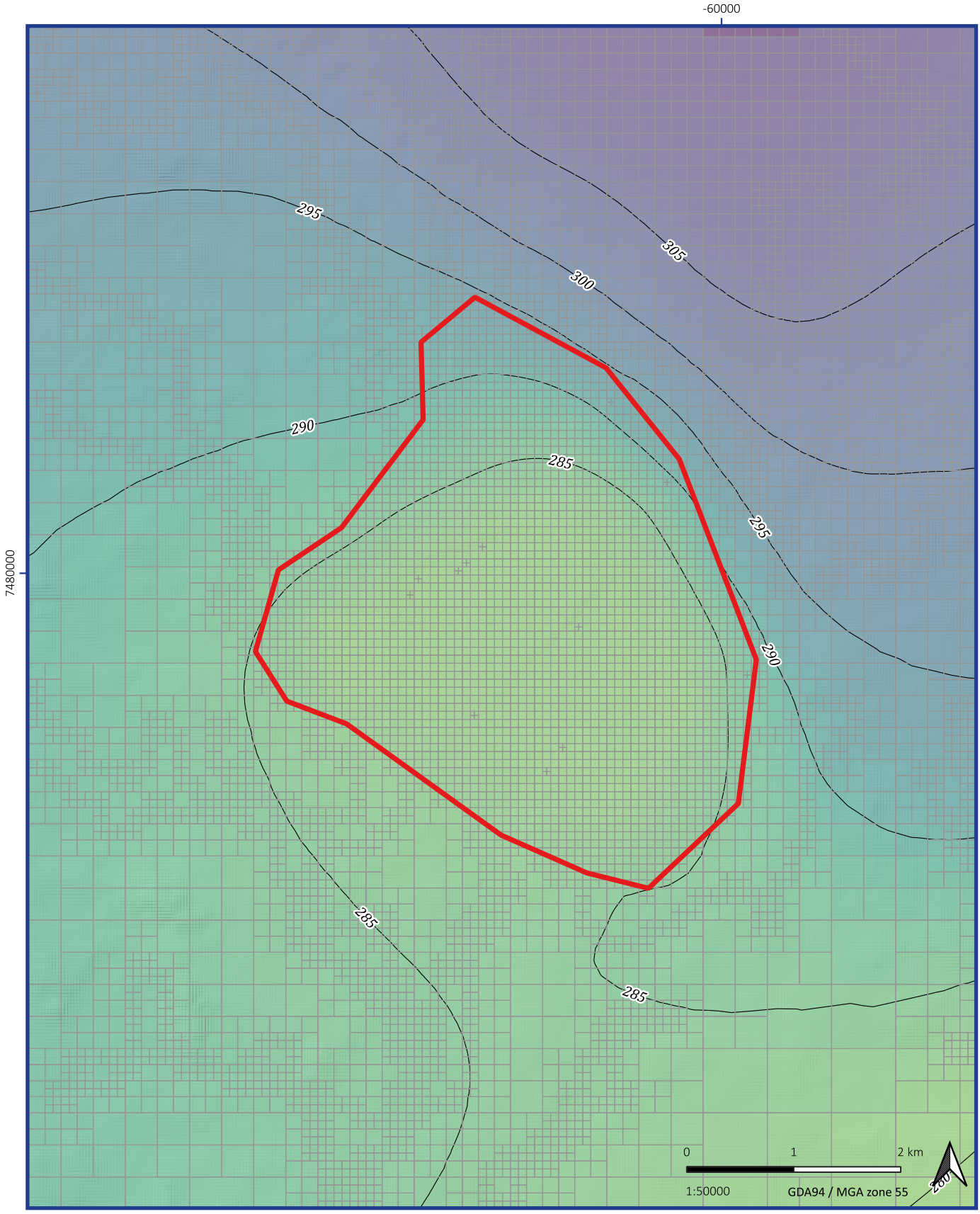
Modelled saturated heads in Layer 5 after 500 years post closure

(4158) Blair Athol model

Figure 42

08/05/2024

hydrogeologist .com.au



©2024 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011 ; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 Z:\4000_Projects\4158_SGM_GW Assessment_Blair Athol_Moorvale_PRCPs\3_GIS\3_11_Workspaces_QGIS\4158_blair_athol_v1\4158_Figure 43_pred_500y_sat_heads_layer_6.qgz

Legend

- Model domain
- Blair athol mine
- Clermont mine
- Model mesh

Modelled saturated heads in Layer 6 after 500 years post closure

(4158) Blair Athol model

Figure 43

08/05/2024

hydrogeologist .com.au

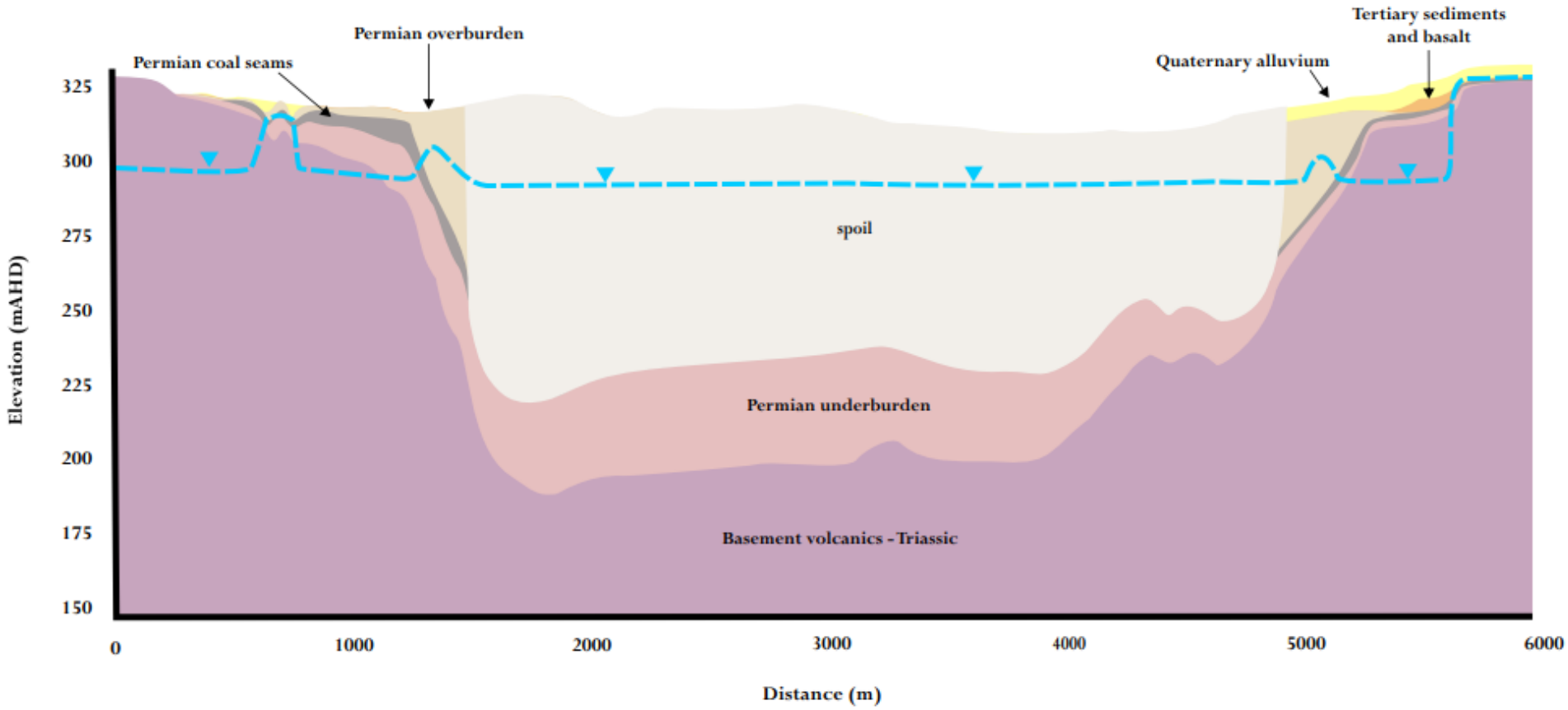


Figure 44 Cross section A-A' – groundwater level after 1000 years post closure

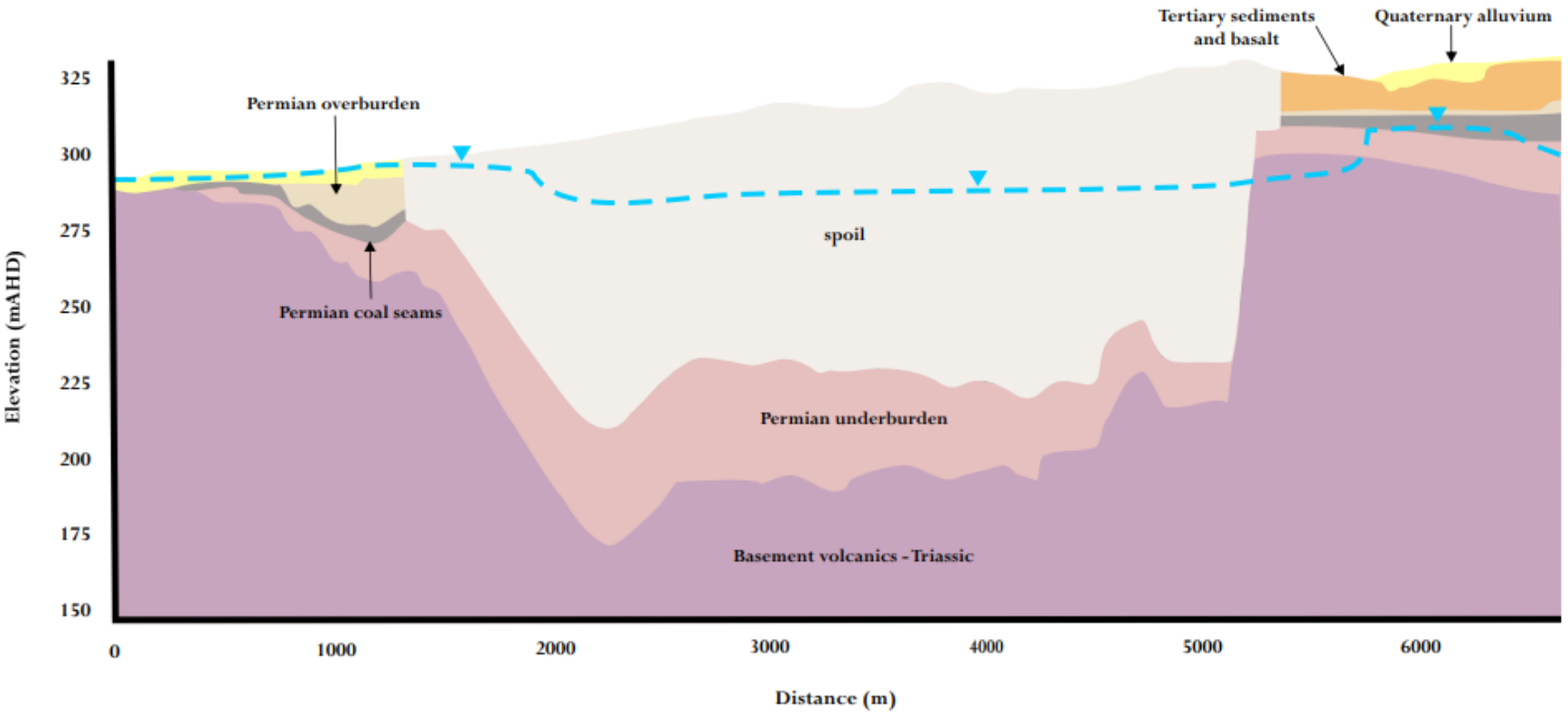


Figure 45 Cross section B-B' – groundwater level after 1000 years post closure

Appendix A Blair Athol Coal Mine – PRCP Groundwater Assessment Prepared for Terracom Ltd. Dated 16 January 2023

REPORT ON

BLAIR ATHOL COAL MINE
PRCP GROUNDWATER ASSESSMENT

For: Terracom Ltd

Project number: 4031

Date: 16/01/2023

ABN: 50 627 068 866 www.hydrogeologist.com.au info@hydrogeologist.com.au

1/149 Boundary Road, Bardon. QLD. 4065 P.O. Box 108, The Gap. QLD. 4061

Table of contents

1. Introduction 1
   1.1. Background 1
   1.2. Report structure 1
2. Project setting 3
   2.1. Climate 3
   2.2. Topography and drainage 4
   2.3. Geology 6
3. Hydrogeology 10
   3.1. Previous studies 10
   3.2. Conceptual understanding 10
      3.2.1. Alluvium 11
      3.2.2. Tertiary basalt 11
      3.2.3. Permian Blair Athol Coal Measures 12
      3.2.4. Proterozoic basement 14
      3.2.5. Spoil and tailings 14
   3.3. Groundwater quality 15
   3.4. Groundwater monitoring network 16
4. Post-mining land use 18
   4.1. Current and potential future uses of groundwater 18
   4.2. EVs and water quality objectives 20
   4.3. Final landform 23
   4.4. Post-mining site hydrogeology 23
   4.5. Post-mining groundwater quality 24
5. Conclusion 24
6. References 25

Table of contents (continued)

Figure list

Figure 1 Project location 2
Figure 2 Cumulative rainfall departure – 2000 to 2022 3
Figure 3 Topography and drainage 5
Figure 4 Surface geology 7
Figure 5 Stratigraphy within the mine area (Source: JBT, 2012) 8
Figure 6 Geological cross-section (Source: JBT, 2012) 9
Figure 7 Conceptual groundwater model cross-sections (Source: JBT, 2012) 11
Figure 8 Groundwater level hydrographs – Tertiary basalt 12
Figure 9 Groundwater level hydrographs – Permian conglomerate 13
Figure 10 Groundwater level hydrograph –Seam 4 14
Figure 11 Groundwater level hydrographs – Spoil 15
Figure 12 Groundwater monitoring network 17
Figure 13 Registered groundwater bores 19

Table list

Table 1 Climate averages 3
Table 2 Details for groundwater quality monitoring bores 16
Table 3 EA compliance groundwater quality limits 16
Table 4 WQOs for groundwater resources within Zone 4 21
Table 5 WQOs for groundwater resources within Zone 9 22

Blair Athol Coal Mine – PRCP Groundwater Assessment

Prepared for

Terracom Ltd

1. Introduction

hydrogeologist.com.au has been commissioned by SGM Environmental (SGM) to prepare a groundwater assessment to support the Progressive Rehabilitation and Closure Plan (PRCP) for the Blair Athol Coal Mine (BAC).

1.1. Background

Blair Athol Coal Mine (BAC) is an open cut coal mine located approximately 20 km northwest of Clermont in central Queensland (Figure 1). BAC open cut pits, overburden emplacement areas, coal stockpiles, a coal handling plant (CHP) and water management infrastructure are located on Mining Lease (ML) 1804.

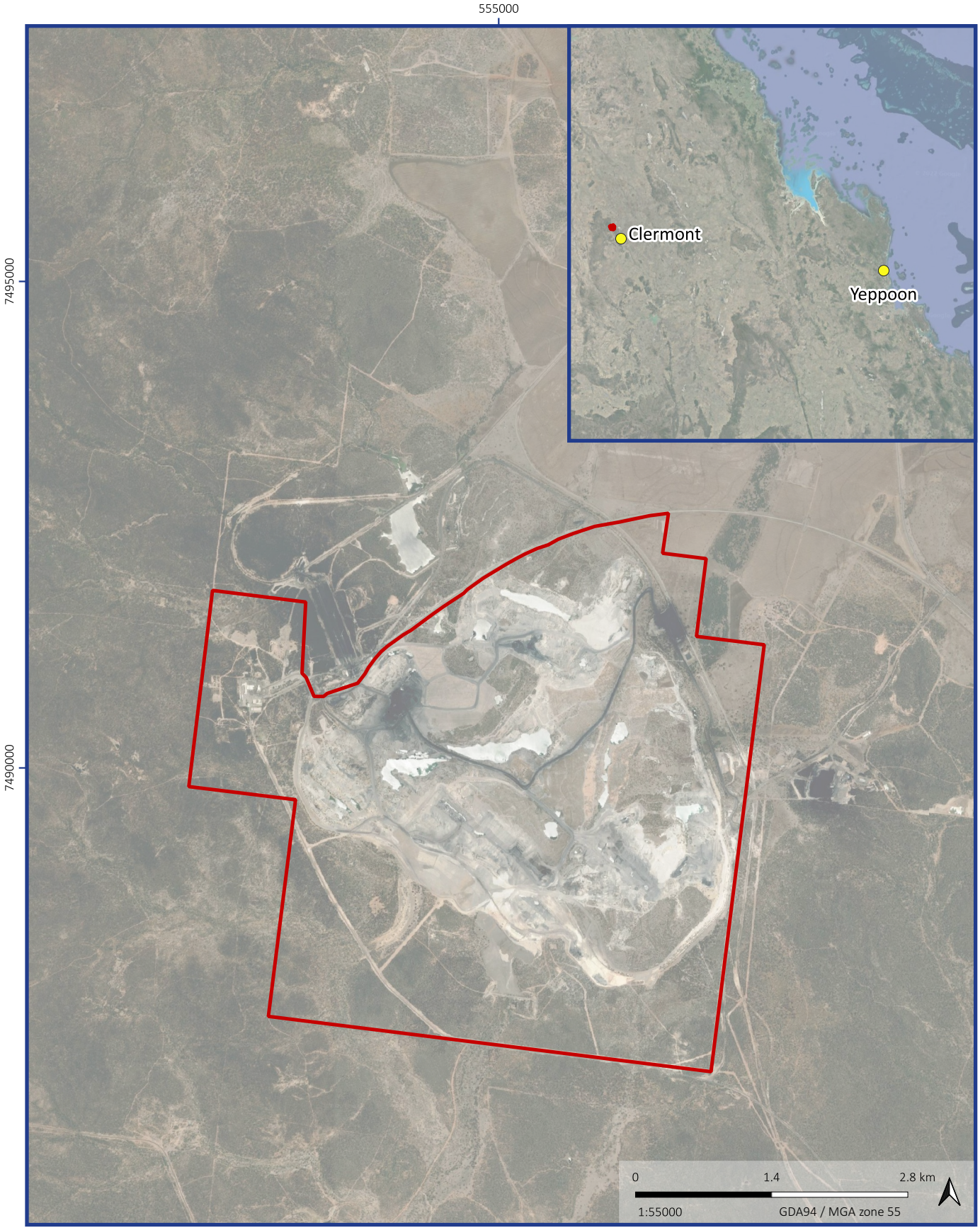
Terracom Limited (Terracom) operates BAC in accordance with Environmental Authority (EA) EPML00876713, effective as of 9 August 2019.

Mining at BAC commenced in 1978 by Rio Tinto, who operated the mine until it was placed under care and maintenance in 2012. In 2017, BAC was sold to Terracom. Mining activity at BAC recommenced in 2018, with the mine currently producing approximately 2.5 million tonnes (Mt) of thermal coal per year.

1.2. Report structure

This report is structured as follows:

- Section 1 – Introduction: provides an overview of the project and the assessment scope.
- Section 2 – Project Setting: describes the environmental and geological setting of the project including local topography and drainage, climate and local geology.
- Section 3 – Hydrogeology: describes the existing groundwater regime for the project site and surrounding area.
- Section 4 – Post-mining Land Use: provides a description of the proposed post-closure plan and the predicted effects on the local groundwater regime. This section also presents an assessment of the post closure groundwater conditions.
- Section 5 – Conclusions.



©2022 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.Z:\4000_Projects\4131_SGM_Blair Athol PRCP\3_GIS\3_11_Workspaces_QGIS\4131_Project_location.qgz

Project location

Legend

Blair Athol Coal Mine Progressive Rehabilitation and Closure Plan

Mining lease

Figure 1

12/12/2022

hydrogeologist .com.au

2. Project setting

2.1. Climate

The climate at the project site is hot and semi-arid, and is characterised by hot wet summers and mild, dry winters.

An interpolated site-specific dataset was downloaded from the DES Scientific Information for Land Owners (SILO) database for the BAC site (at location -22.70°S, 147.55°E). The data is a grid point data set, meaning that the data has been interpolated for this location from station data. A summary of the temperature, rainfall and evaporation from the SILO dataset is shown in Table 1.

Table 1 Climate averages

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean min temp (°C)	18.0	17.6	17.0	12.1	7.3	3.1	3.2	3.8	8.2	12.3	16.4	18.5	14.7
Mean max temp (°C)	37.5	36.8	35.4	32.4	29.3	25.7	25.9	29.7	32.3	35.2	36.6	38.1	29.4
Mean rainfall (mm)	107.3	101.7	67.1	34.0	28.4	28.4	24.3	17.5	16.7	32.8	55.7	87.4	600.7
Mean evaporation (mm)	232.4	187.0	192.9	151.4	116.1	91.9	102.3	135.0	179.4	225.3	235.5	252.0	2,102.3

The annual average rainfall for the area is approximately 600 mm and the annual average evaporation is approximately 2,100 mm. Rainfall predominantly falls between November to March. Monthly evaporation rates exceed monthly rainfall for all months of the year, highlighting a net evaporative loss over a year.

Recent rainfall has been put into a historical context using the Cumulative Rainfall Departure (CRD) method. CRD is calculated by subtracting the long-term average monthly rainfall from the actual monthly rainfall, to provide a monthly departure from the average conditions. A rising trend indicates periods of above average rainfall, whilst a falling trend indicates periods of below average rainfall. The CRD graph, shown below in Figure 2, indicates that BAC has generally experienced a period of below average rainfall since mid-2012.

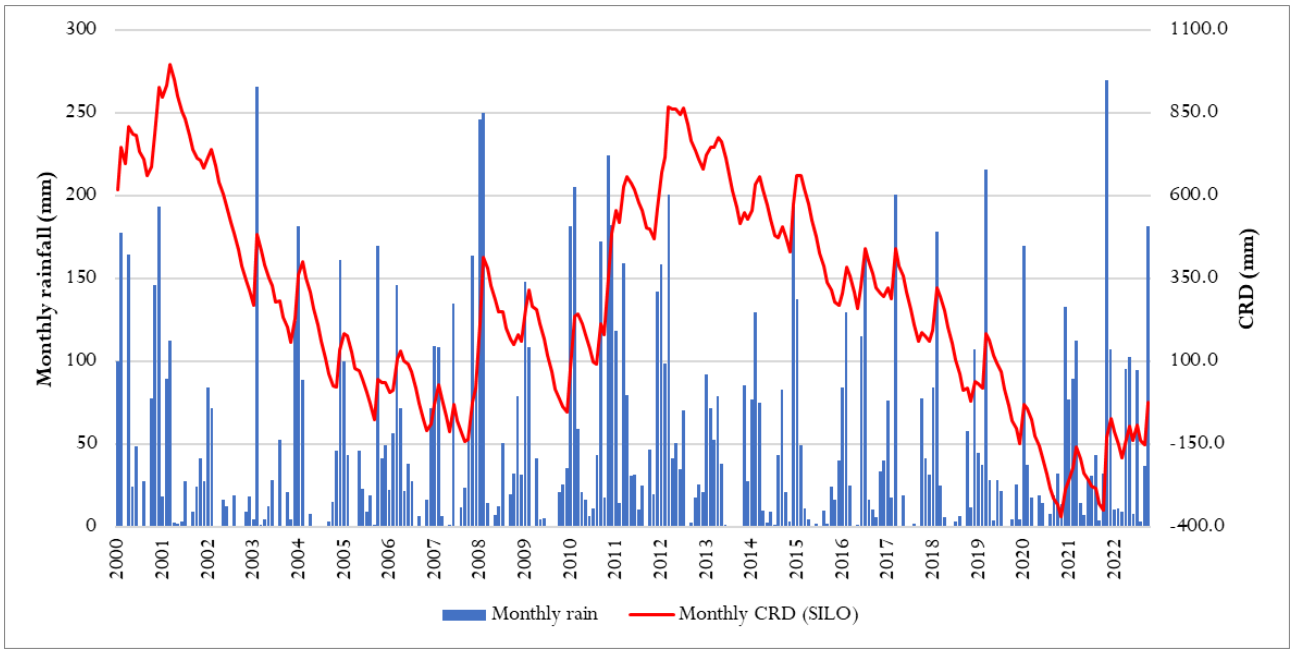


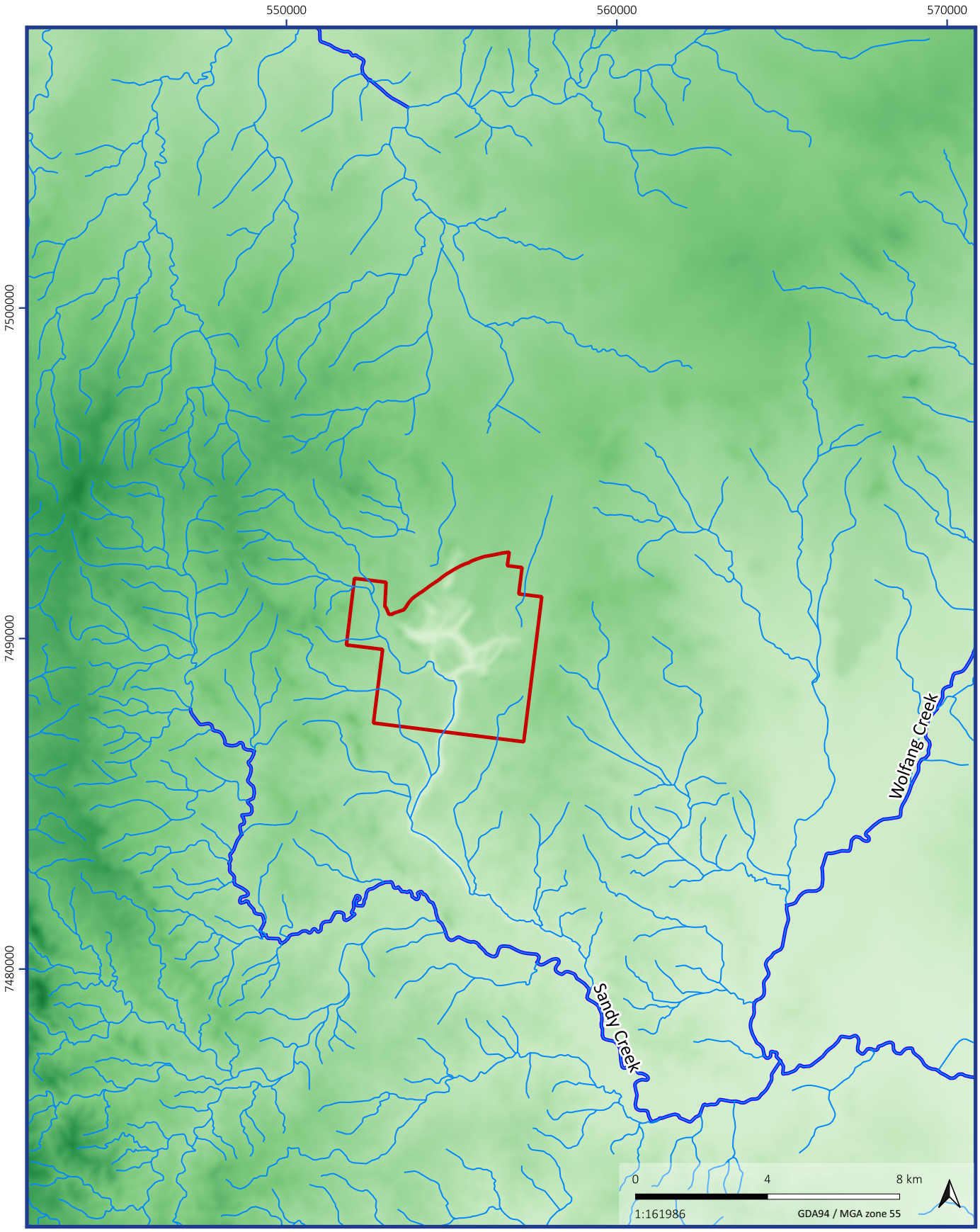
Figure 2 Cumulative rainfall departure – 2000 to 2022

2.2. Topography and drainage

The local topography and surface drainage are shown in Figure 3.

The regional topography is generally flat, rising in the Drummond Ranges to the west of BAC. Within the project site, the terrain gently slopes to the south.

The site is drained by overland sheet flow and minor drainage features. Bath Creek and Washpool Creek run through the lease area and drain from the north and north-east respectively, before discharging into Sandy Creek approximately 9 km south-east of the site. All creeks and drainage features in the area are ephemeral.



©2022 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006 7:\4000_Projects\4131_SGM_Blair Athol PRCP\3_GIS\3_11_Worksnaces_OGIS\4131_Watercourse.qgz

Topography and Drainage

Legend

Mining lease

Watercourse

Minor drainage

Elevation (mAHD)

200

275

350

425

500

Blair Athol Coal Mine Progressive Rehabilitation and Closure Plan

Figure 3

12/12/2022

hydrogeologist.com.au

2.3. Geology

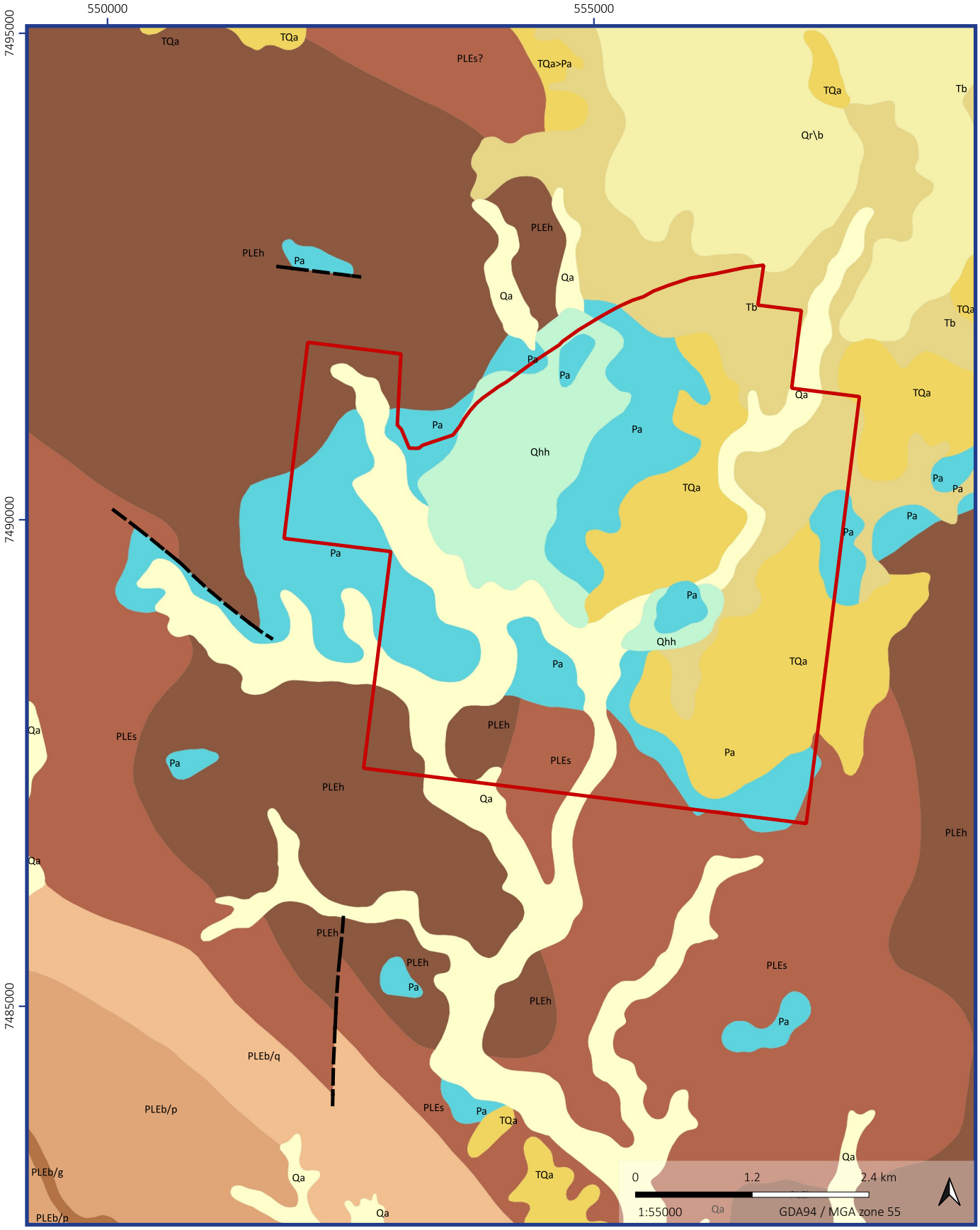
The surface geology in the BAC site and its surrounds is shown in Figure 4.

BAC is located within the Blair Athol Basin, an isolated Permian aged geological basin near the western edge of the northern Bowen Basin. The site geology is comprised of five main lithological units (as shown in Figure 5), listed below from youngest to oldest:

- Tertiary and Quaternary alluvial deposits (TQa and Qa) developed within the ephemeral streams that drain the site, including Bath Creek and Washpool Creek.
- Tertiary basalt (Tb) in the north and east of the ML, with an average thickness of 18 to 22 m within the lease.
- Permian Blair Athol Coal Measures (Pa) which comprise:
    - the upper coal measures, which include sandstone, siltstone, mudstone, conglomerate, as well as the four main coal seams of the basin (referred to as Seams 1, 2, 3 and 4); and
    - the lower coal measures, which include basal conglomerate, sandstone, siltstone, and mudstone with an estimated maximum thickness of 130 to 150 m.
- Early to middle Devonian arenites, present as a small basement trough in the southern part of the basin.
- Proterozoic/Cambrian Anakie Metamorphic Group, comprising schist, phyllite and metabasalt.

As noted by JBT (2012), the basement metamorphics, Blair Athol Coal Measures, Tertiary basalts and Quaternary alluvium all occur at surface in different areas of the BAC ML (Figure 4).

Figure 6 presents a schematic cross-section of the Blair Athol Basin and illustrates the general basin geometry and location of the coal seams.



©2022 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.Z:\4000_Projects\4131_SGM_BlairAthol PRCP\3_GIS\3_11_Workspaces_QGIS\4131_Geology.qgz

Surface geology

Legend

Blair Athol Coal Mine Progressive Rehabilitation and Closure Plan

Figure 4

12/12/2022

- Mining lease
- Fault
- Basalt (PLEb/g)
- Pelite (PLEB/p)
- Foliated quartzite (PLEb/q)
- Blair Athol Coal Measures (Pa)
- Coarse-grain, foliated quartzite (PLEh)
- Alluvium (Qa)
- Gravel, sand and silt (Qhh)
- Colluvium - (Qr\b)
- Metamorphic arenite (PLEs)
- Basalt - (Tb)
- Alluvium - (TQa)
- Alluvium /Blair Athol Coal Measures - (TQa>Pa)

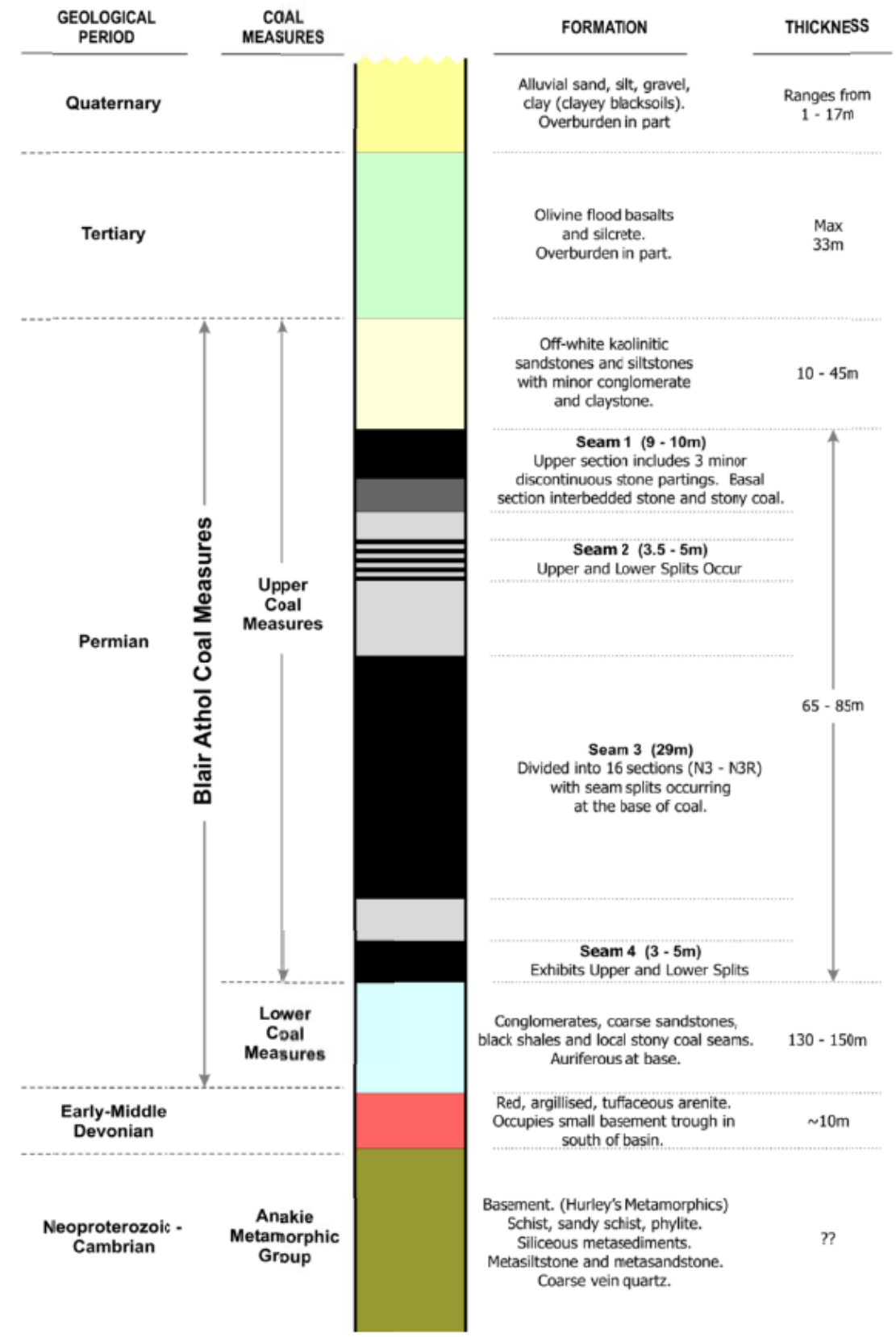


Figure 5 Stratigraphy within the mine area (Source: JBT, 2012)

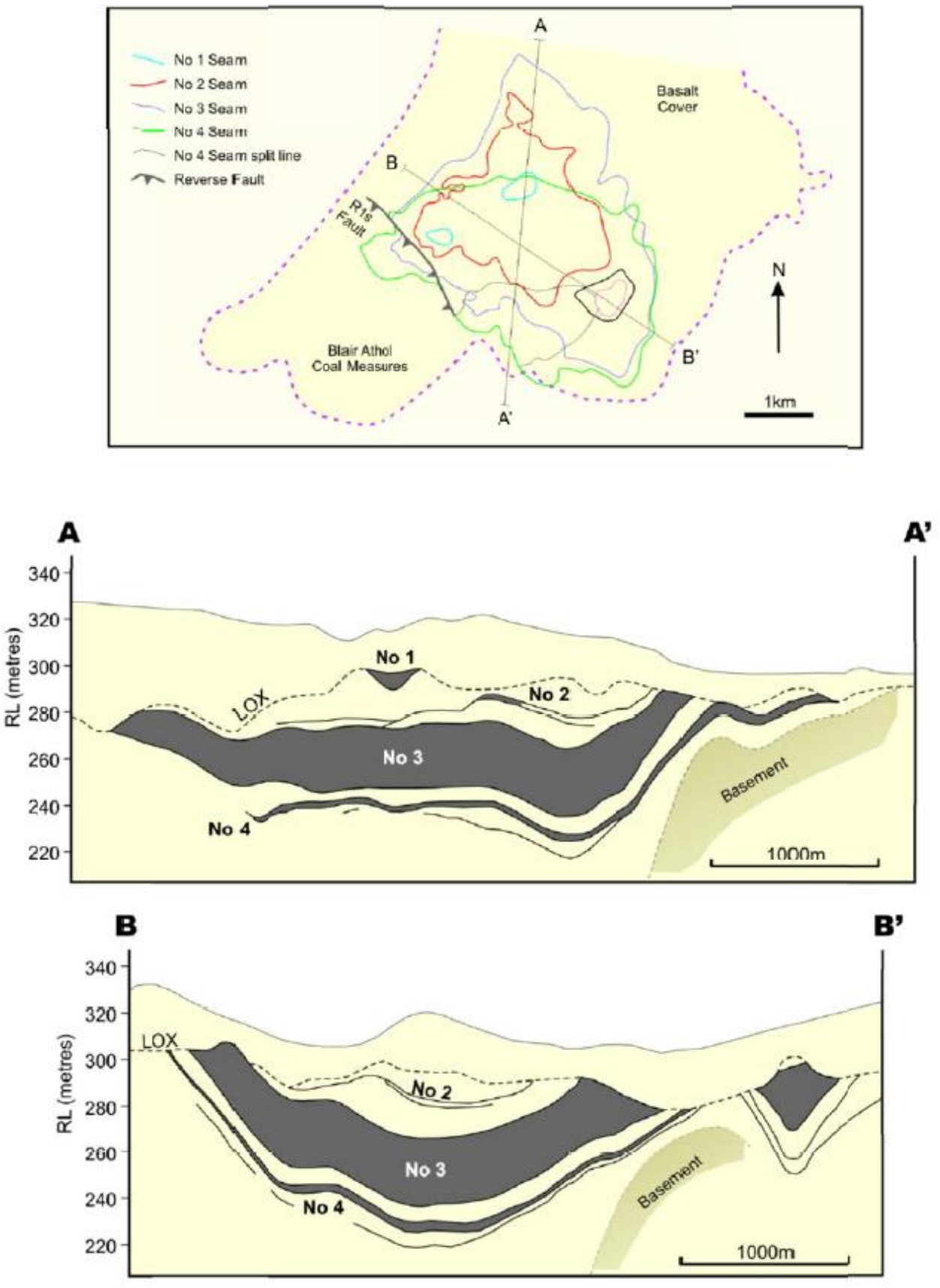


Figure 6 Geological cross-section (Source: JBT, 2012)

3. Hydrogeology

3.1. Previous studies

A number of hydrogeological studies have been completed for Blair Athol. The following studies undertaken at BAC were reviewed:

- Coffey (1980). Groundwater Appraisal – Blair Athol Coalfield. This report outlines the results of hydrogeological test-work carried out at BAC to determine the dewatering requirements for the commencement of mining.
- Coffey (1993). Stage 2 Groundwater Assessment at Blair Athol Coal Mine. This report outlines the results of hydrogeological test-work carried out at BAC to assess the potential for groundwater supply at the site.
- Rio Tinto Coal Australia (2006). Blair Athol Mine – Groundwater Monitoring. This internal report outlines the rationale behind the monitoring network installed at BAC.
- MatrixPlus (2007) Groundwater monitoring bore installation. This report contains a brief overview of the regional and site hydrogeology, followed by a description of the drilling and installation of groundwater and geotechnical monitoring bores.
- Terranus (2009). Groundwater review – Blair Athol Coal Mine. This report was prepared to provide a summary of the groundwater conditions at the site.
- JBT (2012). Blair Athol Mine Closure Groundwater Investigation. This report discussed the conceptual groundwater model over time (pre-mining, during mining and post-closure).
- Terracom (2019). Groundwater Monitoring Program. This document outlines the groundwater monitoring infrastructure and procedures.
- Terracom (2020). Groundwater Monitoring Program. This document outlines the groundwater monitoring infrastructure and procedure as required under the EA.
- WRM (2022). Final Void Hydrology Report – Blair Athol Coal Mine [Draft]. This report outlines the proposed final void geometry at closure and the long-term site water balance post-closure.

3.2. Conceptual understanding

The local groundwater regime is illustrated in Figure 7. The conceptual model can be summarised as follows:

- Rainfall provides direct recharge to the local groundwater system. Infrequent rainfall patterns result in episodic flow and short periods of potential recharge to the groundwater system during surface water flow events.
- Unconsolidated alluvial material is mapped along some of the creeks and drainage features present across the BAC site. As the creeks and drainage features are ephemeral, the presence of groundwater within the alluvium is sporadic and related to rainfall events when the creeks and drainage features flow.
- The Tertiary basalt is the only geological unit considered to be an aquifer, with the remainder of the units considered to be aquitards (namely, units that contain water but have very low yields). High yields have been locally in the Blair Athol Coal Measures where faulting or fracturing has resulted in the development of secondary porosity.
- The direction of groundwater flow reflects topography.
- The excavation of the open pits has locally dewatered the coal seams within the Blair Athol Coal Measures, creating groundwater sinks. Inflow into the open pits occurs from the Tertiary basalt and the Blair Athol Coal Measures.
- Mined-out areas are progressively backfilled with spoil, which is directly recharged by rainfall, which forms a localised aquifer.

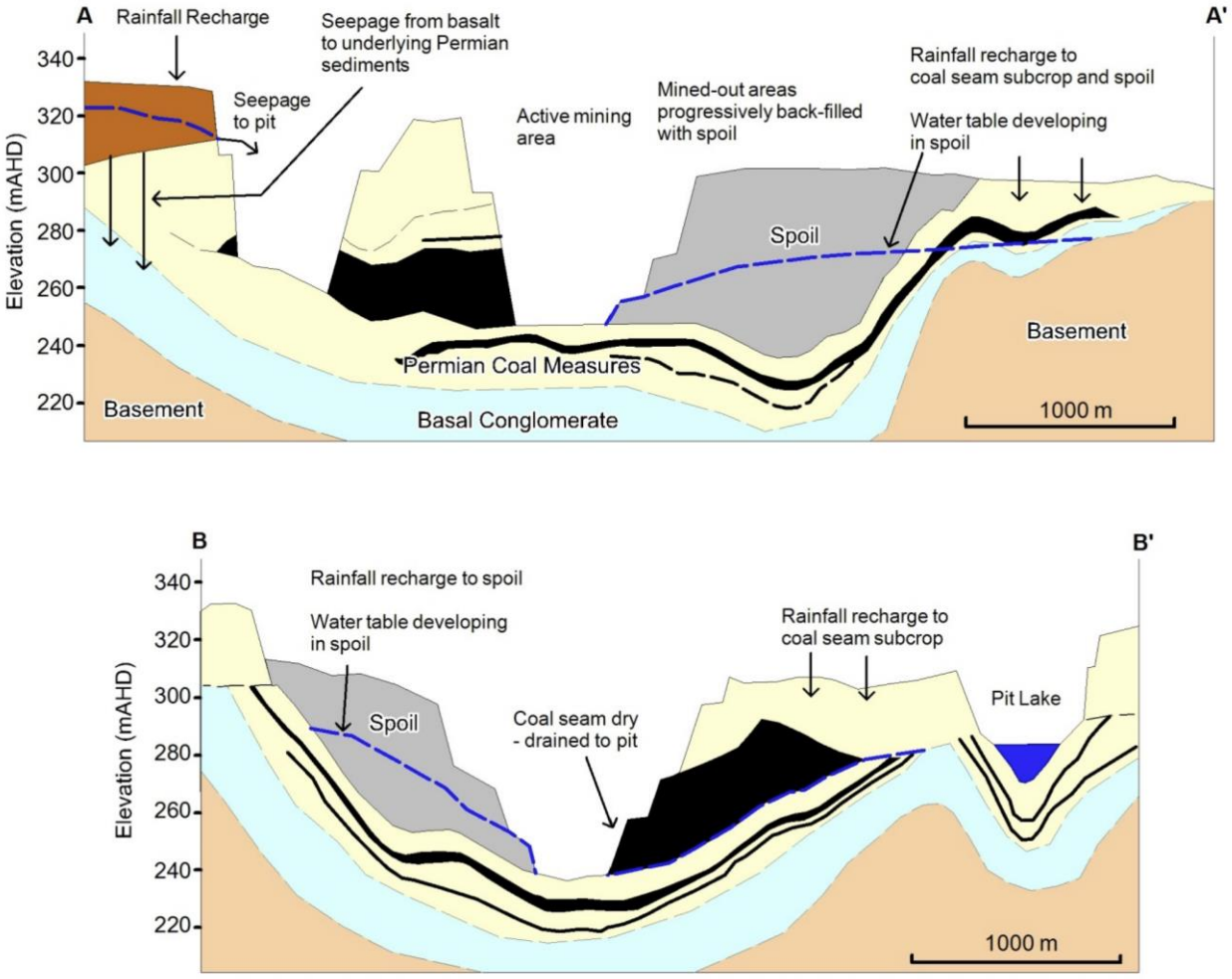


Figure 7 Conceptual groundwater model cross-sections (Source: JBT, 2012)

3.2.1. Alluvium

Unconsolidated alluvial sediments are mapped along Bath Creek and Washpool Creek. Groundwater is present within the alluvial sediments following rainfall events and this groundwater flows in the direction of surface drainage (generally, to the south and south-west).

Groundwater within the alluvium recharges the underlying Tertiary basalt and Blair Athol Coal Measures.

There are no BAC groundwater monitoring bores constructed within the alluvial sediments.

3.2.2. Tertiary basalt

Tertiary basalt is found and intersected within the northern and eastern areas of the ML, where basalt flows infilled drainage channels present in the Permian topography. The basalt located within the BAC ML represents the marginal extent of this basalt flow, resulting in the basalt cover being relatively thin within the ML and thickening towards the north and north-east.

The Tertiary basalt is the most significant aquifer in the region and is accessed by local landholders for stock watering and domestic water supply purposes. Groundwater within the Tertiary basalt occurs within discrete, isolated fracture systems that are poorly connected. As a result, pumping from one fracture system has little to no impact on water levels within adjacent fracture systems within the aquifer (JBT, 2012).

As the uppermost aquifer, the Tertiary basalt is generally recharged via rainfall, with a minor amount of localised recharge occurring from seepage associated with the minor extent of overlying alluvium.

Figure 8 presents a groundwater level hydrograph of the monitoring bores screened within the Tertiary basalt. As the Tertiary basalt is recharged by rainfall events, the overall trend in groundwater levels seen in Figure 8 reflect the historical rainfall trends discussed in Section 2.1. The decline in groundwater level seen in the monitoring bores screened in the Tertiary basalt reflects the below-average rainfall that has been seen at BAC since mid-2012 (see Figure 2).

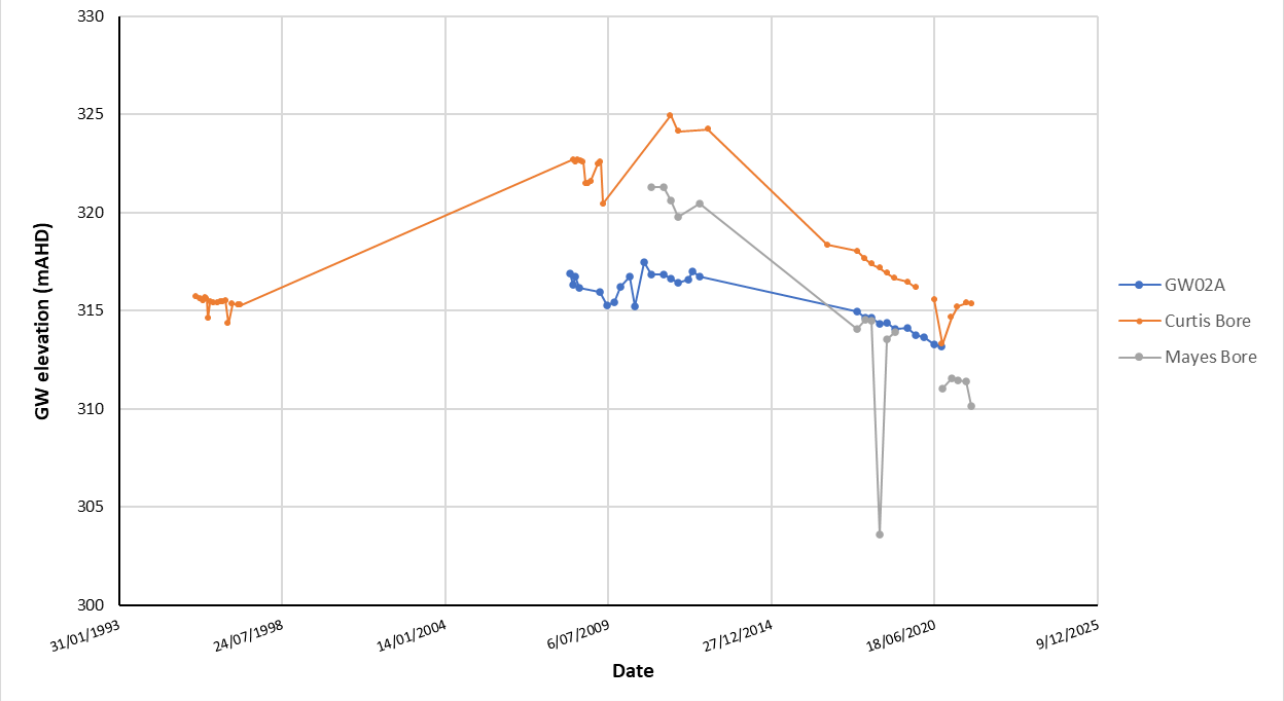


Figure 8 Groundwater level hydrographs – Tertiary basalt

3.2.3. Permian Blair Athol Coal Measures

The Permian Blair Athol Coal Measures are present across the site. The Blair Athol Basin is considered to be a relatively isolated groundwater system (JBT, 2012) with coal seams dipping towards the centre of the basin. While groundwater is present throughout the Blair Athol Coal Measures, it is considered an aquitard due to the low yields. However, localised areas of high yield are seen in the Blair Athol Coal Measures where localised faulting or fracturing has resulted in the development of secondary porosity.

While groundwater is intercepted in all of the coal seams, it is most pervasive in Seams 3 and 4. Seams 1 and 2 are considered to be dry due to dewatering associated with historical mining activity.

Recharge to the Blair Athol Coal Measures occurs primarily as seepage from the overlying Tertiary basalt and through direct recharge from rainfall where the Blair Athol Coal Measures are present at the surface.

A sandstone and conglomerate unit is present at the base of the Blair Athol Coal Measures, occurring below Seam 4 and immediately above the Proterozoic basement. Whilst poorly understood, the conglomerate/sandstone unit is believed to be a regional aquifer within the Blair Athol region (Terranus, 2009) however this aquifer is not utilised due to poor water quality (as discussed in Section 3.3 below). Figure 9 presents a groundwater level hydrograph for the sandstone /conglomerate unit present at the base of the Blair Athol Coal Measures. Groundwater elevations within the conglomerate/sandstone unit reflect the historical rainfall trend, illustrating the influence of rainfall recharge within the Blair Athol Coal Measures.

Groundwater levels seen in GW02A (screened within the Tertiary basalt) are higher than that seen in GW02B (screened within the Permian conglomerate). This hydraulic gradient indicates that the Tertiary basalt provides recharge to the underlying Blair Athol Coal Measures.



Figure 9 Groundwater level hydrographs – Permian conglomerate

Figure 10 presents a groundwater level hydrograph for GT02, which is screened within Seam 4 of the Blair Athol Coal Measures. The hydrograph indicates that groundwater levels within Seam 4 are historically relatively stable, with a minor increase seen in the groundwater elevation over the period that BAC was in care and maintenance. The significant decrease in groundwater elevation since 2018 corresponds to the resumption of mining at BAC and associated dewatering of the coal seams.

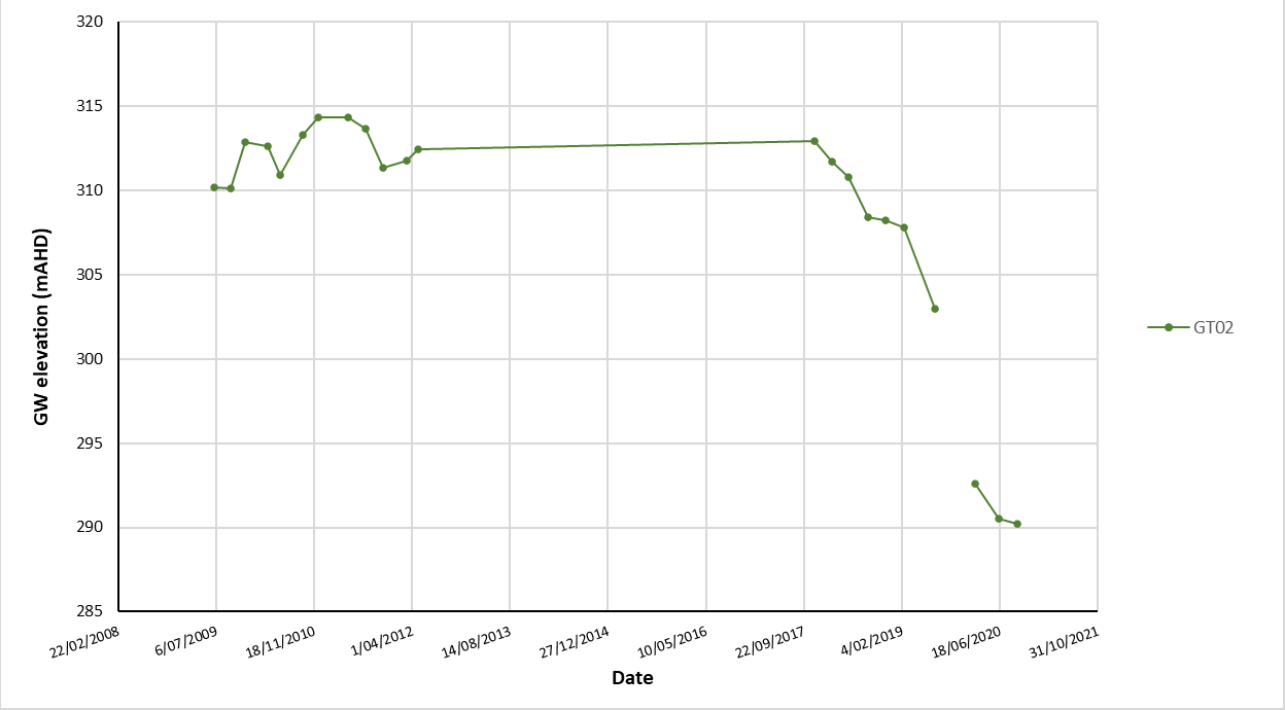


Figure 10 Groundwater level hydrograph –Seam 4

3.2.4. Proterozoic basement

The Proterozoic basement occurs at or close to surface on the western and southern areas of the BAC ML, and to the east of BAC between BAC and the nearby Clermont Coal Mine. Terranus (2009) notes that the Proterozoic basement is believed to be a very 'tight' hydrogeological unit (i.e., with a very low porosity and hydraulic conductivity). As such, the Proterozoic basement is believed to restrict vertical groundwater movement and act as a hydraulic basement to the other groundwater units in the region.

Recharge to the Proterozoic basement occurs through seepage from the overlying Blair Athol Coal Measures and via direct rainfall recharge in areas where the Proterozoic basement is present at the surface. However, due to the very low hydraulic conductivity of the Proterozoic basement, much of the rainfall on basement outcrop areas reports as runoff to the surface drainage system (JBT, 2012).

There are no BAC groundwater monitoring bores constructed within the Proterozoic basement.

3.2.5. Spoil and tailings

Mined out areas are progressively backfilled with spoil. The spoil is comprised of overburden and interburden that has been removed to access the coal seams.

The spoil is directly recharged by rainfall, which forms a localised groundwater table within the spoil. The hydraulic properties of spoil are highly variable and are influenced by factors such as the permeability of the overburden and interburden material, the dumping pattern of the backfill operation, the degree of compaction within the spoil, and settlement of the spoil with time.

Figure 11 presents a groundwater level hydrograph of GW10, a monitoring bore screened within the spoil. Initially, the groundwater elevation within the spoil increased, representing the influence of rainfall recharge and the development of the localised water table within the spoil. Since the resumption of mining at BAC in 2018, the groundwater elevation in the spoil has slowly decreased, illustrating the influence of dewatering associated with mining activity.

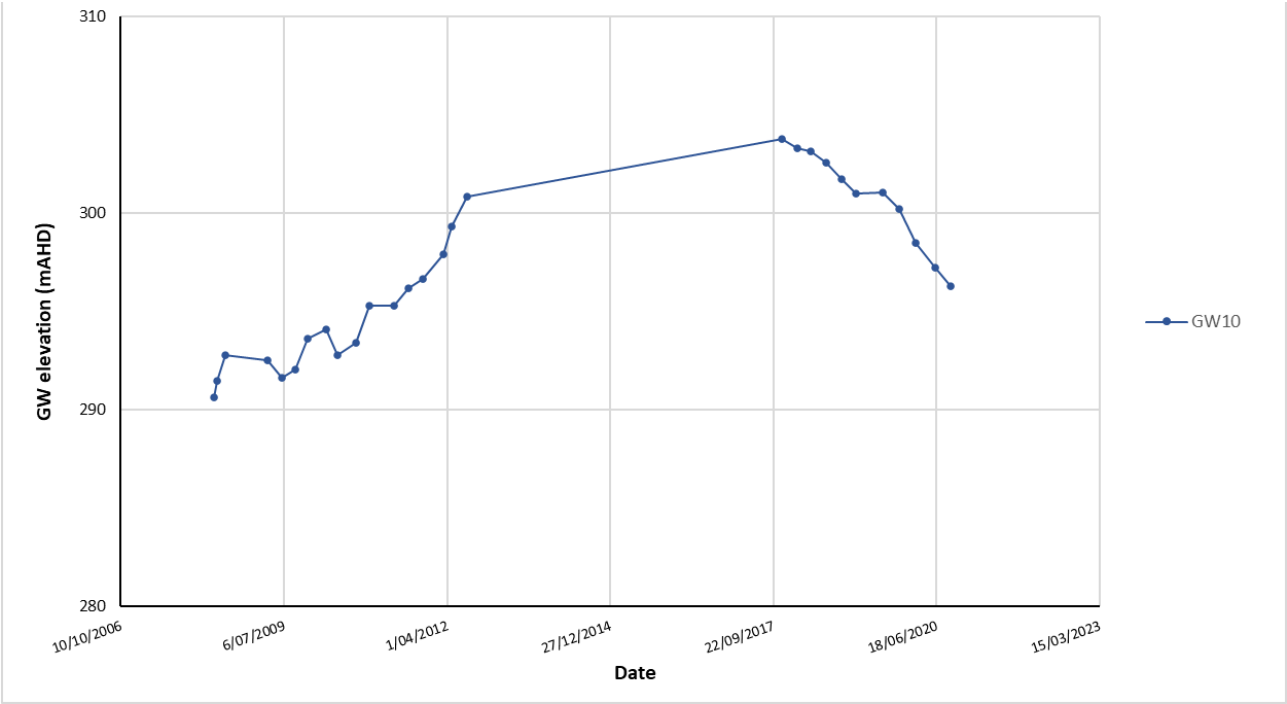


Figure 11 Groundwater level hydrographs – Spoil

Tailings at BAC were deposited as a slurry (comprising approximately 40 – 60% solids [Terranus, 2009]) into the tailings storage facility (TSF). In 2018 and 2019, the TSF was capped with an average of 3 m of spoil cover and rehabilitated (Terracom, 2020). The TSF is considered to be a locally perched aquifer (JBT, 2012).

Recharge to the TSF occurs from rainfall. However, as the elevation of the TSF lies below the base of the basalt aquifer (Terranus, 2009), it is not possible for the TSF to influence the quality or elevation of groundwater within the Tertiary basalt aquifer.

3.3. Groundwater quality

Groundwater at BAC is classified as slightly acidic to slightly alkaline, with pH ranging from 6.2 to 8.2. Groundwater is typically fresh to moderately saline, with measured electrical conductivity (EC) values ranging from 487 to 13,258 µS/cm. Within the Tertiary basalt, groundwater is typically fresh. Groundwater within the Blair Athol Coal Measures is typically slightly brackish to moderately saline, with higher EC values observed within the coal seams. Groundwater present within the spoil is typically neutral and brackish.

The major ion chemistry of the groundwater at BAC varies across the site, with two distinct water types reflecting the influence of the various host rocks present.

Groundwater within the Tertiary basalt, or within the Blair Athol Coal Measures where they underlie the Tertiary basalt, is a magnesium-calcium bicarbonate water type. This is reflective of rainfall recharge into the shallow basalt aquifer with a short residence time. The presence of this water type within the Blair Athol Coal Measures underlying the Tertiary basalt indicates that the Blair Athol Coal Measures are partially recharged via downward seepage from the Tertiary basalt.

Groundwater within the Blair Athol Coal Measures is a sodium-chloride water type, reflecting a deeper aquitard with an extended residence time. Mixed water types are also present due to the mixing that occurs between the different groundwater units. Groundwater quality within the spoil shows a range of water types (JBT, 2012), indicating the influence of the lithology of the backfill material on the groundwater chemistry.

3.4. Groundwater monitoring network

Terracom maintains the BAC groundwater monitoring network in accordance with the BAC EA. The current groundwater monitoring network is outlined in Terracom (2020). Details of the groundwater monitoring network are listed in Table 2, and the location of the groundwater monitoring bores are shown in Figure 12.

Two EA compliance bores (Curtis Bore and Mayes Bore) monitor the Tertiary basalt as it is the only aquifer suitable for domestic and stock watering purposes. The two EA compliance bores are located outside the ML.

The Groundwater Management Plan (GWMP) lists a further eight monitoring bores in addition to the two EA compliance bores. These bores are monitored to ensure that mining activities do not cause any environmental harm to the aquifers present at BAC. Five of the monitoring bores are located within the ML, with three located outside the extent of the ML. The monitoring bores are not used or pumped for mining operations and there are no production bores installed at BAC.

In accordance with the requirements of the BAC EA and as outlined in the current GWMP (Terracom, 2020), the groundwater monitoring program includes the following:

- Groundwater levels recorded on a quarterly basis. This data is used to enable natural groundwater level fluctuations (such as seasonal responses to rainfall) to be distinguished from potential groundwater level impacts due to drawdown resulting from mining activities.
- Groundwater quality monitoring is undertaken on a quarterly basis to detect any changes in groundwater quality due to mining activities. In accordance with the BAC EA, groundwater samples are analysed for a suite of parameters including pH, EC, total dissolved solids (TSS) and total sulfate.

Table 2 Details for groundwater quality monitoring bores

Bore	Aquifer	Easting	Northing	RL (mAHD)	Depth (m)	Screen interval (m)
GW01B	Permian conglomerate	556021	7492053	327	27.66	33 – 39
GW02A	Tertiary basalt	555284	7492697	329	60	21 – 27
GW02B	Permian conglomerate	555284	7492697	329	60.3	53 – 59
GW04A	Permian conglomerate	557069	7490417	314	15.8	11 – 14
GW04B	Permian conglomerate	557069	7490417	314	46.58	39 – 45
GW06	Permian conglomerate	553976	7491409	318	36	28 – 34
GW10	Spoil	555711	7489930	328	72	-
Curtis Bore	Tertiary basalt	557350	7491750	325	24.80	-
GT02	Coal Seam 4	555631	7488834	318	40.59	-
BA Station (Mayes Bore)	Tertiary basalt	558120	7493142	324	-	-

The groundwater quality limits set out within the EA are listed below in Table 3.

Table 3 EA compliance groundwater quality limits

Parameter	Units	Limit (as per EA Table K2)
Depth to water	m	2 m non-seasonal decrease in standing water level when not affected by pumping
pH	-	Between 6.5 to 9.0, or background levels at BA Station (whichever is lower/higher)
Electrical conductivity (EC)	µS/cm	2000, or background levels at BA Station (whichever is higher)
Total suspended solids (TSS)	mg/L	1000, or background levels at BA Station (whichever is higher)
Total sulfate	mg/L	500, or background levels at BA Station (whichever is higher)



©2023 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.Z:\4000_Projects\4131_SGM_Blair Athol PRCP\3_GIS\3_11_Workspaces_QGIS\4131_bore_location.qgz

Groundwater monitoring network

Blair Athol Coal Mine Progressive Rehabilitation and Closure Plan

Figure 12

13/01/2023

Legend

- Mining lease
- Monitoring Bore
- Compliance bore

hydrogeologist.com.au

4. Post-mining land use

4.1. Current and potential future uses of groundwater

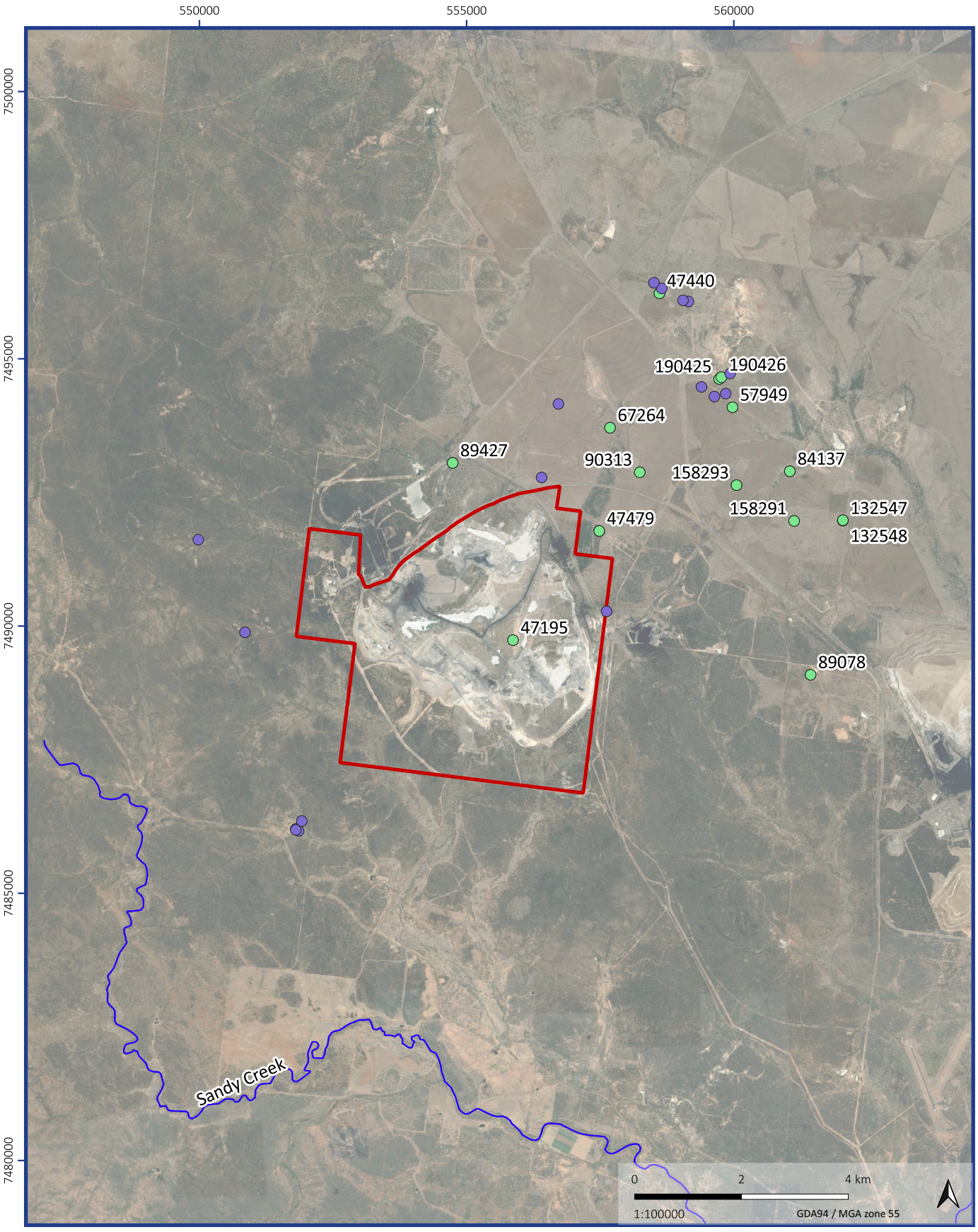
A search was undertaken of the Department of Regional Development, Manufacturing and Water (DRDMW) groundwater database of registered groundwater bores. Information stored in the database includes bore location, groundwater levels, construction details, stratigraphic logs, hydrogeological testing, and groundwater quality.

The registered groundwater bores located within a 5 km radius of the ML are shown in Figure 13. A total of 32 registered groundwater bores were identified, of which 15 are registered as existing (17 are listed as abandoned and destroyed). Nine registered groundwater bores are utilised for water supply, and four registered groundwater bores are utilised for mining monitoring purposes. The usage of two registered groundwater bores (RN 84137 and RN 89427) is unknown.

One registered groundwater bore utilised for water supply purposes (RN 47195, or the Venus SRF bore) is located within the extent of the ML. The remaining registered groundwater bores are located outside the extent of the ML.

Landholders in the region utilise the Tertiary basalt aquifer for stock and domestic purposes. The existing registered groundwater bores are located to the north-east of BAC, as this is where the basalt increases in thickness. No existing registered groundwater bores are located to the south or west of BAC due to the absence of the Tertiary basalt in this area.

Yields from the Tertiary basalt aquifer are variable and are in the order of 0.5 L/s to 10 L/s. Due to the fractured nature of the Tertiary basalt aquifer, yield and drawdown response is dependent on the connectivity of the fracture system, which is not easily predicted. As the Tertiary basalt present at BAC has been either mostly removed, or is absent, the potential for impacts to users of groundwater from this aquifer is expected to be low.



©2023 Oasis Hydrogeology Pty Ltd - trading as hydrogeologist.com.auSource: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.Z:\4000 Projects\4131 SGM Blair Athol PRCP\3 GIS\3 11 Workspaces QGIS\4131 registered bores.qgz

Registered groundwater bores

Legend

Blair Athol Coal Mine Progressive Rehabilitation and Closure Plan

Mining lease

Figure 13

Registered water bores within 5 km

16/01/2023

Abandoned and Destroyed

Existing

hydrogeologist.com.au

4.2. EVs and water quality objectives

The *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP Water) provides a framework for the protection of environmental values (i.e., uses) associated with Queensland groundwaters. Under this framework, environmental values for specific catchments and drainage basins have been formalised through a process of statutory declaration. Environmental values formalised in this way are listed in Schedule 1 of the EPP Water. For other waters, a site-specific assessment of the potential environmental values is required.

The BAC ML and its surrounds are located within Drainage Basin 130 (i.e., the 'Fitzroy Basin'). The Fitzroy Basin comprises seven sub-basins. The ML is located within the Lower Nogoa Groundwaters of the Nogoa River sub-basin. The declared environmental values for the Lower Nogoa Groundwaters are:

- aquatic ecosystems;
- industrial use;
- irrigation supply;
- farm supply and use;
- stock water;
- recreational use, including swimming;
- drinking water supply; and
- cultural and spiritual values.

The EPP Water also establishes water quality objectives (WQOs) to protect the relevant groundwater environmental values. WQOs are quantitative measures or narrative statements established to protect relevant environmental values. WQOs comprise water quality indicators and corresponding water quality guidelines. The water quality indicators are the physical, chemical, or biological properties that can be quantitatively measured, while the water quality guidelines are the quantitative measure for an indicator.

WQOs vary across the Fitzroy Basin and are defined based on groundwater chemistry zones (GCZs). The BAC ML intersects two separate GCZs. The applicable GCZs for BAC are Zones 4 and 9. The WQOs for these zones are provided in Table 4 and Table 5.

Table 4 WQOs for groundwater resources within Zone 4

Water quality indicator	Unit	Deep*			Shallow*		
		20th percentile	50th percentile	80th percentile	20th percentile	50th percentile	80th percentile
EC	µS/cm	765	938	1243	625	740	1012
Hardness	mg/L	152	219	437	118	251	321
Ph	-	7.50	7.70	8.00	7.81	7.95	8.28
Alkalinity	mg/L	250	315	400	266	289	357
Ca	mg/L	25	48	65	26	48	52
Mg	mg/L	16	31	67	13	33	49
Na	mg/L	76	98	137	57	82	143
Cl	mg/L	65	100	215	35	51	100
SO_4	mg/L	6	13	20	6	8	18
HCO_3	mg/L	325	399	487	324	348	435
NO_3	mg/L	0.50	1.00	5.35	8.14	22.00	27.62
SiO_2	mg/L	31	34	43	28	38	40
F	mg/L	0.100	0.105	0.200	0.028	0.110	0.200
Fe	mg/L	0.010	0.135	1.400	0.003	0.020	0.044
Mn	mg/L	0.010	0.020	0.060	0.003	0.010	0.024
Zn	mg/L	0.010	0.010	0.010	0.020	0.040	0.060
Cu	mg/L	0.010	0.010	0.010	-	-	-
Sodium adsorption ratio (SAR)	-	1.70	2.50	4.80	1.53	2.30	6.56
Residual alkali hazard (RAH)	meq/L	0.74	2.09	2.69	0.68	2.25	2.88

*Note: * Groundwater WQOs are given for two depths (shallow less than (<) 30 m below ground (mbGL) and deep greater than (>) 30 mbGL).*

Table 5 WQOs for groundwater resources within Zone 9

Water quality indicator	Unit	Deep*			Shallow*		
		20th percentile	50th percentile	80th percentile	20th percentile	50th percentile	80th percentile
EC	µS/cm	18117	19800	20372	526	642	889
Hardness	mg/L	4491	4685	5074	139	165	243
pH	-	6.90	7.10	7.35	6.80	7.40	7.90
Alkalinity	mg/L	535	542	618	106	129	182
Ca	mg/L	353	365	437	18	21	30
Mg	mg/L	888	920	963	22	26	39
Na	mg/L	3024	3091	3216	47	65	91
Cl	mg/L	6030	6870	6907	70	95	143
SO4	mg/L	1216	1240	1325	32	47	55
HCO3	mg/L	645	658	671	126	157	210
NO3	mg/L	0.00	0.55	1.00	0.00	0.70	3.30
SiO2	mg/L	-	-	-	19	22	30
F	mg/L	-	-	-	0.110	0.140	0.224
Fe	mg/L	0.037	0.170	8.585	0.000	0.010	0.065
Mn	mg/L	0.635	1.150	1.455	0.000	0.010	0.010
Zn	mg/L	-	-	-	0.010	0.030	0.060
Cu	mg/L	-	-	-	0.001	0.020	0.030
Sodium adsorption ratio (SAR)	-	18.43	19.5	20.45	1.63	2.20	2.48
Residual alkali hazard (RAH)	meq/L	-	-	-	0.00	0.00	0.05

*Note: * Groundwater WQOs are given for two depths (shallow less than (<) 30 m below ground (mbGL) and deep greater than (>) 30 mbGL).*

4.3. Final landform

The proposed final landform will be a "depressed landform", with areas of mining activity partially backfilled with spoil (WRM, 2022). Due to the proposed topography, rainfall and runoff are predicted to report to the final void. This water will be stored within the final landform, as well as within the pore space of the backfilled spoil below and adjacent to the final landform (WRM, 2022).

A final void hydrology investigation was completed by WRM in September 2022 (WRM, 2022). The key levels of interest determined in this investigation were:

- the proposed elevation to which mining will occur (~214 mAHD);
- the elevation of the final void (~246 mAHD);
- the elevation at which the final void will spill to surface water (~305 mAHD);
- an assumed post closure groundwater inflow rate of 3 – 5 L/s (JBT, 2012);
- the modelled average long-term pit lake water level (~276.6 mAHD); and
- the modelled maximum long-term pit lake water level (~282 mAHD, approximately 23 m below the final void spill level).

Water within the final void is projected to rapidly rise within the first year to the base of the final void. This recovery represents filling of the pore space of the backfilled spoil under the final void, before water begins to collect within the final void, forming a permanent pit lake.

The water elevation within the final void is projected stabilise after a period of approximately 75 years and is projected to oscillate between approximately 270 mAHD and 282 mAHD.

4.4. Post-mining site hydrogeology

Within the first year of the cessation of mining activity, the backfilled spoil below the final void is predicted to rapidly fill with water from groundwater seepage, surface runoff and rainfall. This will result in the spoil forming a localised aquifer. Once the spoil reaches saturation, a pit lake will develop within the final void.

As the modelled maximum long-term pit lake water level (282 mAHD) is below the groundwater elevations observed in the Tertiary basalt (305 mAHD to 325 mAHD - Figure 8) and the Blair Athol Coal Measures (295 mAHD to 315 mAHD - Figure 9 and Figure 10) , the final void is predicted to act as a permanent sink. As a result, salinity within the pit lake is predicted to increase over time.

As there is no connectivity between the alluvium and the final void, no flow from the residual void into the alluvium is expected post-mining.

Groundwater from the Tertiary basalt and the Blair Athol Coal Measures will seep into the spoil and pit lake post-closure. WRM (2022) have assumed a constant groundwater inflow rate to the pit void of 3 L/s to 5 L/s. Due to the fractured nature of the Tertiary basalt, with each fracture storing a finite volume of water, the seepage rate from the Tertiary basalt is expected to decrease over time as the pit lake level increases, with temporal increases in the rate of seepage following periods of rainfall recharge.

Post-mining, the TSF is expected to remain a locally perched aquifer. Minimal seepage is predicted to occur through the floor of the TSF into the underlying spoil and then into the Blair Athol Coal Measures (JBT, 2012). The rate of groundwater seepage is expected to decrease post-closure as the tailings progressively dewater and the TSF cap minimises rainfall recharge.

4.5. Post-mining groundwater quality

Potential sources of groundwater contamination at BAC post-closure include the final void and the TSF, and areas associated with mining activity such as those that involve chemical and/or hydrocarbon use and storage.

The salinity of the pit lake within the final void is predicted to increase over time (WRM, 2022). However, due to the final void acting as a sink, there is highly unlikely to be impact on the local groundwater quality as water will not be able to migrate away from the pit lake. Baseline groundwater salinity of the Blair Athol Coal Measures has shown it to be slightly brackish to moderately saline. Consequently, it is not expected that residual salts accumulating in the pit lake will cause a significant increase in the salinity of groundwater.

Terracom (2020) notes that testing of coarse and fine rejects indicates that the material stored at the TSF is classified as both potentially acid forming (PAF) and non-acid forming (NAF). Additionally, Terracom (2020) notes that the seepage chemistry indicates that seepage from beneath the TSF is pH neutral. This indicates that the inherent buffering capacity of the rejects and tailings to self-neutralise is occurring. This process of self-neutralisation is expected to continue post-closure. Furthermore, as the elevation of the TSF lies below the base of the Tertiary basalt aquifer, there is unlikely potential for seepage from the TSF into the Tertiary basalt.

5. Conclusion

Extensive hydrogeology data and information for BAC has been analysed and reported over many years. The groundwater conditions for the BAC site are well understood.

The water elevation within the final void is projected stabilise after a period of approximately 75 years and is projected to oscillate between approximately 270 mAHD and 282 mAHD.

The observed groundwater elevations in the Tertiary basalt are between 305 mAHD to 325 mAHD and observed groundwater elevations in the Blair Athol Coal Measures are between 295 mAHD to 315 mAHD. On this basis the final void at BAC is predicted to act as a groundwater sink.

The salinity of the pit lake within the final void is predicted to increase over time. As the final void will behave as a groundwater sink, there is highly unlikely to be impact on the local groundwater quality as water in the pit lake will not be able to migrate away from the sink.

6. References

Coffey, 1980. Groundwater Appraisal – Blair Athol Coalfield. Prepared for Blair Athol Coal Pty Ltd. Report No. B9433/2D. July 1980.

Coffey, 1993. Stage 2 Groundwater Assessment at Blair Athol Coal Mine. Prepared for BAC. Report No. G351/2-AB. October 1993.

JBT Consulting (JBT), 2012. Blair Athol Mine Closure Groundwater Investigation. Prepared for Rio Tinto Coal Australia. JBT01-018-002. December 2012.

Matrix Plus Consulting Pty Ltd (Matrix), 2007. Blair Athol Coal – Groundwater Monitoring Bore Installation. Prepared for Rio Tinto Coal Australia. Project No. RTB705. 26 October 2007.

Rio Tinto Coal Australia (RTCA) 2006. Blair Athol Mine - Groundwater Monitoring. Internal report. 21 June 2006.

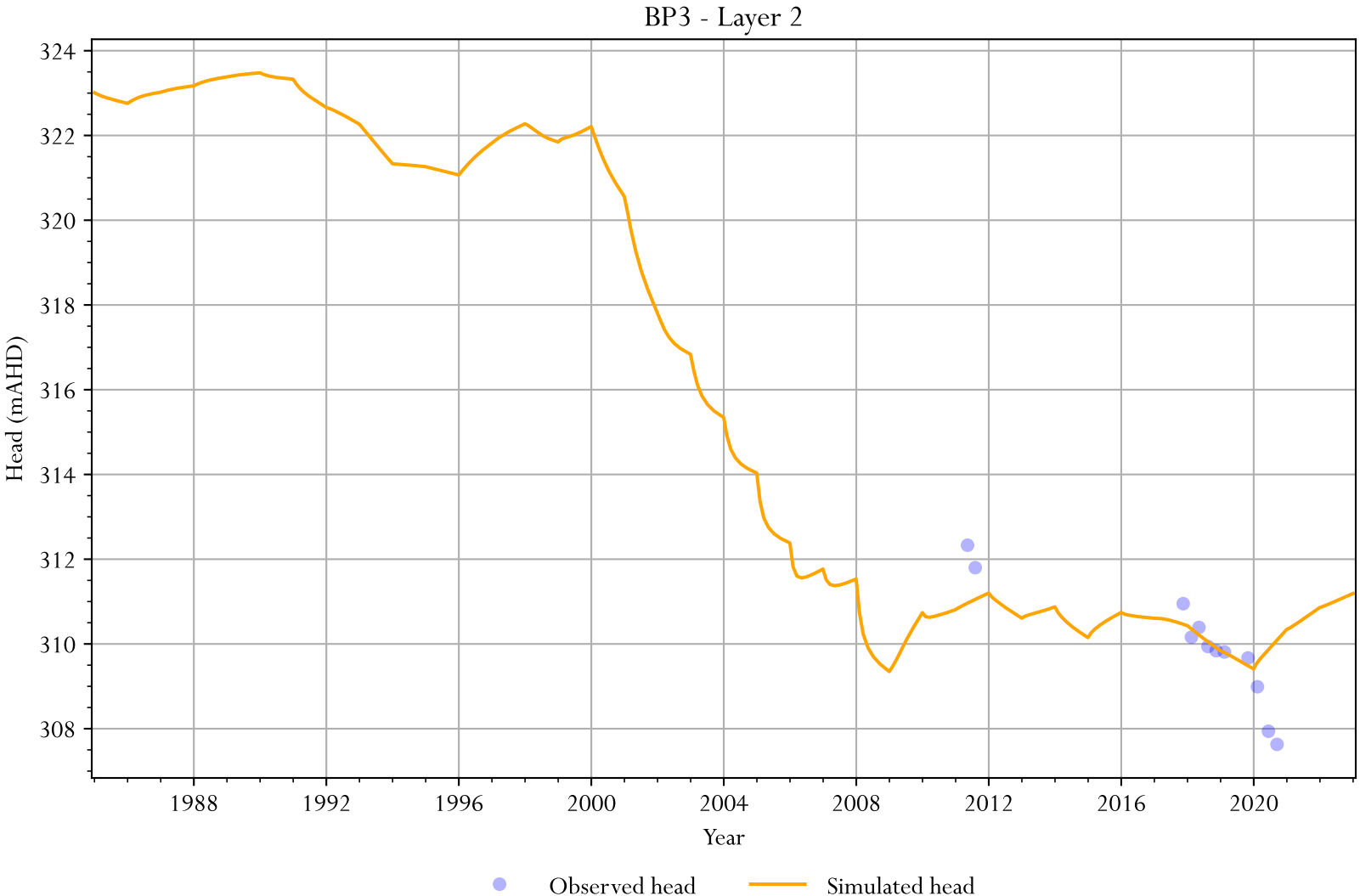
Terracom, 2019.Groundwater Monitoring Program 2019.

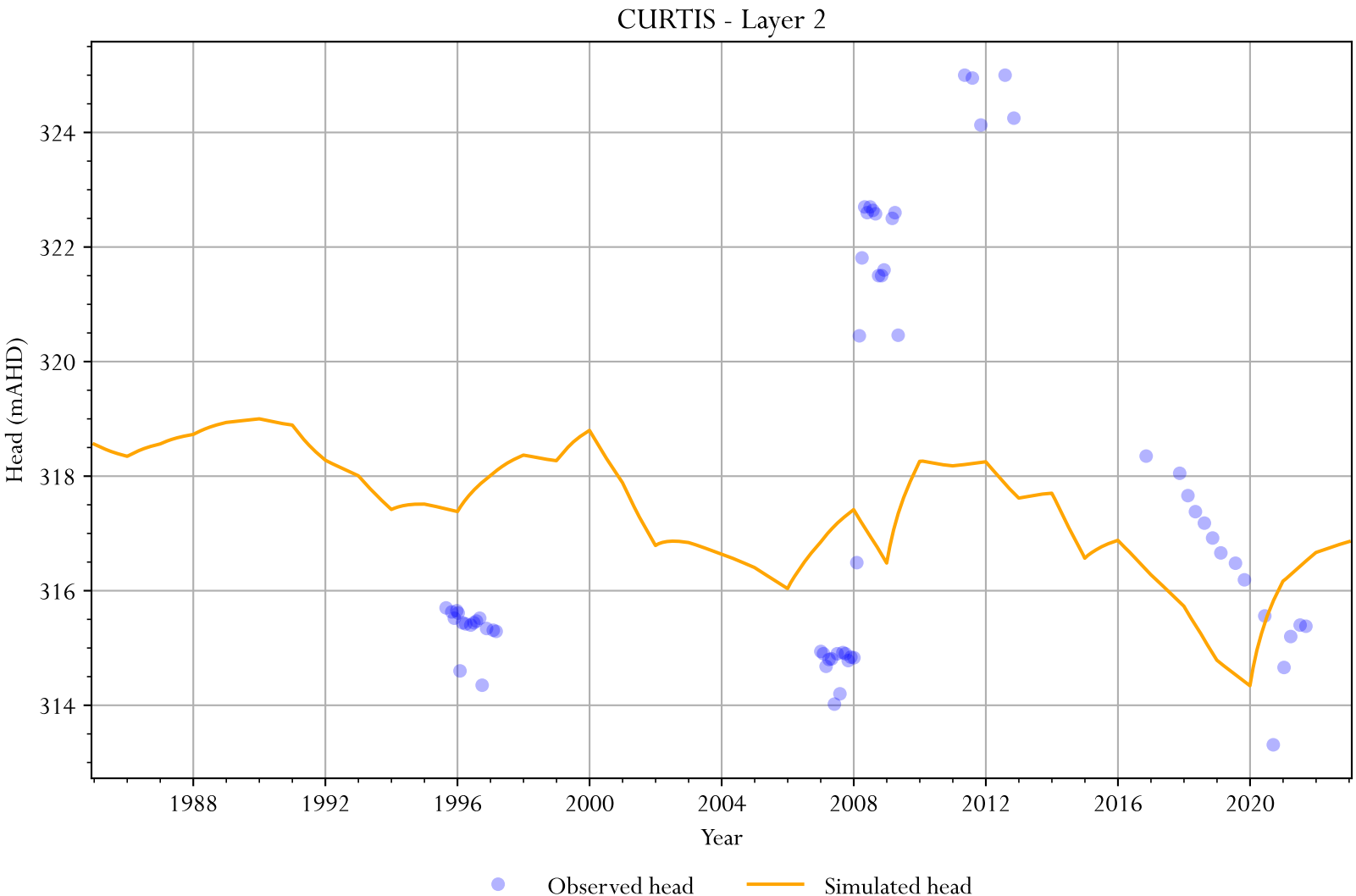
Terracom, 2020. Groundwater Monitoring Program. October 2020.

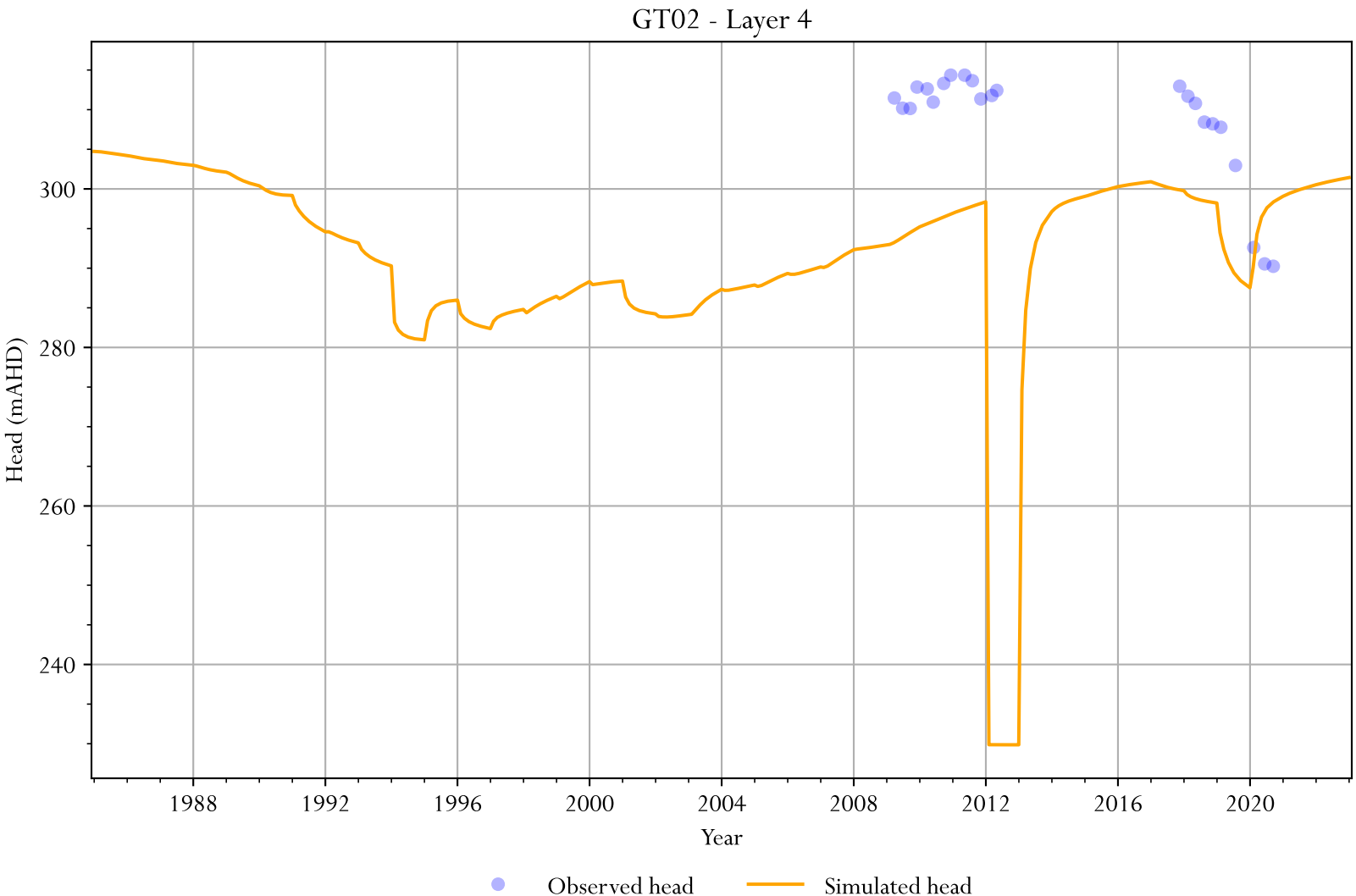
Terrenus Earth Sciences, 2009. Blair Athol Coal Mine Groundwater Review. Prepared for Rio Tinto Coal Australia. Job No. 09-011-24, Report No. R001. 16 June 2009.

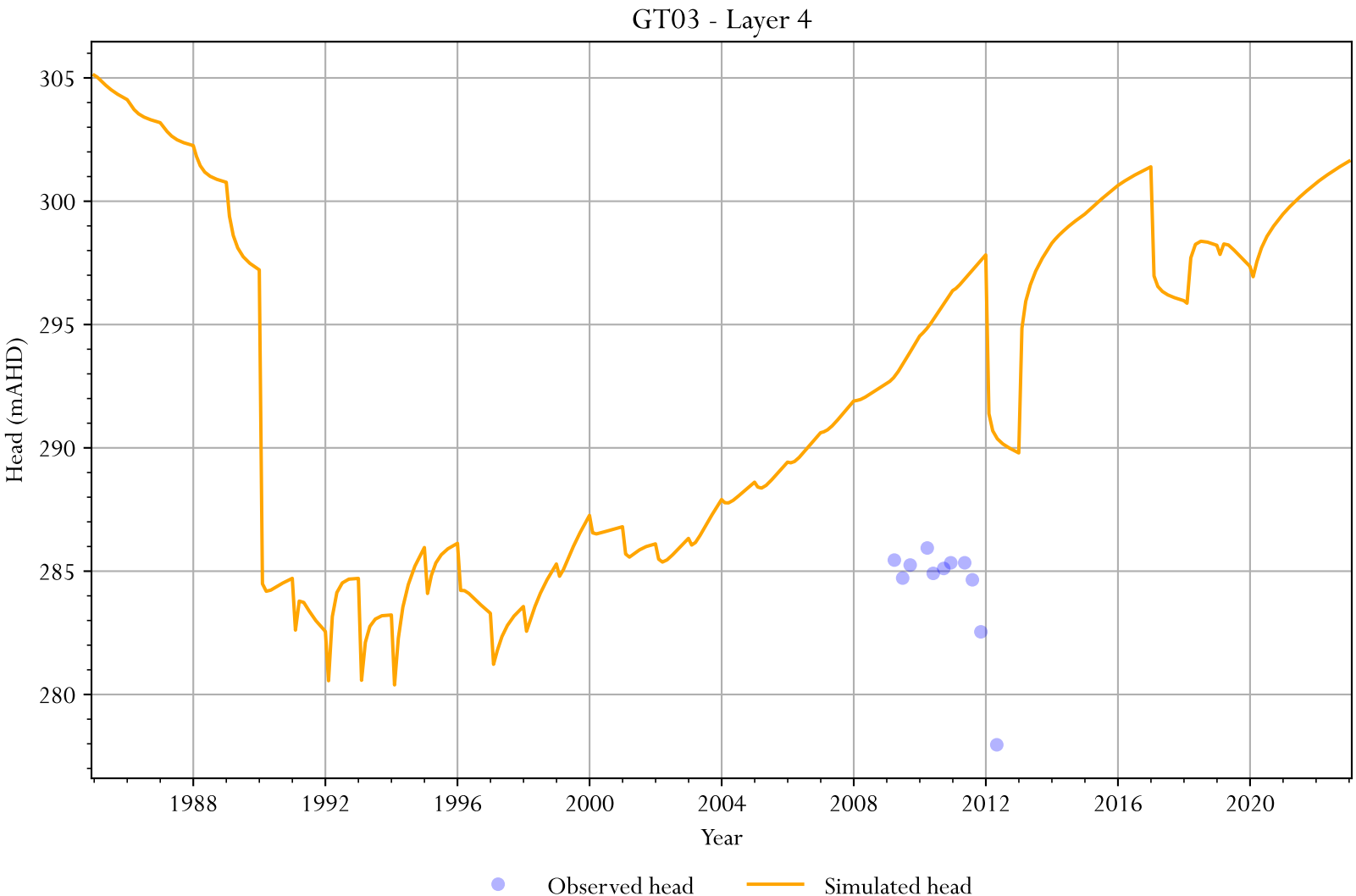
WRM Water & Environment Pty Ltd (WRM), 2022. Final Void Hydrology Report – Blair Athol Coal Mine. Prepared for Terracom Resources. Draft 1549-02-C. 30 September 2022.

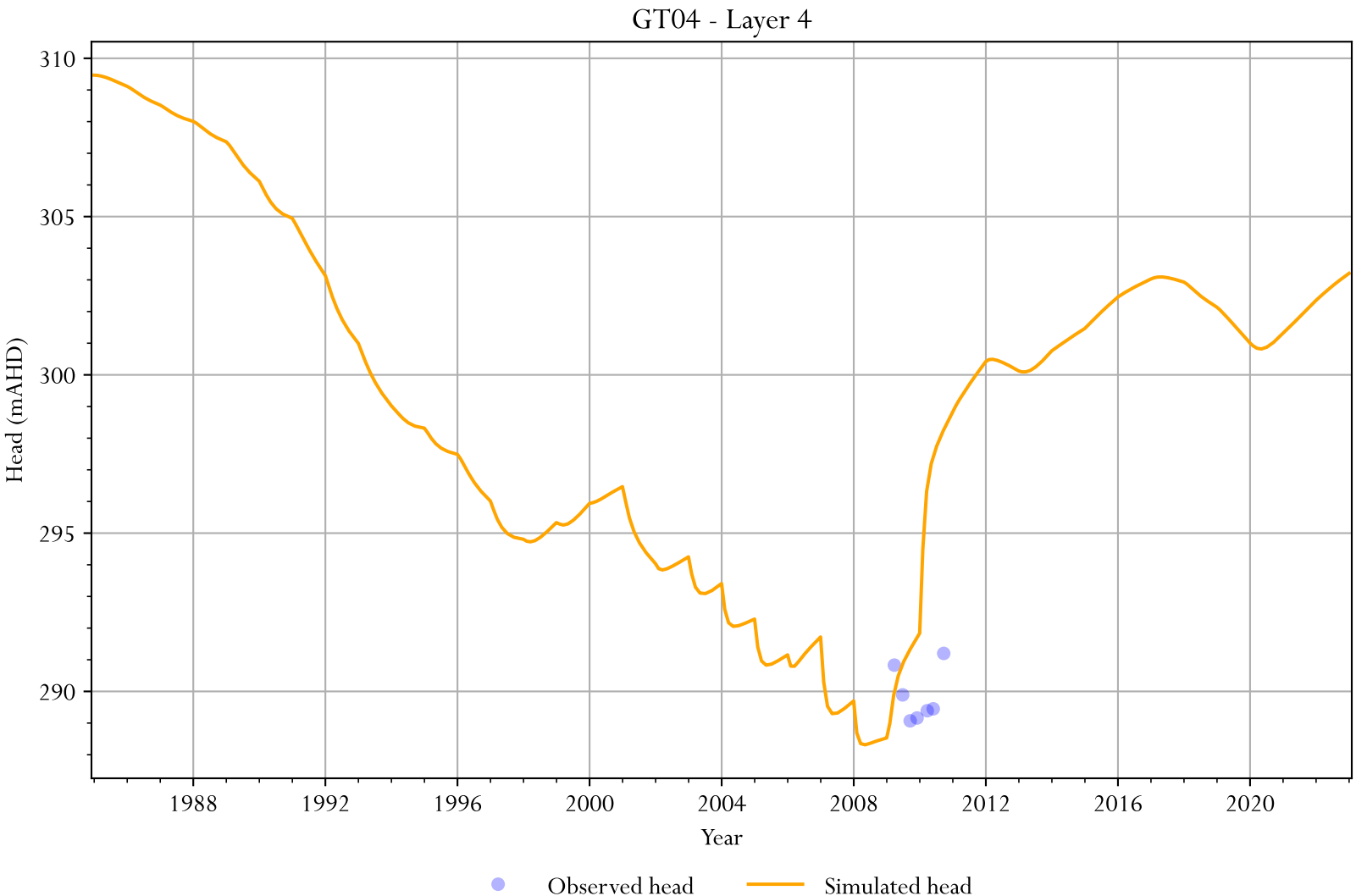
Appendix B Calibration hydrographs

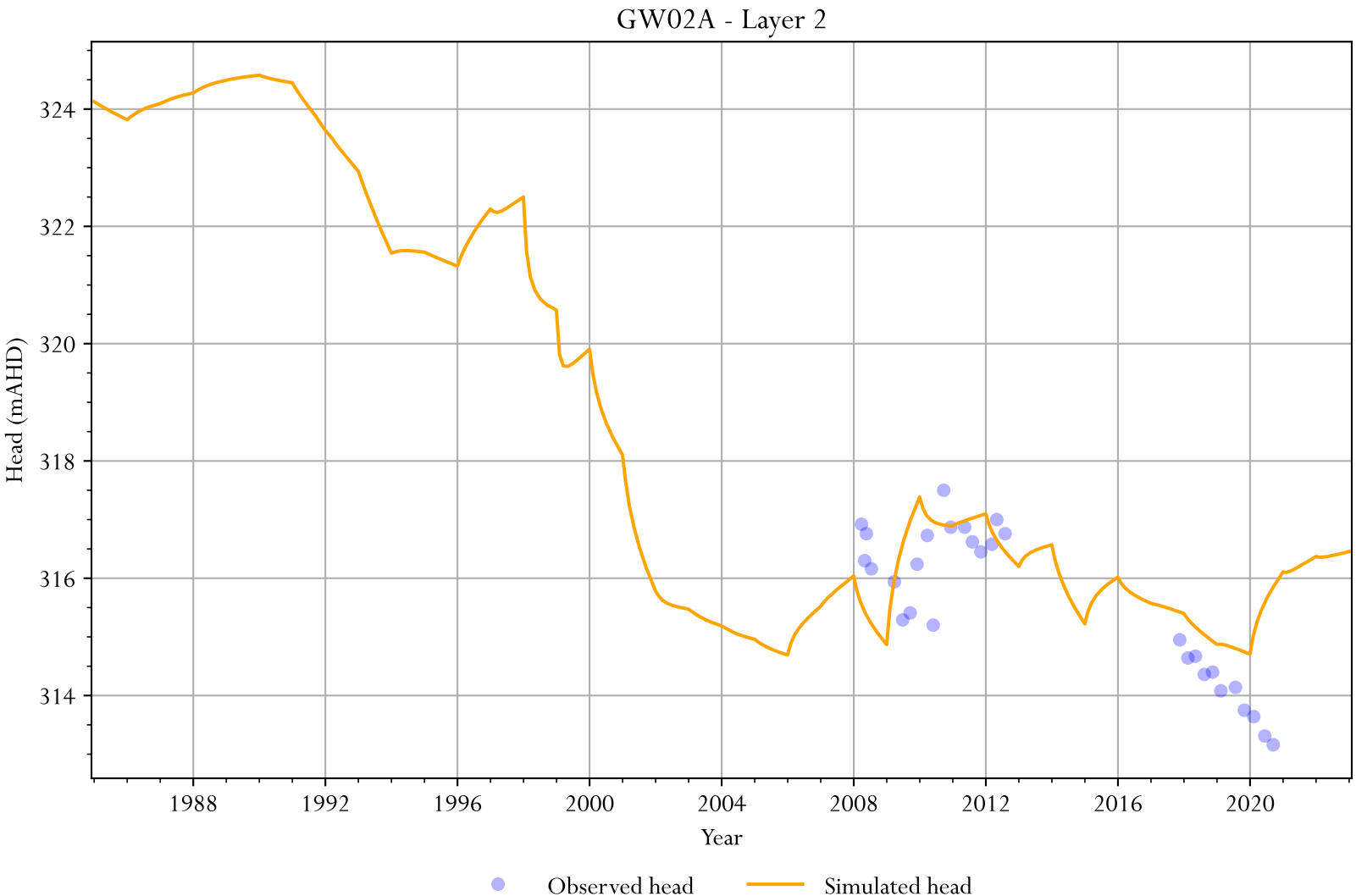

BP3 - Layer 2
Head (mAHD)
324
322
320
318
316
314
312
310
308
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head

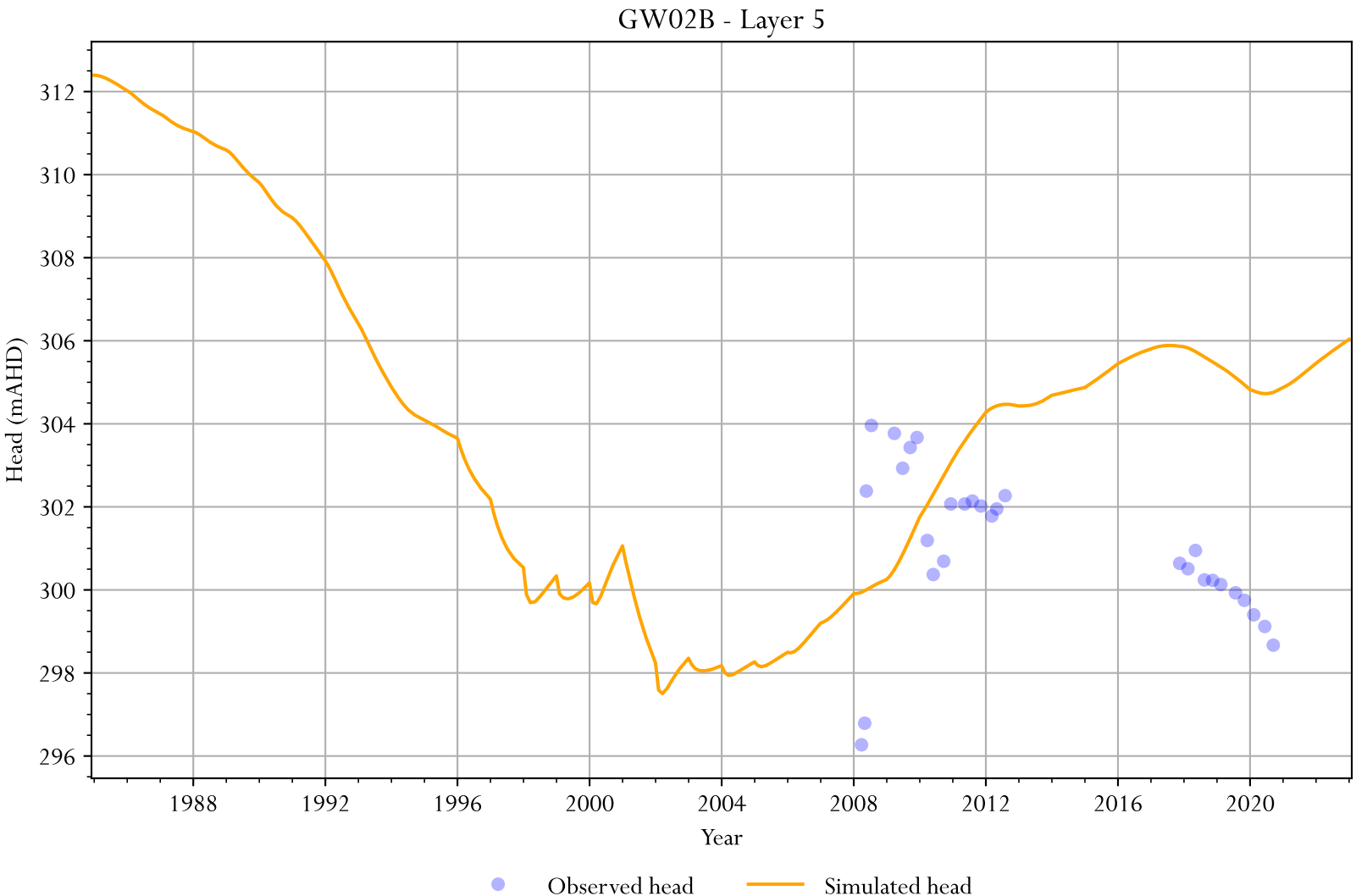

CURTIS - Layer 2
Head (mAHD)
324
322
320
318
316
314
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head

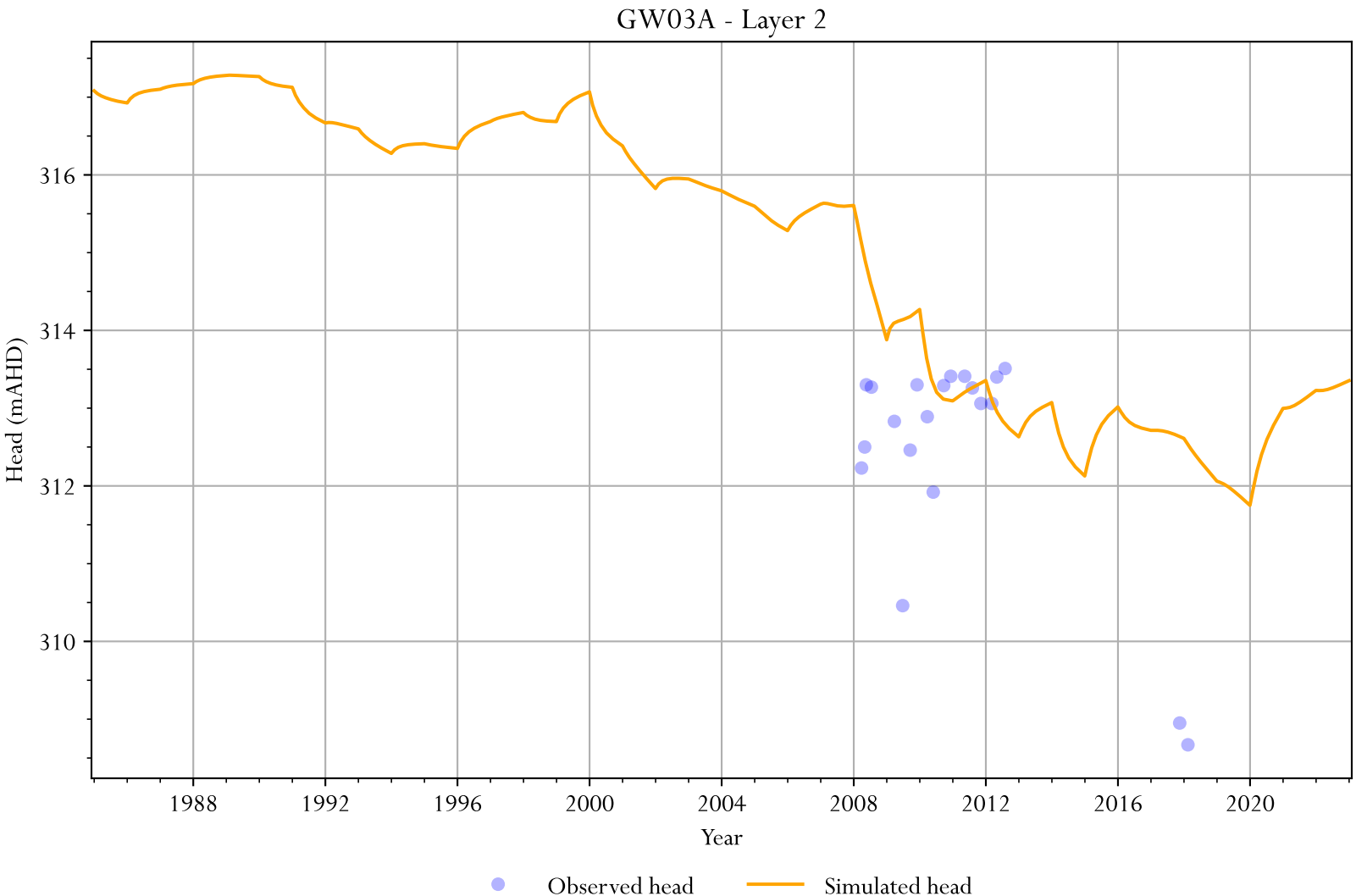

GT02 - Layer 4
Head (mAHD)
300
280
260
240
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head

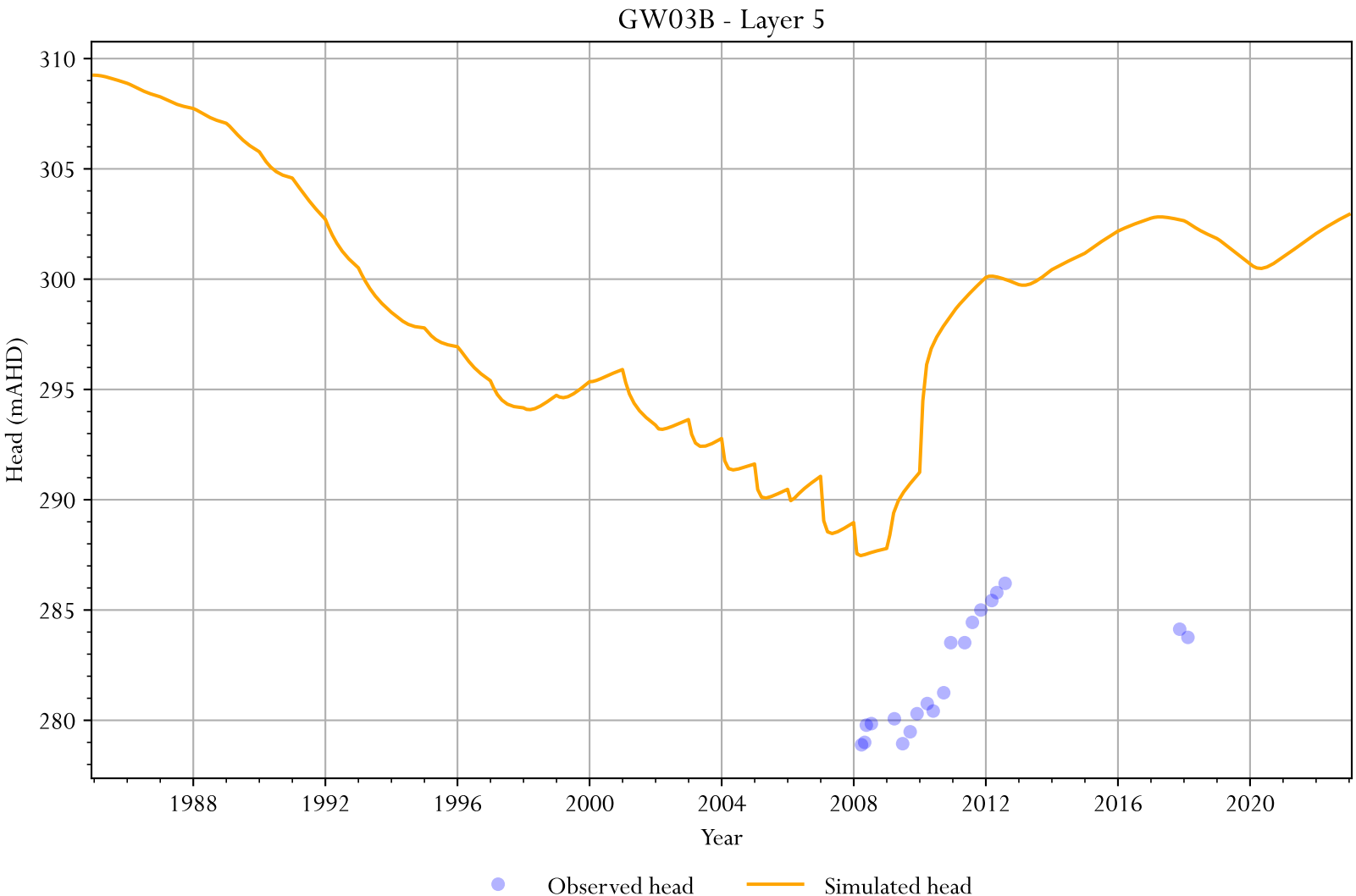

GT03 - Layer 4
305
300
295
290
285
280
Head (mAHD)
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head

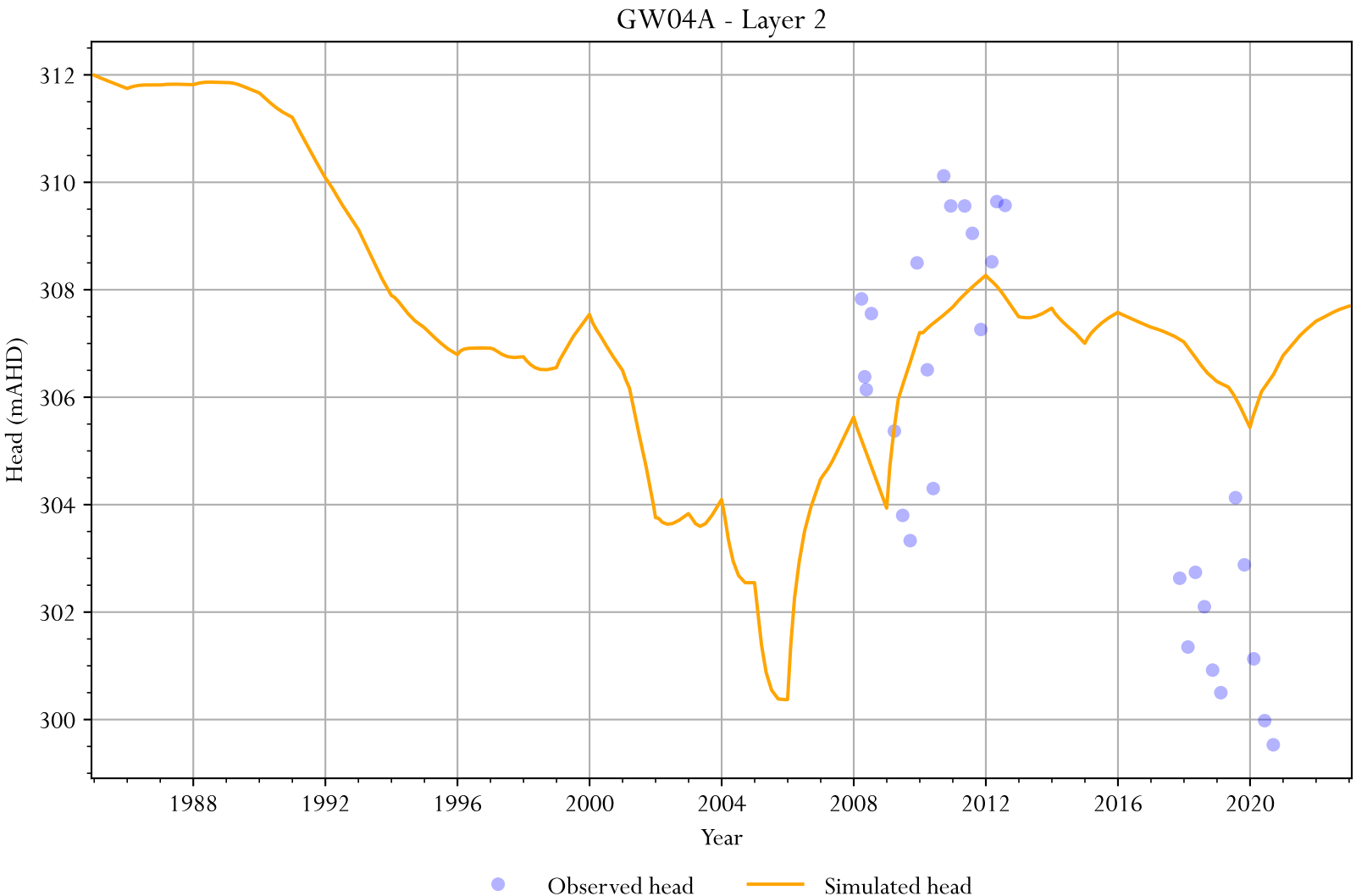

GT04 - Layer 4
310
305
300
295
290
Head (mAHD)
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head

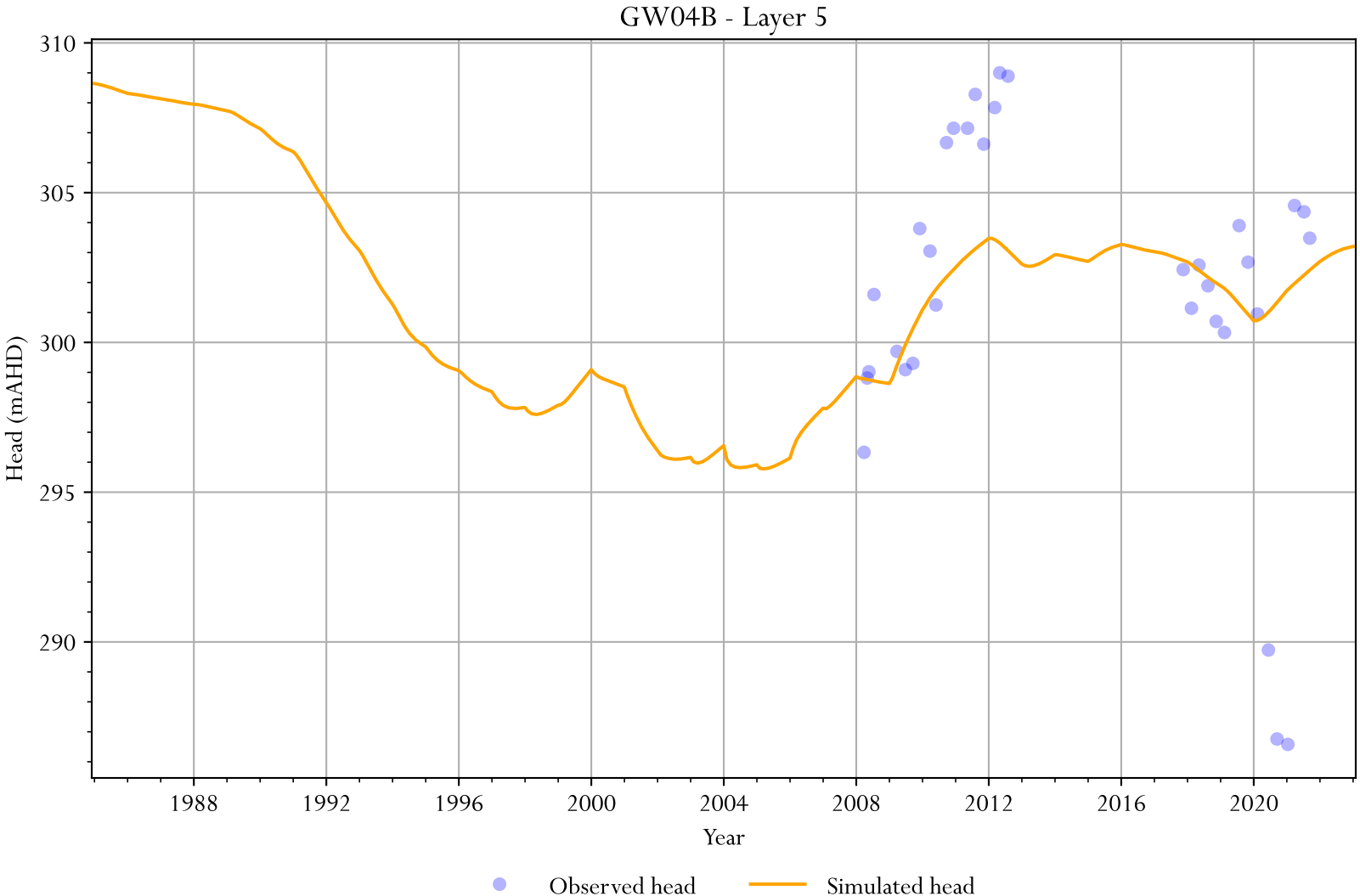

GW02A - Layer 2
Head (mAHD)
324
322
320
318
316
314
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head

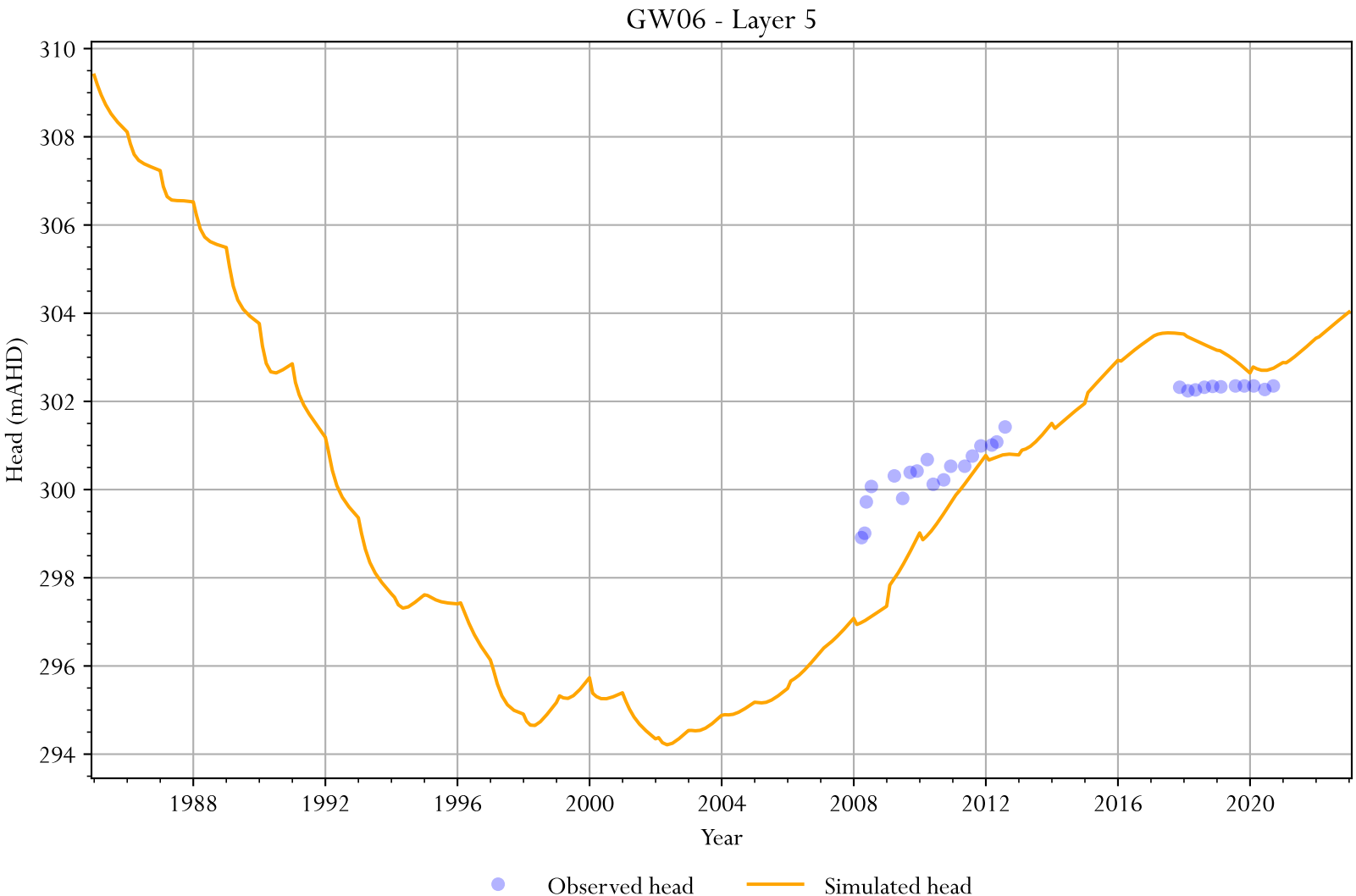

GW02B - Layer 5
Head (mAHD)
312
310
308
306
304
302
300
298
296
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head

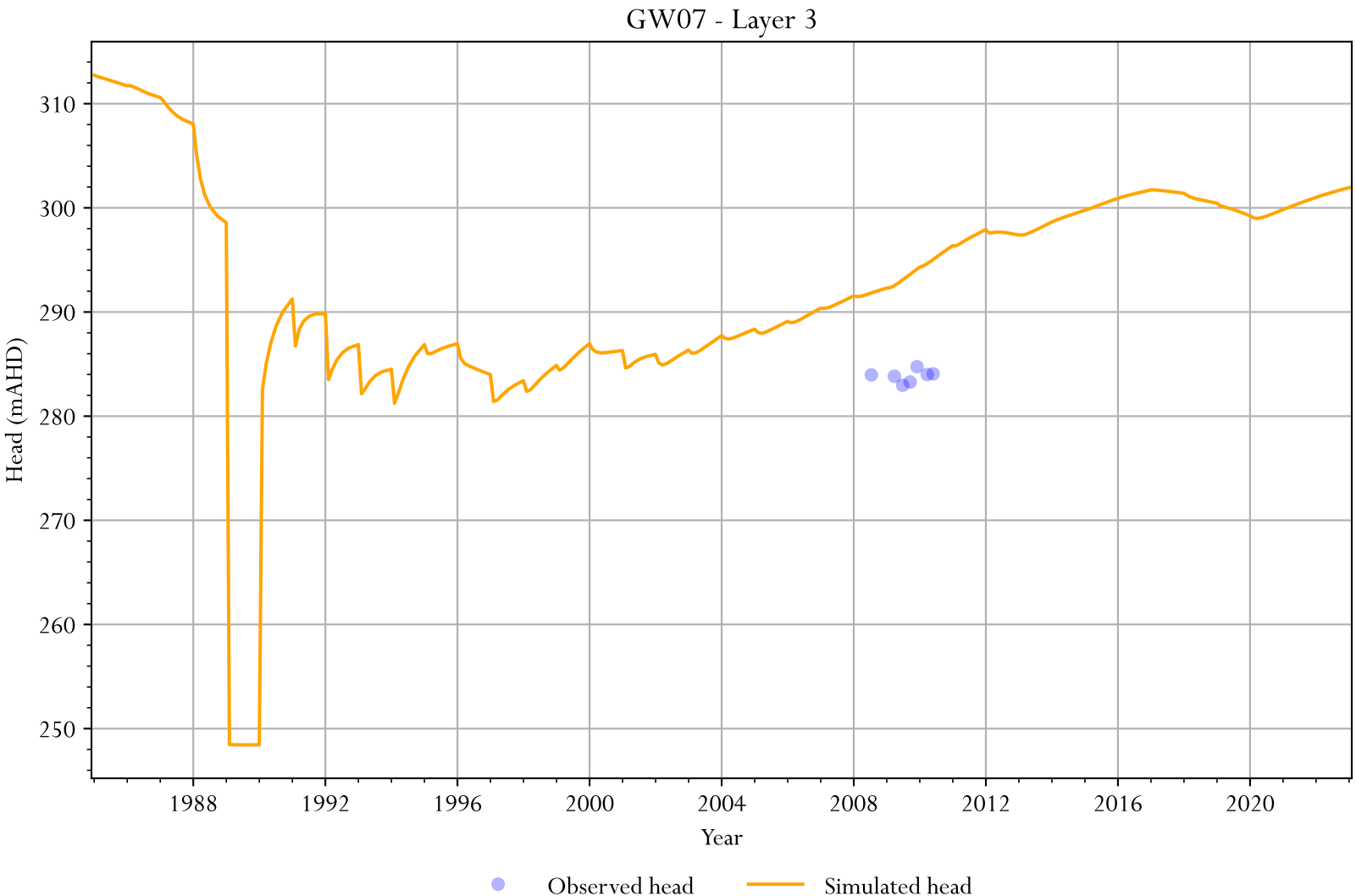

GW03A - Layer 2
Head (mAHD)
316
314
312
310
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head

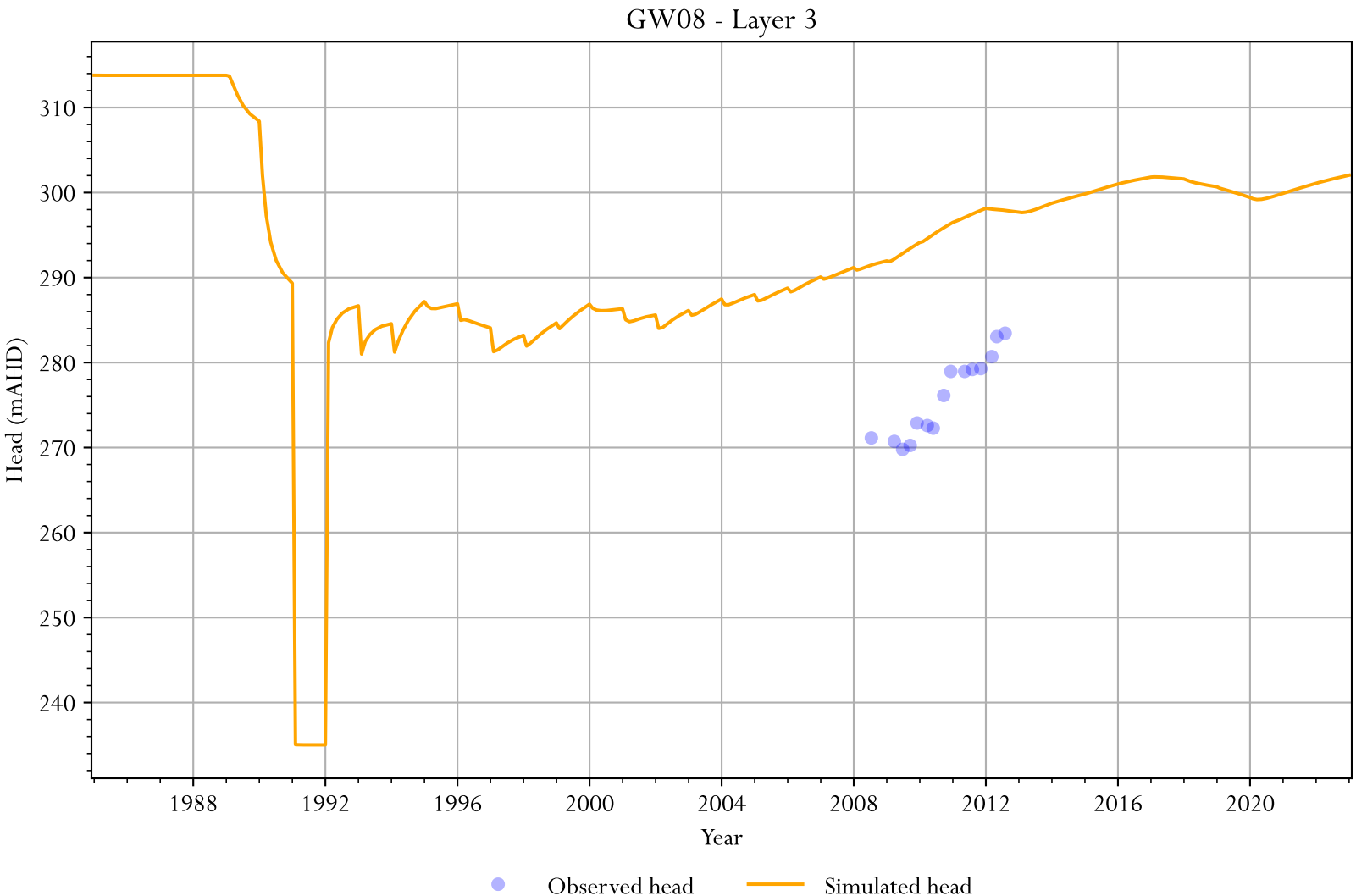

GW03B - Layer 5
Head (mAHD)
310
305
300
295
290
285
280
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head

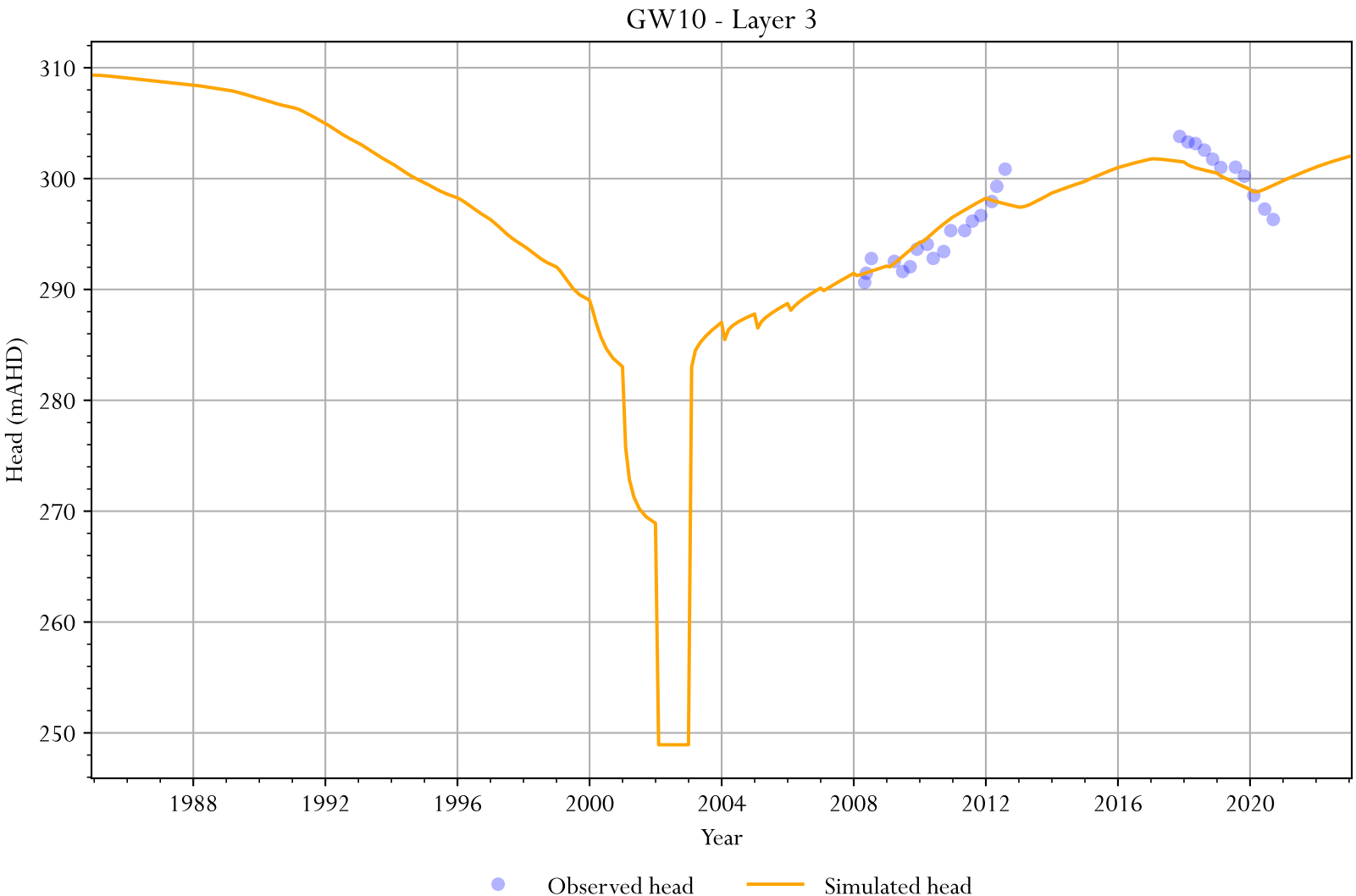

GW04A - Layer 2
Head (mAHD)
312
310
308
306
304
302
300
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head

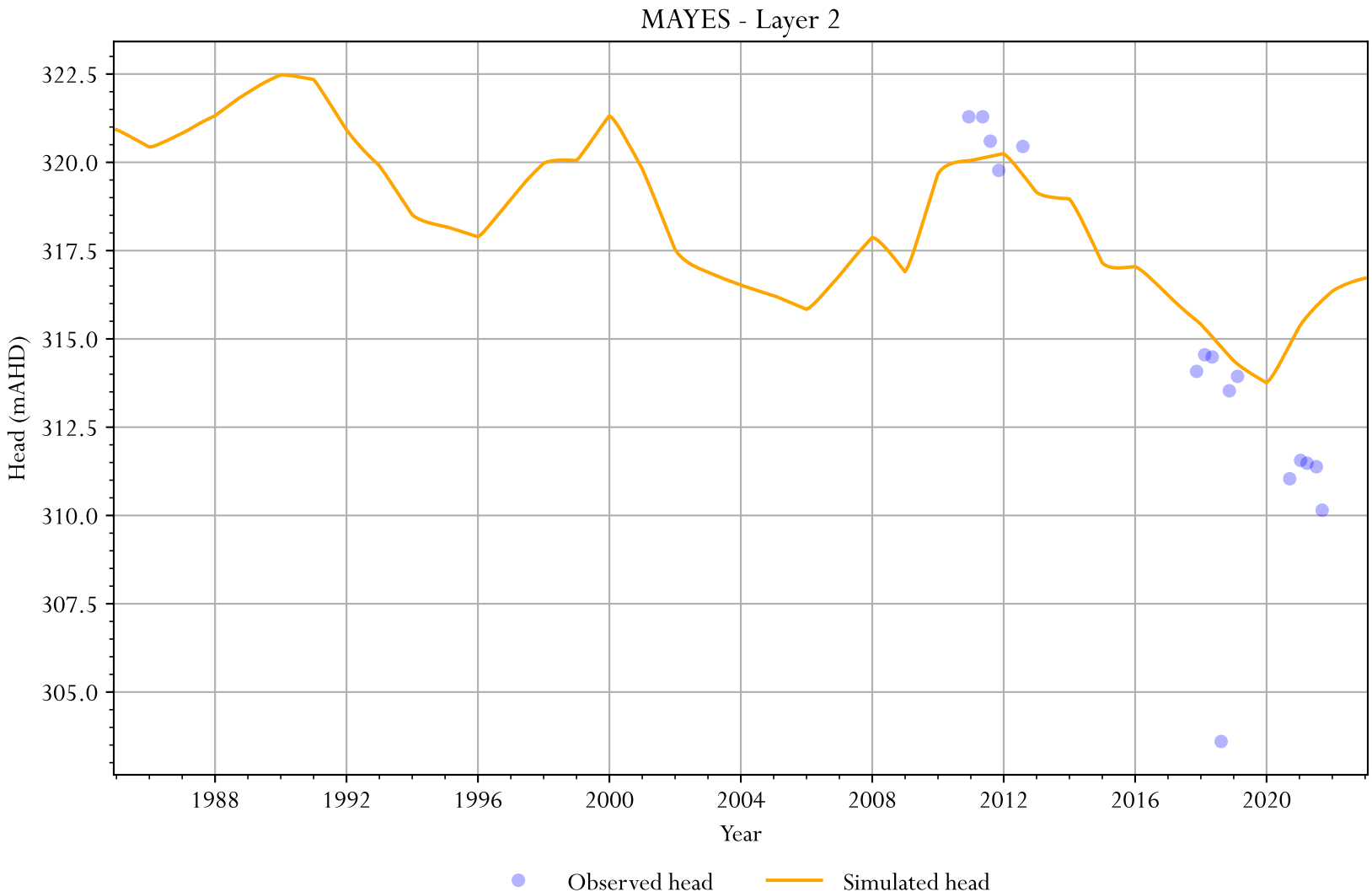

GW04B - Layer 5
310
305
300
295
290
Head (mAHD)
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head

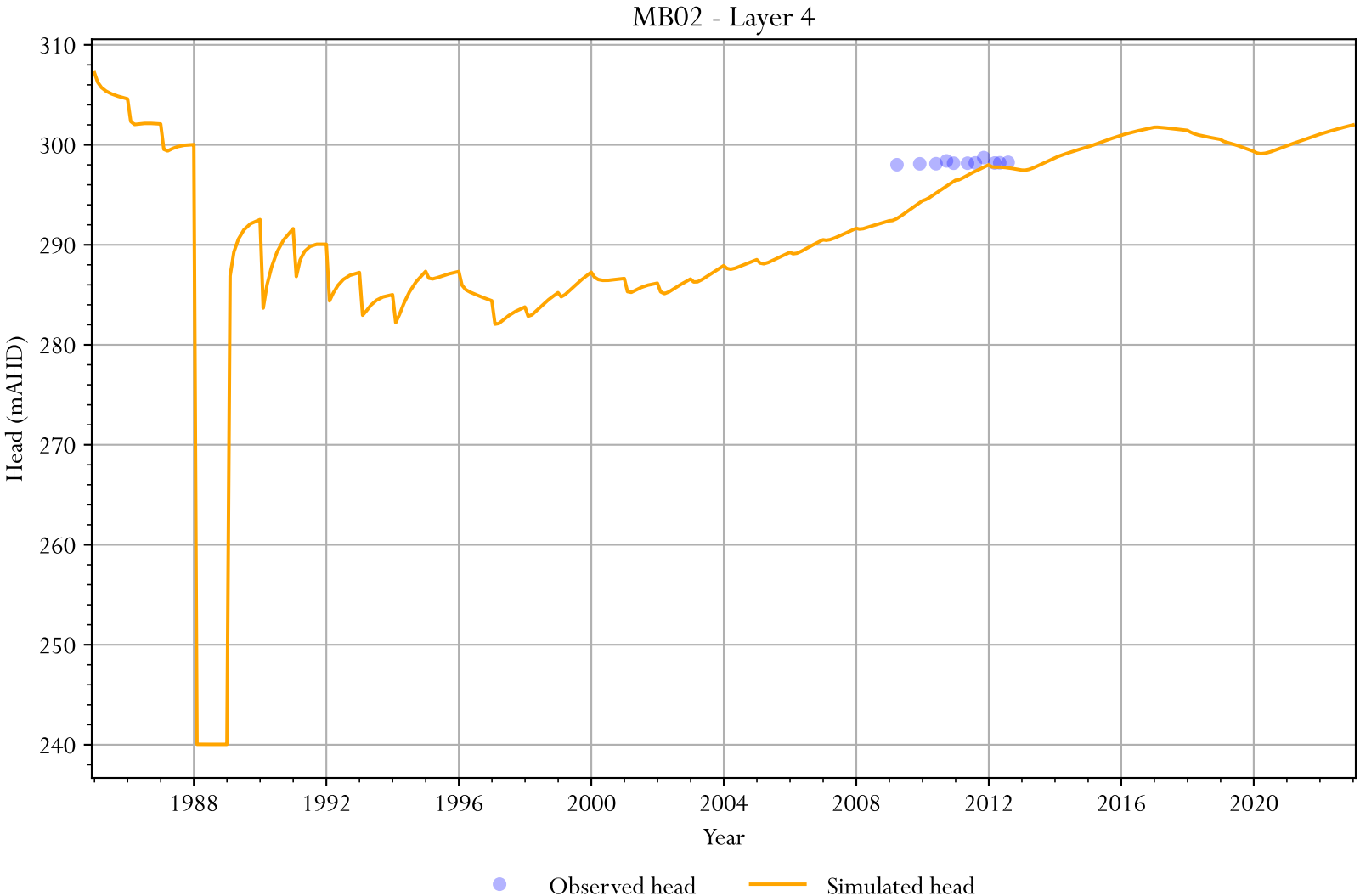

GW06 - Layer 5
Head (mAHD)
310
308
306
304
302
300
298
296
294
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head

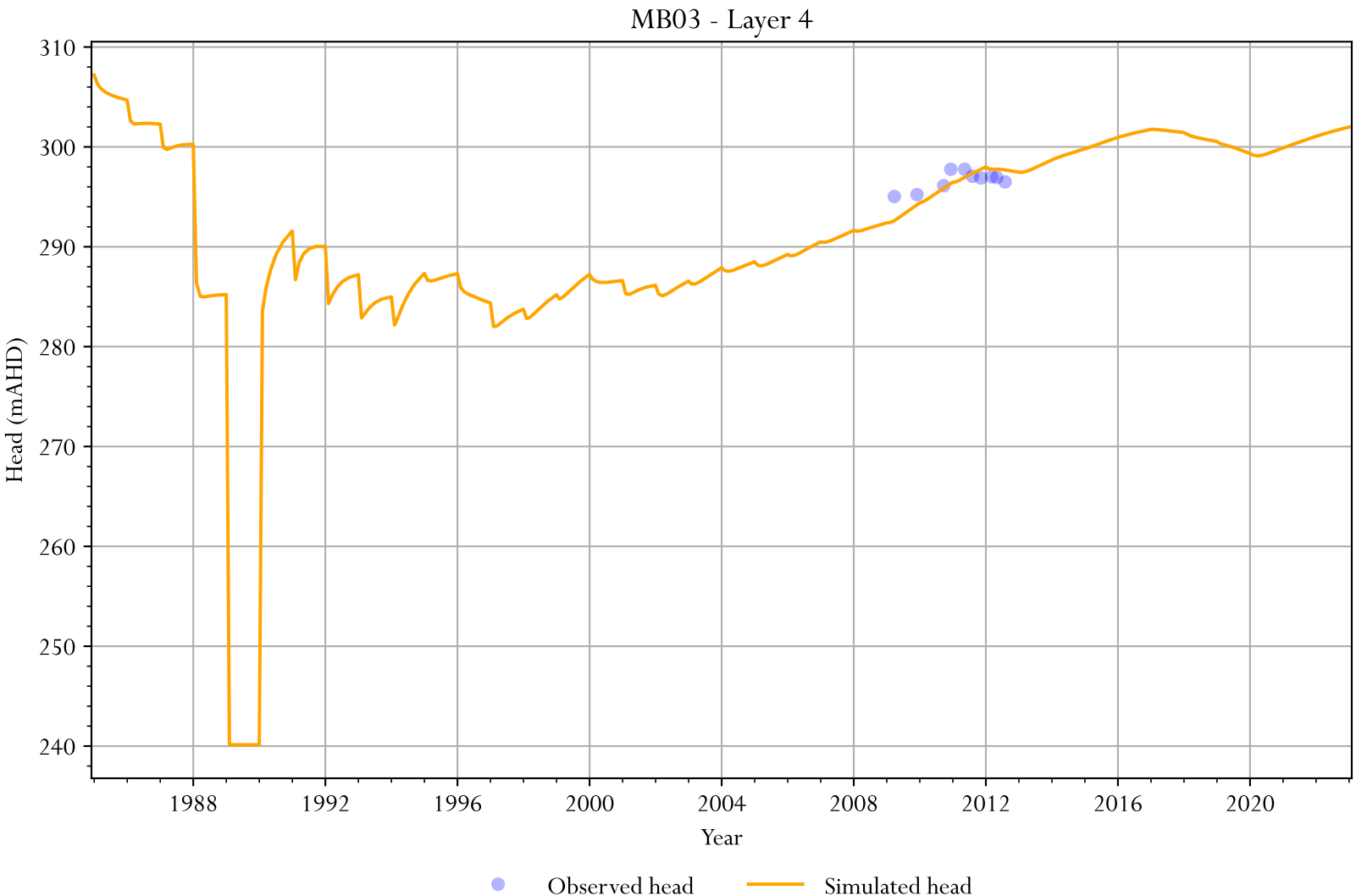

GW07 - Layer 3
Head (mAHD)
310
300
290
280
270
260
250
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head

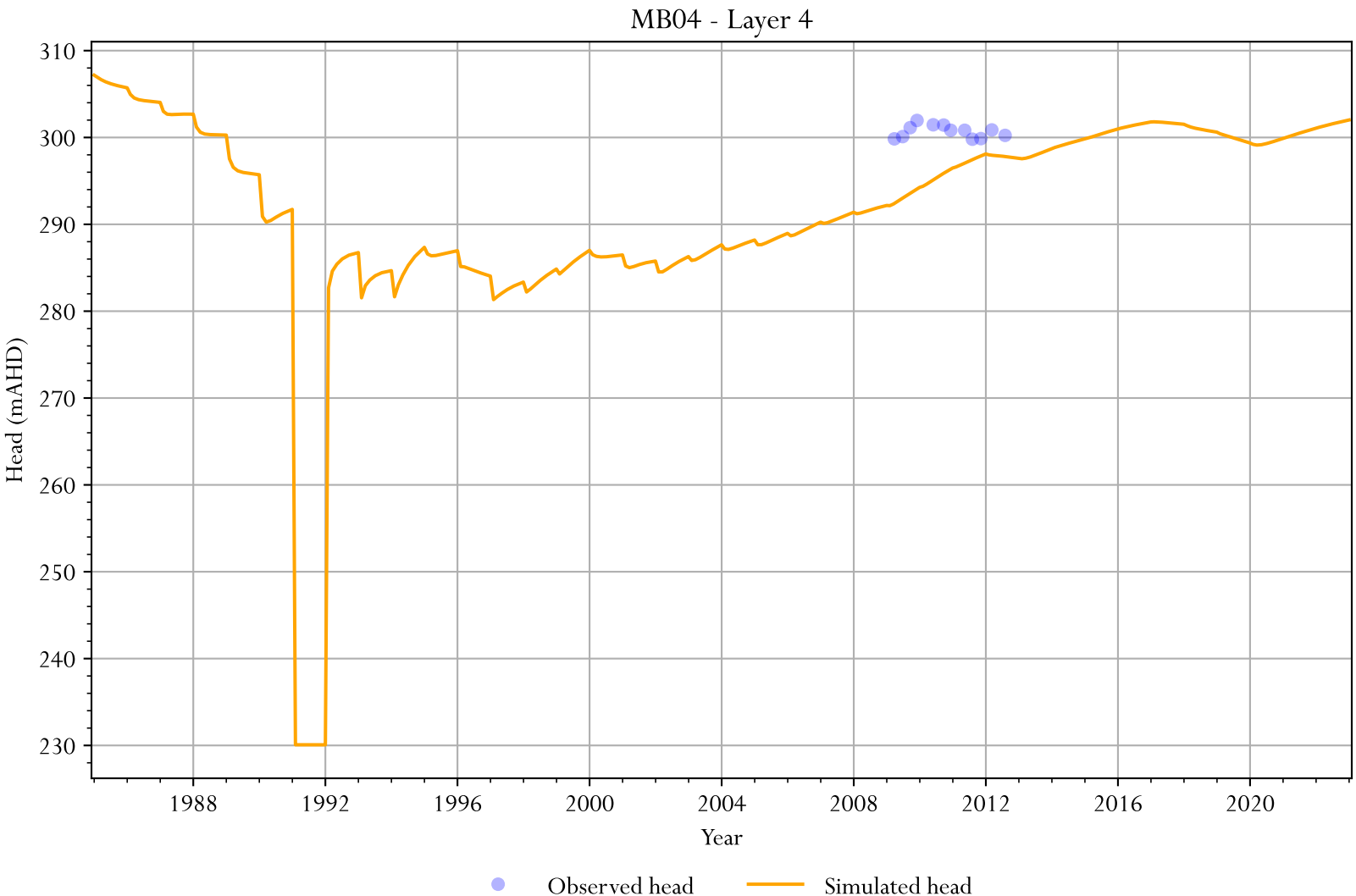

GW08 - Layer 3
Head (mAHD)
310
300
290
280
270
260
250
240
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head

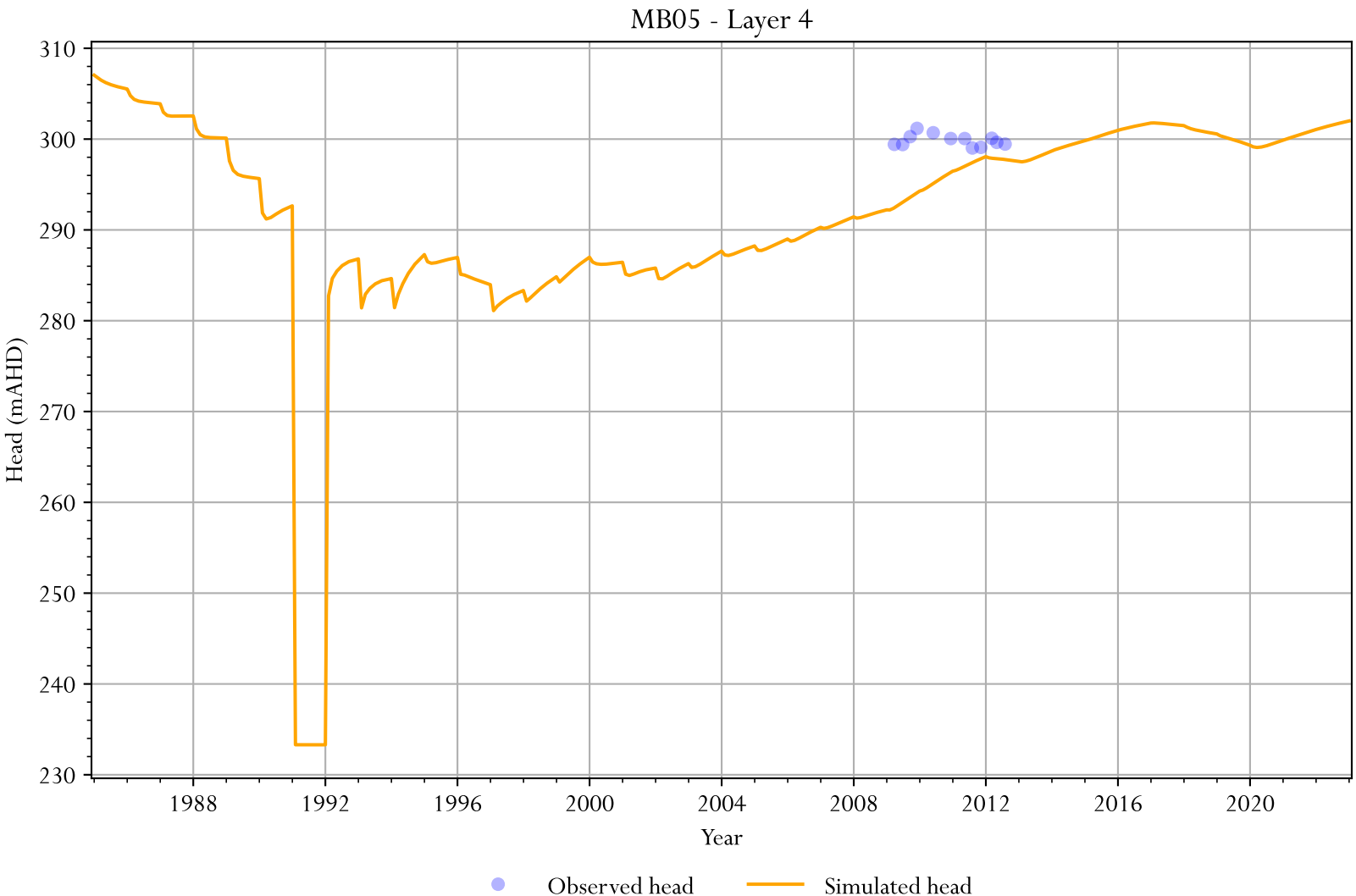

GW10 - Layer 3
Head (mAHD)
310
300
290
280
270
260
250
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head

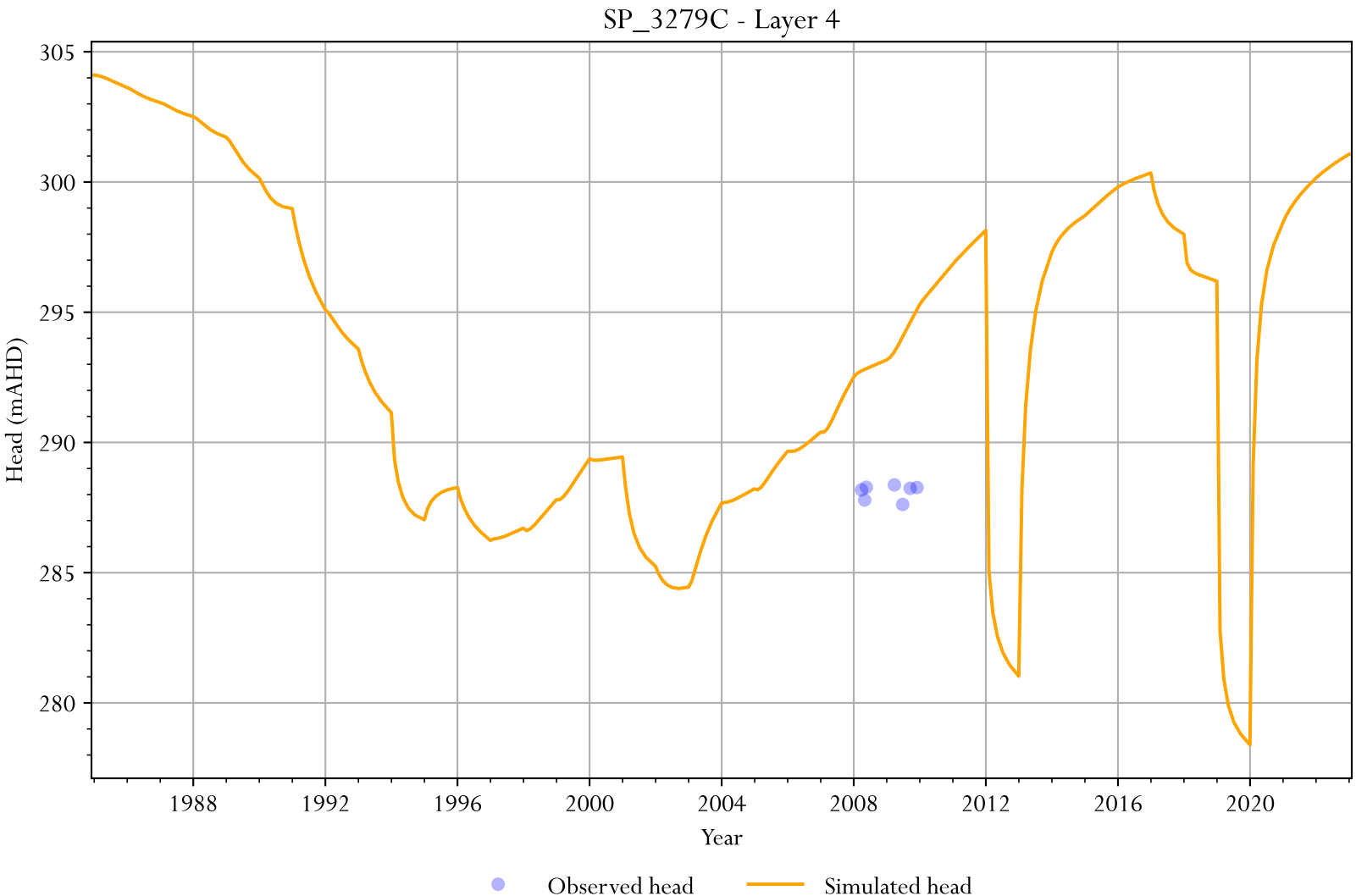

MAYES - Layer 2
322.5
320.0
317.5
315.0
312.5
310.0
307.5
305.0
Head (mAHD)
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head

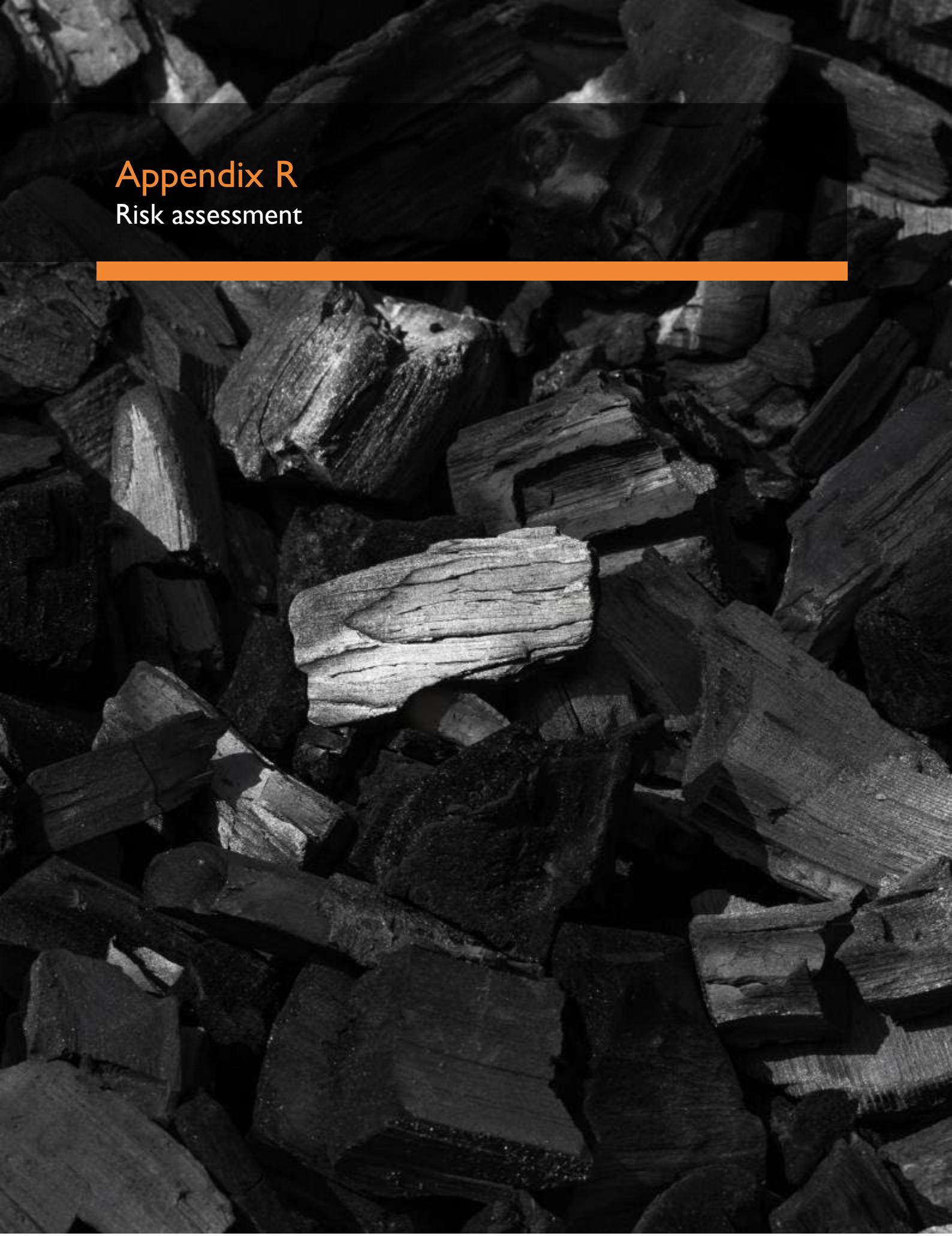

MB02 - Layer 4
Head (mAHD)
310
300
290
280
270
260
250
240
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head


MB03 - Layer 4
Head (mAHD)
310
300
290
280
270
260
250
240
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head


MB04 - Layer 4
Head (mAHD)
310
300
290
280
270
260
250
240
230
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head


MB05 - Layer 4
Head (mAHD)
310
300
290
280
270
260
250
240
230
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head


SP_3279C - Layer 4
305
300
295
290
285
280
Head (mAHD)
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year
Observed head
Simulated head



Appendix R
Risk assessment

Risk assessment and risk treatment plan

R.1 Method

The risk matrix used to evaluate each risk event is in Table Y1.

The likelihood ratings and descriptions are in Table Y2.

The consequence categories and definitions are in Table Y3.

Table Y1 Risk matrix

Likelihood	Consequence					
	1	2	3	4	5	6
A	Medium	High	High	Very High	Very High	Very High
B	Medium	Medium	High	High	Very High	Very High
C	Low	Medium	Medium	High	High	Very High
D	Low	Low	Medium	Medium	High	High
E	Low	Low	Low	Medium	Medium	High

Table Y2 Likelihood ratings and descriptions

Likelihood	Rating	Description
Almost certain	A	Likely to occur multiple times a year.
Likely	B	Might occur once a year.
Possible	C	Might occur multiple times during the LOM.
Unlikely	D	Might occur once during the LOM.
Rare	E	Unlikely to occur during the LOM.

Table Y3 Consequence categories and definitions

Consequence	Definition				
	Financial loss	**Safety and people**	**Environment**	**Legal compliance**	**Reputation**
Catastrophic (6)	> $ 50 million	Effects on safety and people include: • multiple fatalities; or • major injury or illness among multiple employees.	Environmental impacts include: • offsite impact requiring long-term remediation (years) with residual damage; • species extinction or permanent impairment of ecosystem function; or • irreversible loss of cultural heritage value.	Legal issues include regulatory, permit or community agreement of non-compliance with probable fines of > $20 million and involving criminal investigation of officers or directors.	Impacts to reputation include significant international media, public criticism or public condemnation.
Major (5)	$ 10-50 million	Effects on safety and people include: • single fatality; • total and permanent disability; or • major irreversible health effects.	Environmental impacts include: • offsite impact requiring long-term remediation (years); • impact requiring long-term remediation (years) with residual damage; • change to ecosystem function; or • irreversible damage of cultural heritage value.	Legal issues include regulatory, permit or community agreement of non-compliance with probable fines of $5-20 million.	Impacts to reputation include international adverse media, public criticism or public concern.
Significant (4)	$ 1-10 million	Effects on safety and people include: • permanent disabling injury or illness; • multiple lost time injuries; or • multiple community medical treatment injuries.	Environmental impacts include: • offsite impact requiring medium-term remediation (months); • impact requiring long-term remediation (years); • temporary impairment to ecosystem function; or • repairable damage of cultural heritage value.	Legal issues include regulatory, permit or community agreement of non-compliance with probable fines of $1-5 million.	Impacts to reputation include international adverse media, public criticism or public concern.
Moderate (3)	$ 100,000-1 million	Effects on safety and people include: • reversible disability or illness; • single lost time injury; or • single community medical treatment injury.	Environmental impacts include: • offsite impact requiring short-term remediation (weeks); or • impact requiring medium-term remediation (months).	Legal issues include regulatory, permit or community agreement of non-compliance with probable fines of $100,000-1 million.	Impacts to reputation include regional media, public concern or local criticism.
Minor (2)	$ 10,000-100,000	Effects on safety and people include: • medical treatment injury or illness; or • restricted work injury.	Environmental impacts include those requiring short-term remediation (weeks).	Legal issues include regulatory, permit or community agreement of non-compliance with probable fines of $10,000-100,000.	Impacts to reputation include local media or public concern.
Low (1)	< $ 10,000	Effects on safety and people include first aid treatment.	Environmental impacts include those confined to a small area with a prompt (within a day) clean-up.	Legal issues include regulatory, permit or community agreement of non-compliance with probable fines of < $10,000.	Impacts to reputation are minor and have no media or public concern.

R.2 Results

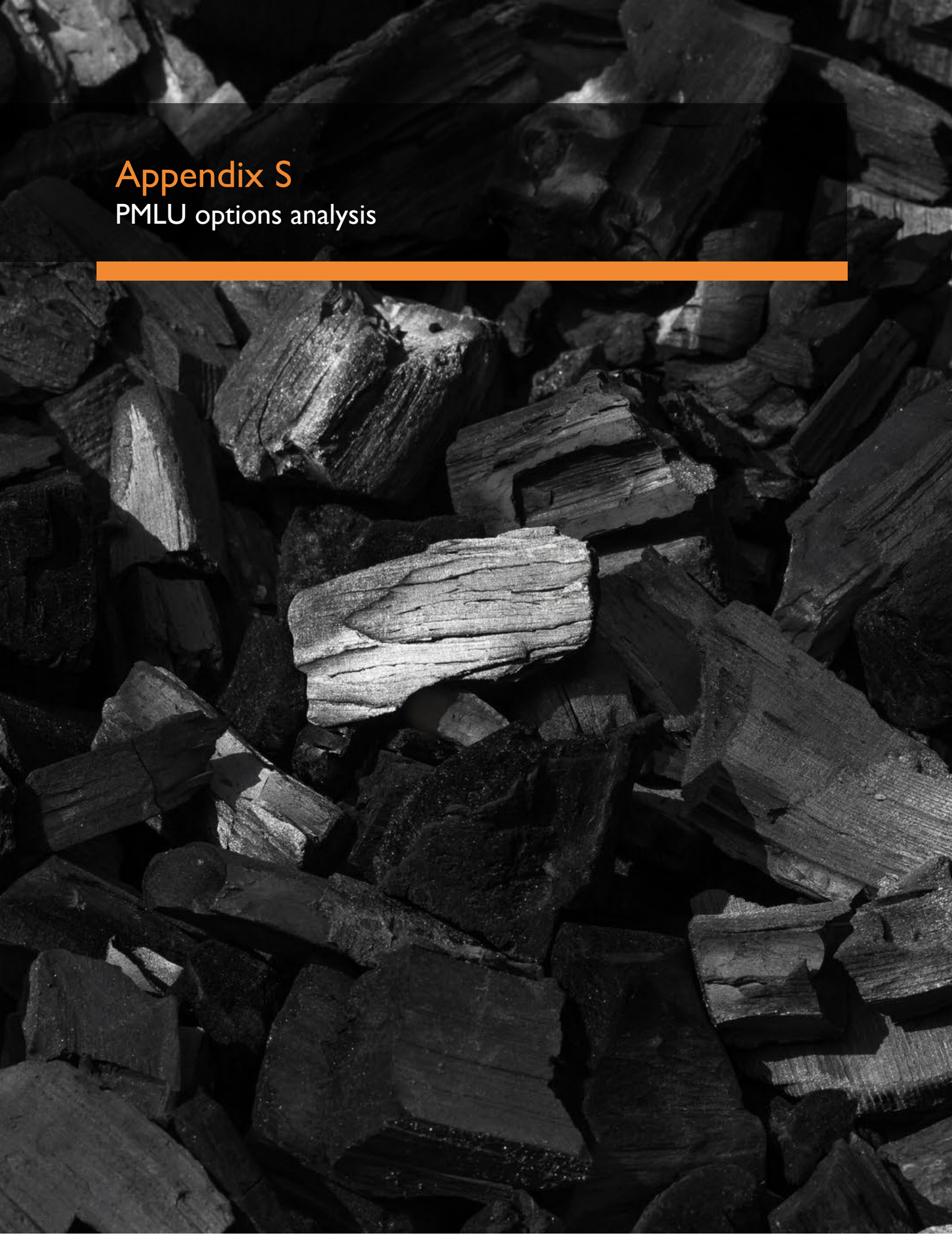
The risk assessment and risk treatment plan for not achieving stable condition is in Table Y4.

The risk assessment and risk treatment plan for not achieving sufficient improvement is in **Error! Reference source not found.**.

Table Y4 Risk assessment and treatment plan for land with a PMLU not achieving stable condition

monitoring

This page is intentionally blank



Appendix S
PMLU options analysis

This page is intentionally blank.

Engineering new environments

Unit 3, 37 McDonald Road, Windsor, Qld 4030
T +61 7 3148 6288
E admin@sgme.au
W sgme.au
ABN 65 621 989 866

Memorandum

Date:	13 February 2025
To:	T Fannin
From:	C Brownbill / M Forbes
Subject:	24B056 – Bair Athol Options Analysis

Dear Tane,

Please see below the options analysis completed for Blair Athol EA amendment. This provides an assessment on alternative PMLUs which could be incorporated into the rehabilitated landform to satisfy DETSI's requirement. It is understood that at this point, State Forest and State Land recommendations is to return disturbed land to grazing, excluding the State Forest Land, which is predominantly the mining infrastructure area, which will be returned to native ecosystem.

Overall, it aligns with the proposed PMLU in the PRC plan, where grazing has been selected for the entire site. If this has changed since the PRC plan was prepared, please inform us and we can make changes as required.

This appendix will be included into the updated PRC plan with a more in-depth analysis within the PRC plan main text.

A.1 Review of PMLU options

Land use options have been assessed based on the following suitability criteria:

- consideration of the surrounding landscape;
- consideration of existing rehabilitation;
- Traditional Owner and community views; and
- objectives of the local and regional statutory instruments.

Potential suitable PMLU options are broadly grouped as:

- native ecosystem;
- commercial use:
  - agriculture / intensive horticulture (cropping);
  - grazing; and
  - forestry.

The following PMLU options were excluded from the assessment and assessed non-suitable based on the suitability criteria:

- landfill;

- water storage;
- industrial;
- renewable energy facility; and
- aquaculture.

A.2 Assessment method

A.2.1 Criteria

The criteria used to rank the potential PMLUs for the Mine are:

- regulatory constraints on, or objectives for, proposed land use;
- physical constraints (eg slopes, voids and geology);
- chemical characteristics (eg residual contamination from rejects or other waste material);
- available rehabilitation methods, including best practice (eg backfill, profile, capping)
- relative costs of each rehabilitation option;
- potential economic benefits for community or landholder;
- potential environmental benefits of each option (eg wildlife corridors, revegetation)
- potential social benefits of each option (eg recreational use, public amenity, employment)
- compatibility with surrounding land uses (eg agriculture and ecosystem); and
- land use before the mining activity commenced.

1.1.1 Ranking

The subjective ranking used to rank the PMLU options described in Section A.1 is based on a scale of one to five:

- 1 — suitable with negligible limitations;
- 2 — suitable with minor limitations;
- 3 — suitable with moderate limitations;
- 4 — marginally suitable; and
- 5 — extreme limitations or unsuited.

1.1.2 Results

The ranked PMLU for the Mine is given in Table 1. The preferred PMLU option based on the quantitative assessment is light grazing pasture.

Table 1 PMLU options assessment

Options	Native ecosystem	Commercial use (agriculture / intensive horticulture)	Commercial use (light grazing pasture)	Commercial use (forestry)
Advantages	• Native ecosystem is expected to restore connectivity between remnant vegetation and other habitat corridors. • Native ecosystem will support the continuation of threatened ecological communities (TECs) and threatened species.	• Agriculture or intensive horticulture has the potential to provide employment strategies after closure of the Project and increased capacity among the community to create, develop and run their own businesses.	• Compatible with predominant rural land use in the region which is likely to be viewed favourably by neighbours and landholder. • Aligns with pre-mining land use of grazing pasture. • Returning land outside of State Forest to grazing would align with both State Land and State Forest departments. • Long term commercial returns can be anticipated if land management practices are sustainable.	• Forestry has the potential to provide economic benefits.
Disadvantages	• Returning land, outside of the state forest, to native ecosystem does not align with community consultation or pre-mining land use. • Long-term pest and invasive species management is needed. • Rehabilitated areas are vulnerable to the impacts of fire regimes and a fire	• Land management practices will be needed to avoid triggering erosion during fallow periods. • Flat and gently sloping land is needed to minimise the potential for erosion and to allow safe operation of farm machinery. • Land has restricting limitations such as nutrient deficiencies.	• Grazing pasture would require ongoing land management by the land holder and reliable access to water (ie management of weeds and periods of drought). • Repeated trafficking by livestock has the potential to trigger erosion. Steeper slopes are at greater risk.	• The landholder does not intend to use the land for permanent plantation. • Forestry does not align with community consultation and is in-consistent with the pre-mining land use and surrounding land use. • The material change to the land use would require development approval and any impact would need to be assessed.

Options	Native ecosystem	Commercial use (agriculture / intensive horticulture)	Commercial use (light grazing pasture)	Commercial use (forestry)
	management plan is needed. • Slow growing native species may hinder landform stability in the short-term and community structure and habitat development in the long-term due to interspecific competition or weed infestation.	• There may be insufficient soil depth for ploughing resulting in poor crop growth and yield.		• Permanent plantation (forestry) could result in a monoculture with minimal biodiversity and reduced environmental and cultural benefit. • Investment in forestry equipment would be needed. • Long-term pest and invasive species management and fire management would be required.
Ranking criteria				
Regulatory constraints	2	4	2	4
Physical constraints	2	3	2	3
Chemical constraints	3	4	3	4
Relative costs	3	3	2	4
Potential economic benefit	4	4	2	2
Potential environmental benefit	1	4	2	4
Potential social benefit	2	3	3	3
Surrounding land use compatibility	1	3	1	3
Pre-mining land use	3	1	1	3

Options	Native ecosystem	Commercial use (agriculture / intensive horticulture)	Commercial use (light grazing pasture)	Commercial use (forestry)
Alignment with community's preferred outcomes	4	4	1	4
Ranking points	25	33	19	34
Overall ranking	**2**	**3**	**1**	**4**

Yours sincerely



Matt Forbes (PhD)
Senior Associate Hydro-geochemist
mforbes@sgme.au



Appendix T
Geotechnical clarification memo

Engineering new environments

Unit 3, 37 McDonald Road, Windsor, Qld 4030
T +61 7 3148 6288
E admin@sgme.au
W sgme.au
ABN 65 621 989 866

Memorandum

Date:	24 February 2025
To:	Matthew Forbes
From:	Michael McMahon
Subject:	Request for information for Environmental Authority for Blair Athol Mine – geotechnical component

Dear Matthew

1.0 RFI item 3

1.1 Scope and background

This memorandum addresses item 3(b) in the additional information request made by the Department of Environment, Tourism, Science and Innovation (DETSI) regarding the environmental authority (EA) EPML00876713 amendment application.

DETSI stated in request for information (RFI) item 3 that "*further information on the predicted stability of the residual void pit walls, including a factor of safety criterion that demonstrates the residual void will remain safe and stable"* as well as requesting additional commentary regarding the "*setback distance from highwall crest to bund*" and whether ''*buttressing of highwall, is required*".

Previous geotechnical investigations carried out by Henderson Geotech in the report titled "*Blair Athol Coal Mine Geotechnical Stability of Residual Voids*" (Henderson 2023) found that the pit walls and its internal spoil structures as per the current proposed life of mine (LoM) plan all achieved the long-term stability factor of safety (FoS) requirement of >1.5. However, due to modifications in the LoM plan specifically in the backfill quantities, additional analysis was required to verify the new long-term stability. Notably, the previous LoM plan to which the initial analysis was applied to had the pit walls completely buttressed by backfill spoil and thus there were no exposed excavated pit walls.

1.2 Digital elevation model

To complete the new round of analysis an updated site digital elevation model (DEM) was created. This was based on the updated LoM plan, , original ground surface, proposed post-mining landform and coal seams DEM's.

1.3 Methodology

Three critical cross sections were chosen to be analysed, two across a south-west to north-east transect and one across a north-west to south-east transect (refer to figure 1). Initially, pit cross sections were created without the additional buttressing of spoil as per the intended final landform to assess the worst-case stability scenario. Due to the marginal stability results for the cross-section, an additional analysis was done that incorporated the spoil buttressing as per the intended final landform design. It was noted that for cross sections two and three the final landform was designed above the existing pit highwall. Hence, additional analysis was not undertaken to assess the highwall stability condition as the buttressing would enhance the stability condition above marginal safety factors recorded pre-buttressing of the highwall.

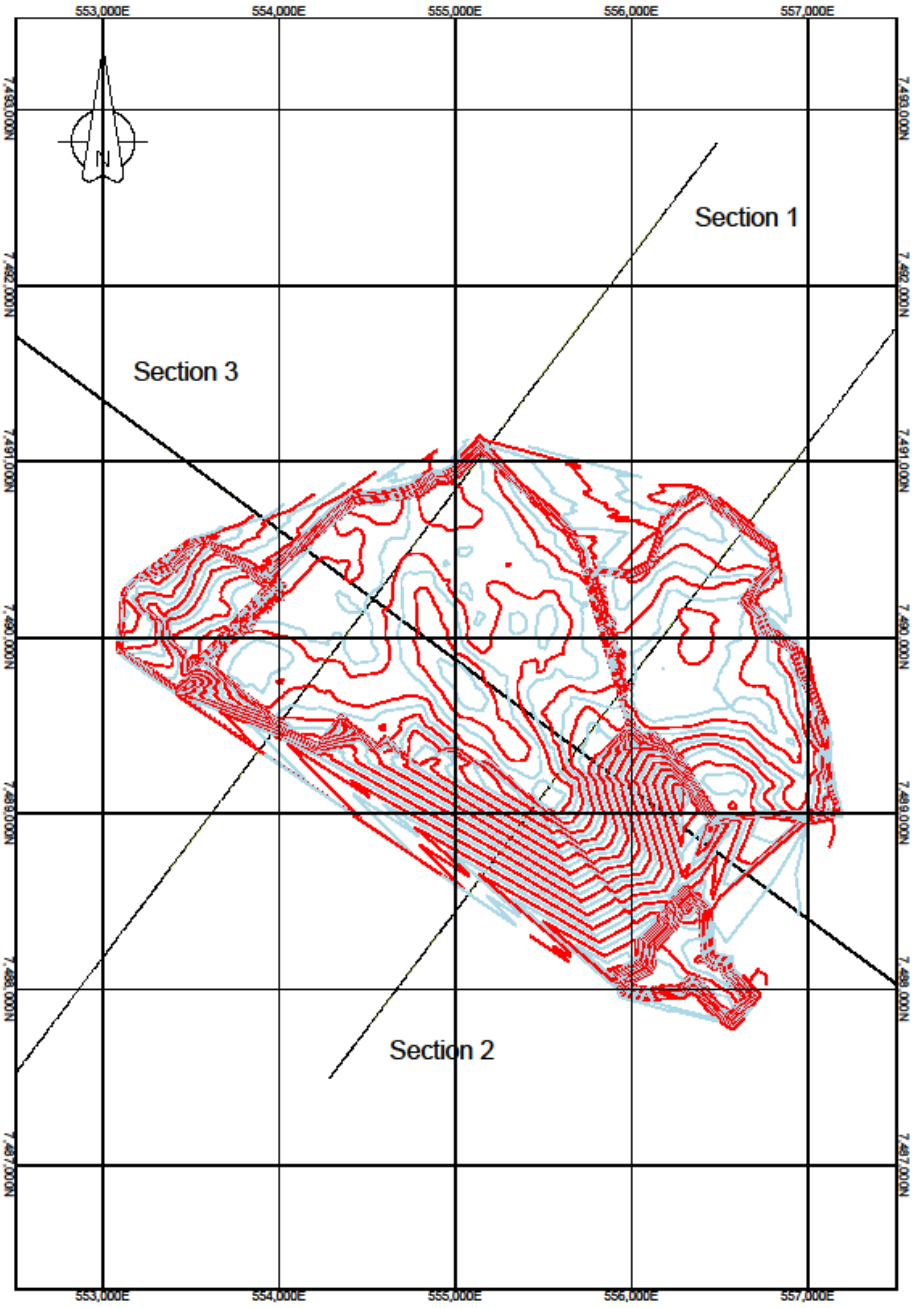


Figure 1 Plan view all cross-sections analysed

1.3.1 Material parameters

The material parameters used in the model were taken from the Blair Athol Coal Mine Geotechnical Stability of Residual Voids (Henderson 2023) report and the Strip 1 Low wall Back Analysis and Strip 2 Stability Analysis report (Rio Tinto 2012). Material parameters are presented below in Table 1.

Table 1 Material parameters

Material	Source	Unit weight (kN/m3)	Cohesion c′ (kPa)	Friction angle φ′ (°)
Spoil	Blair Athol Coal Mine Geotechnical Stability of Residual Voids (Henderson 2023)	18	20	25
Coal	Strip 1 Low wall Back Analysis and Strip 2 Stability Analysis (Rio Tinto 2012)	15	30	35
Fresh Permian	Strip 1 Low wall Back Analysis and Strip 2 Stability Analysis (Rio Tinto 2012)	22	100	45

1.3.2 Phreatic surface

Modelling was done under both dry and piezometric conditions. Hydrological modelling of the pit conducted by WRM Water in Environment estimated that the long-term water level of the pit would range from RL 270 metre (m) to RL 282 m. Conservatively, the measured phreatic surface was assumed to be at RL 282 m, the peak water level from model results, which was considered a worst-case scenario condition. For cross-section one, results returned a FoS value less than one (FoS < 1), which represents a failed stability condition that is not evident in the field. As a result the phreatic surface was modified to represent a FoS above one (FoS > 1), indicating stability, which is evident in field conditions. The phreatic surface was lowered within the model to RL 274.5 m, which established equilibrium conditions, to resemble probable current piezometric conditions.

1.3.3 Model assumptions

The following assumptions were made during the model set-up:

- it was assumed that spoil represented the section above the original ground surface that formed part of the pit highwall;
- it was assumed that the fresh Permian represented the units between the coal seams with the same material parameters as the surrounding fresh Permian; and
- given the limited structural geology data available it was assumed that all material below the original ground surface (except for the coal seams) was homogenous.

1.4 Results

The results for all scenarios modelled can be seen below in Table 2.

Table 2 **Stability analysis results**

Section	Dry conditions FoS	With phreatic surface FoS
1	1.36	1.00 (RL 274.5 m)

Section	Dry conditions FoS	With phreatic surface FoS
1 with buttressing	3.07	3.07 (RL 282 m)
2	1.49	1.23 (RL 282 m)
3	1.74	1.33 (RL 282 m)

1.5 Discussion

The results obtained from the models, without the buttress, represent the worst-case scenario for each section Buttressing the highwalls will further enhance the safety factors to meet the long-term stability requirement (FoS > 1.5) as required by DETSI. When this was included in the critical section (section one) it could be seen that the factor of safety increased from 1.00 to 3.07. Additional analysis for cross sections two and three was deemed unnecessary as the spoil buttressing practically covered the entire pit wall and the FoS qualitatively could be determined to far exceed the long-term stability requirement. Additionally, the phreatic surface was conservatively assumed to be at the highest modelled level of RL 282 m, with the exception of section one without the buttressing, which was modelled at RL 274.5. As this is likely not to be the case it can be creditably assumed the FoS would theoretically be higher under current and most probable long-term conditions.

Regarding the safety bund location given that currently there are no official guidelines in Queensland detailing the appropriate location of safety bunds, Western Australia's *Department of Industry and Resources Safety Bund Walls Around Abandoned Open Pit Mines Guidelines* (1997) were followed in deciding an appropriate safety bund offset. The guidelines specify that a minimum offset of 10 metres (m) from the potentially unstable pit edge zone, which is defined as "the ground surface representing the intercept of a 45° plane projected from the slope toe", (*Department of Industry and Resources 1997*) for pit walls excavated in un-weathered rock, as shown in Figure 2.

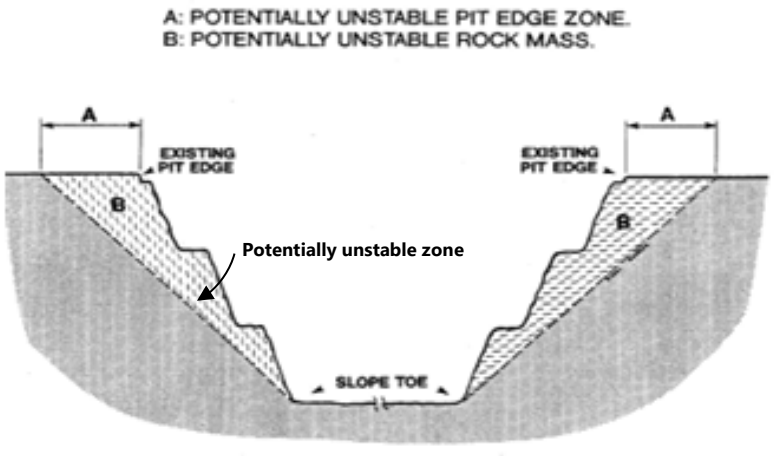


Figure 2: Definition of terms of instability (*Department of Industry and Resources 1997*)

With this taken into account the required minimum distance from the pit crest would vary across different sections of the pit. Thus it is recommended, that based on the critical section cross section one, a minimum offset of 30 m is adopted.

1.6 Conclusion

Based on the modelling results the following conclusions were drawn:

- For Sections 1,2 and 3, the slope stability results, under dry conditions, indicate a range of safety factors between 1.4 to 1.7. Considering the maximum phreatic surface of RL 282 m the factor of safety was reduced to between 1.0 and 1.3.
- The factor of safety results for Section 1 determined for the highest phreatic surface was below 1, representing instability. Considering that the highwall has not failed, the phreatic surface was adjusted to RL 274 5 m to represent the field condition, which ensured that the safety factor was at equilibrium (FoS = 1).
- Buttressing at a minimum offset of 30 m the toe section of this highwall returned a factor of safety greater than 3 (FoS = 3.1), implying that buttressing will enhance the stability condition to the required long-term stability conditions (FoS > 1.5).
- Buttressing of other sections at a minimum offset of 30 m will enhance the safety factor to meet long-term stability conditions requirements (FoS > 1.5).
- Based on the above analysis results, the overall stability of the highwall post-buttressing will meet long-term stability conditions as required by DETSI.

2.0 References

DIR 1997, *Safety bund walls around abandoned open pit mines guideline*, Department of Industry and resources.

Henderson Geotech 2023, *Blair Athol Coal Mine Geotechnical Stability of Residual Voids*, prepared for SGME Pty Limited by Henderson Geotech Pty Ltd.

Rio Tinto, 2012, *Strip 1 Lowwall Back Analysis and Strip 2 Stability Analysis,* prepared by Rio Tinto Coal Australia Pty Limited for Orion Mining Pty Ltd

WRM Water & Environment, 2022, *Draft Final void hydrology report Blair Athol Coal Mine*, prepared by WRM Water & Environment Pty Ltd for Orion Mining Pty Ltd

Yours sincerely



Michael McMahon
Geotechnical Engineer
mmcmahon@sgme.au

Appendix A

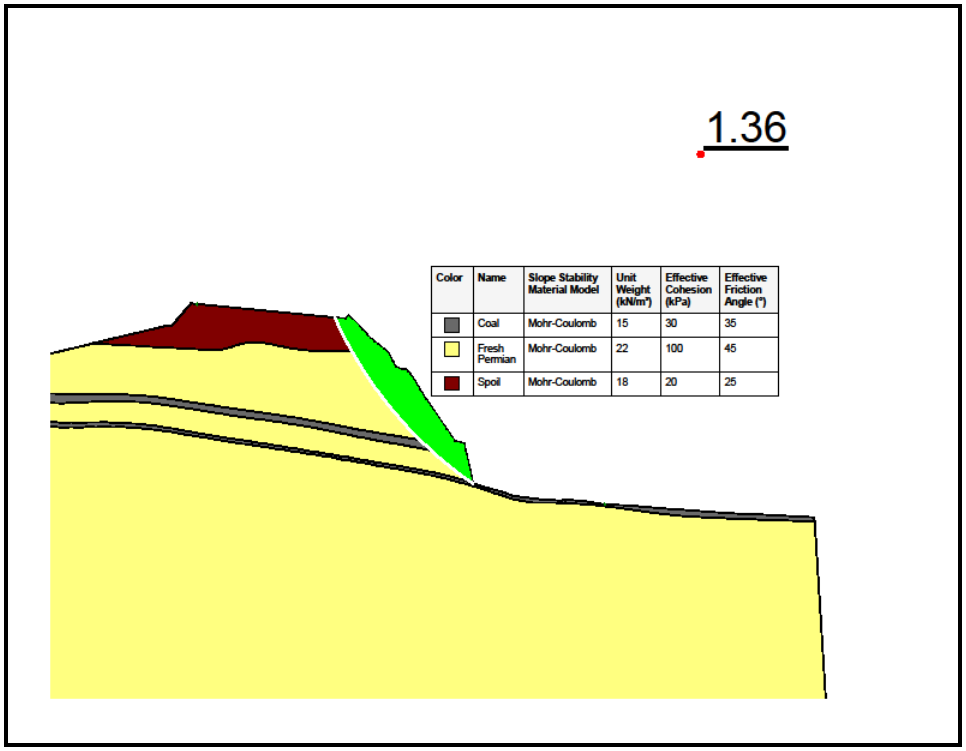


Figure 3 **Cross-section one dry conditions**

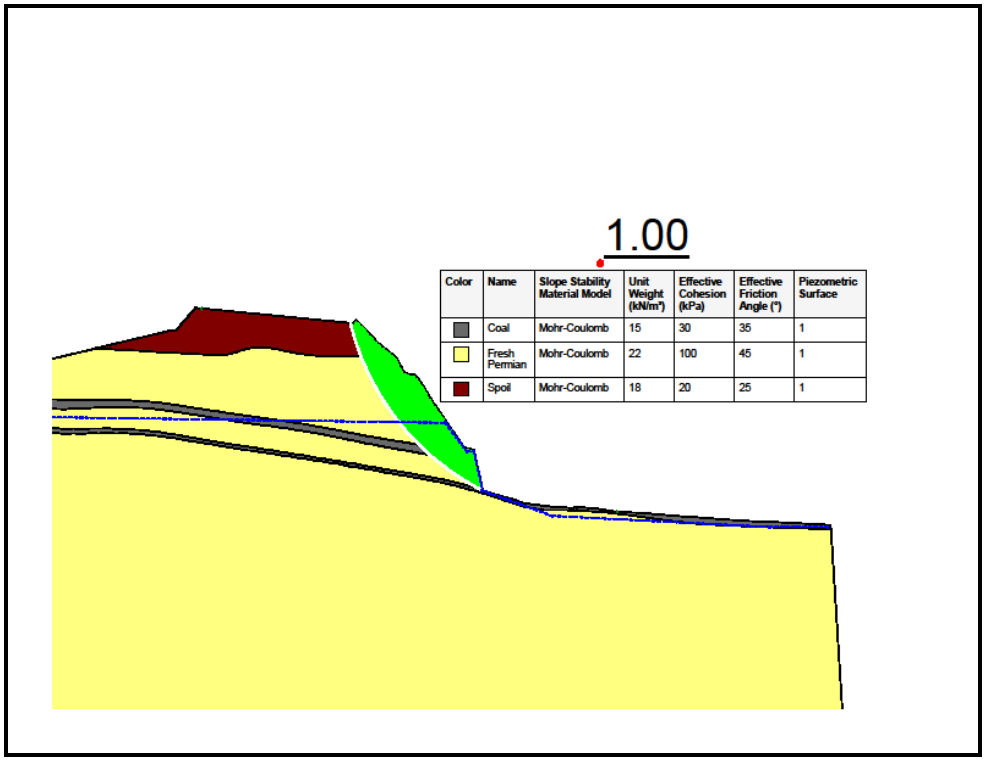


Figure 4 **Cross-section one piezometric conditions**

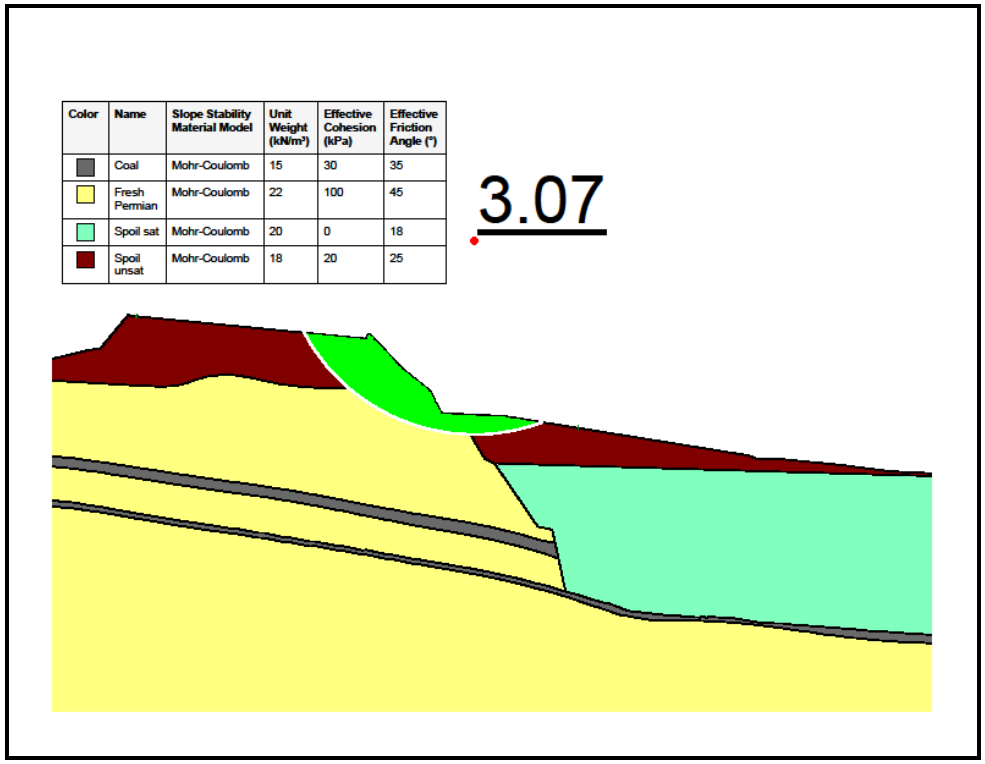


Figure 5 **Cross section one buttressed dry conditions**

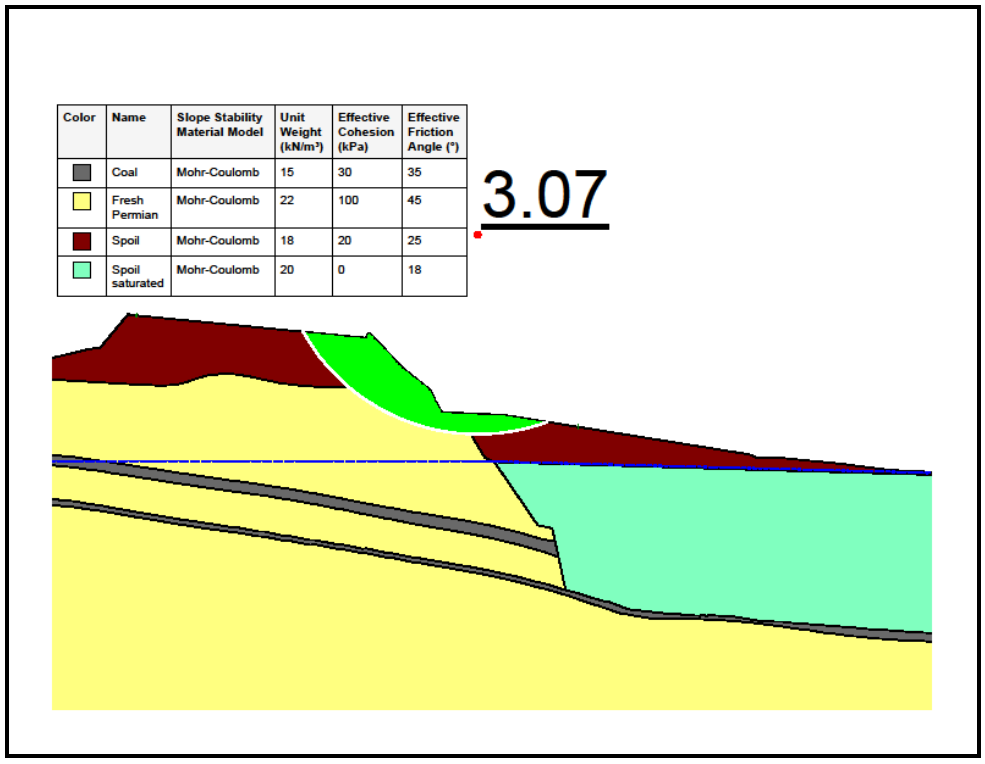


Figure 6 **Cross-section one buttressed piezometric conditions**

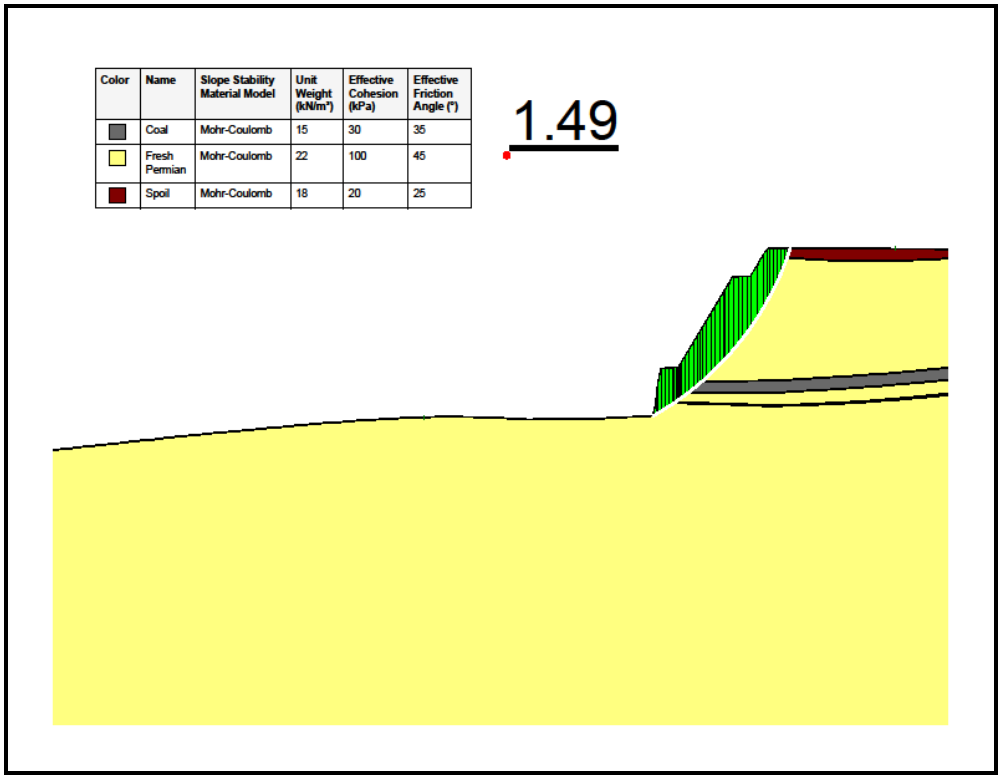


Figure 7 **Cross section two dry conditions**

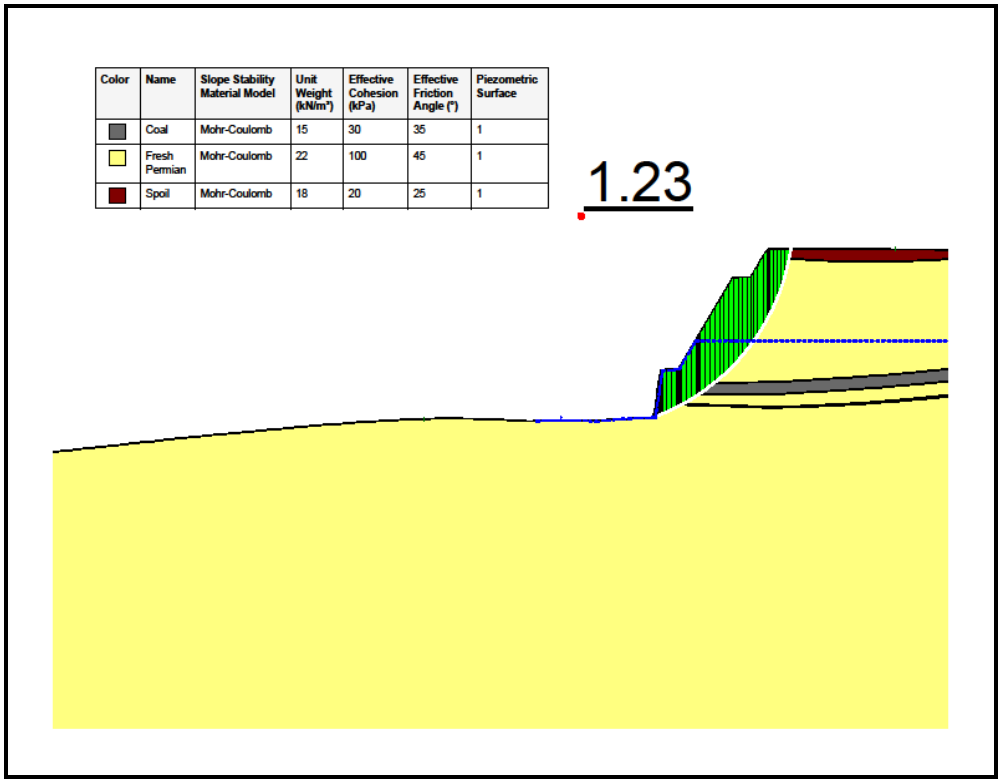


Figure 8 **Cross-section two piezometric conditions**

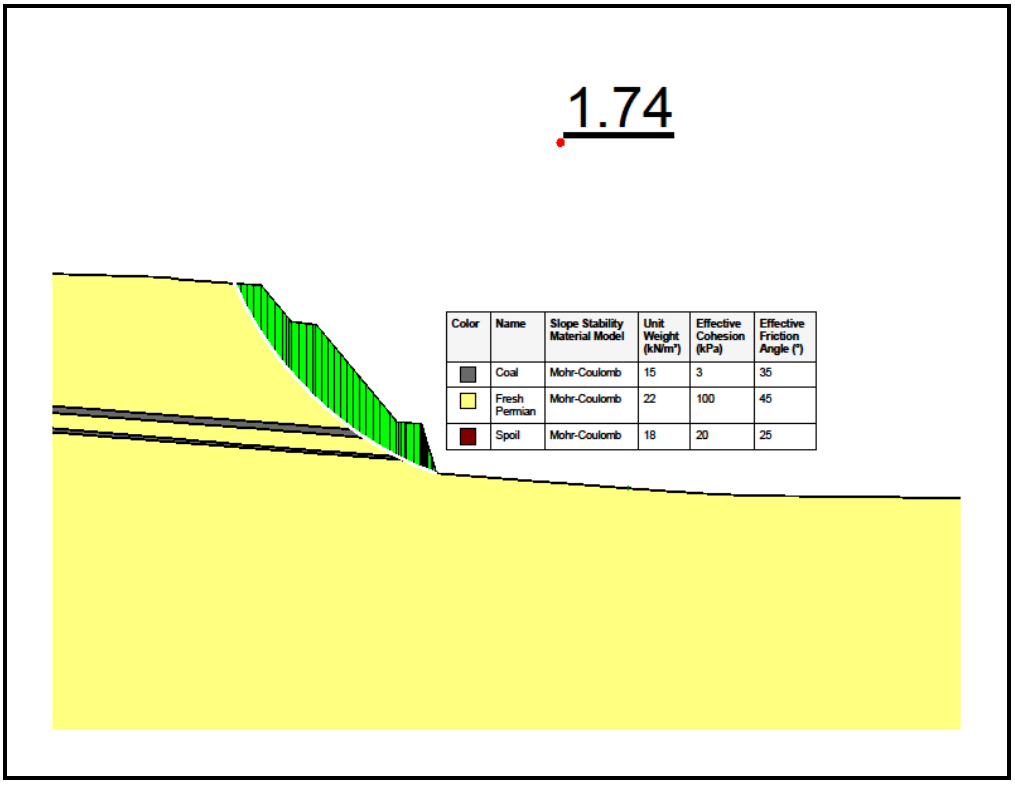


Figure 9 **Cross section three dry conditions**

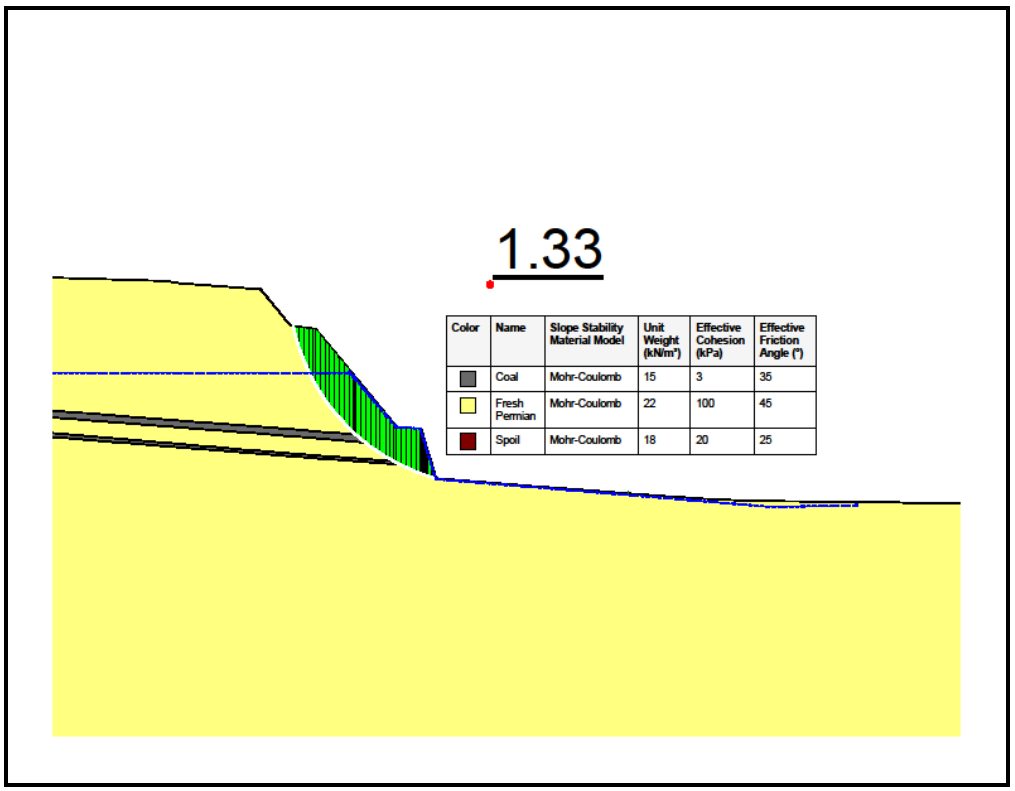
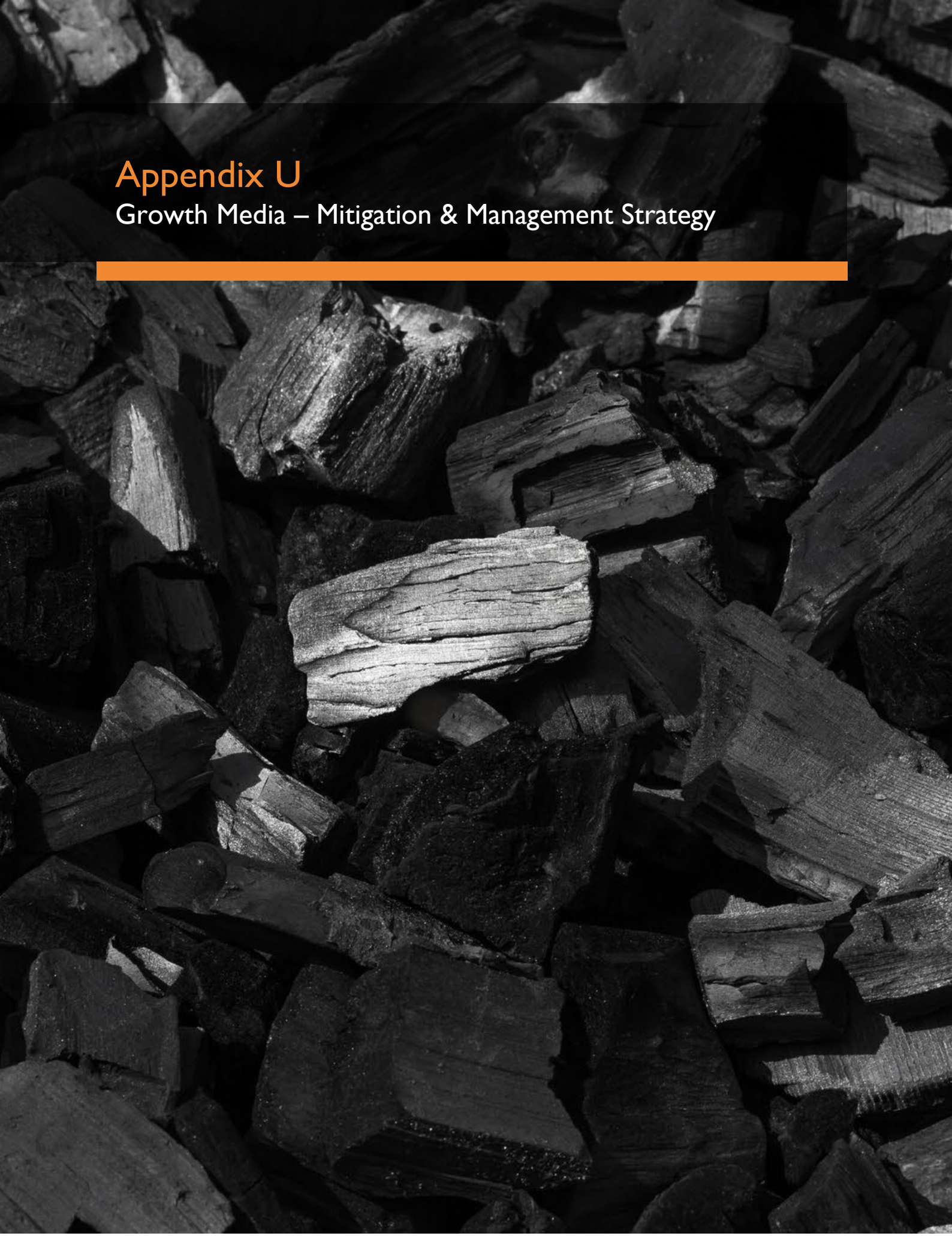


Figure 10 **Cross-section three piezometric conditions**



Appendix U

Growth Media – Mitigation & Management Strategy

This page is intentionally blank.

TERRACOM

REPORT

Blair Athol Coal Mine

Growth Media - Mitigation & Management Strategy

CONTENTS

EXECUTIVE SUMMARY **2**

BACKGROUND **2**

AVAILABLE TOPSOIL ON ML1804 ..... **4**

MITIGATION STRATEGY **6**

APPLICATION RATE OF TOPSOIL **7**

References: *7*
FA Calculations: *7*

STRIP PLACEMENT **8**

FA Calculations: *8*

HYDROMULCH **10**

FA Calculations: *10*

DIRECT SEEDING INTO OVERBURDEN **11**

FA Calculations: *11*
References *11*

TOPSOIL NOT REQUIRED **13**

FA Calculations: *13*

SOIL IMPROVEMENTS **14**

External Sources of Growth Media 14
Biosolids / Organic Supplements *14*

OPPORTUNITIES **15**

REFERENCES & ABSTRACTS **16**

APPENDIX A – TOPSOIL STOCKPILES – ALLOCATION AND DISTANCE MOVED **18**

Table 1 - Site Topsoil Stockpiles 5
Table 2 - Domain Categories per Mitigation Strategy 6
Table 4 - Estimated Stem Densities Ramp 3 (North) Trial Site 12
Table 5 - Estimated Stem Densities Ramp 4 (East) Trial Site 12
Table 3 – Soil Amelioration 14

Figure 1- ML1804 3
Figure 2 - Revegetation Trial Locations 9

EXECUTIVE SUMMARY

The submission of the Plan of Operations on 31st May 2017 with the associated Financial Assurance (10th May 2017) was based on the prior approved and assessed works completed and submitted by the RTCA. The Blair Athol POO and associated assumptions mirrored RTCA in their approved FA November 2015. Discussions between the Blair Athol site and regulatory authorities had noted a deficiency in the quantum and associated management of the topsoil available to complete the rehabilitation for the mining disturbance.

Following an agency focus on rehabilitation, TerraCom were requested to document their strategy to demonstrate the delivery and execution for successfully managing the shortfall enabling the sustainable rehabilitation of the site to meet the expected Environmental Authority criteria. There is 1,060,994m^3 of stockpiled topsoil onsite and using the strategies outlined in this document, the mining disturbance can be remediated to achieve a safe, stable and non-polluting landform. This Growth Media Mitigation & Management Strategy is based on a dedicated process to:

1. Effectively use the remaining topsoil resources in the elevated risk zones (predominately mined areas);
2. Manage the depth of topsoil application to the original prescribed depth of 0.1m to 0.15m (EMOS 1992);
3. Ration defined areas to strip placement of topsoil – a beneficial process that reduces competition between grass species (sown into topsoil) and the tree and shrubs that are sown into bare spoil (Mulligan 1996,1991);
4. Applying ameliorants to overburden i.e. gypsum that improves its physical and chemical properties (SKM 2012) along with specific fertilizer types and rates;
5. Undertake trial onsite that shows satisfactory germination and survival from direct seeding into overburden – following the successful GSS 2007 works;
6. Utilise specific treatments for the complex remediation projects – i.e. hydromulch the diversion upgrade and tailings capping;
7. Review importation of organic complexes to enhance topsoil properties and as a potential standalone solution.

The calculation of the financial assurance for BACM has been prepared in accordance with the DEHP prescribed guidelines using the FA calculator. The FA amount has increased to cater for the level of detail explained in this strategy document and to confirm TerraCom's commitment to achieving a safe, stable and non-polluting landform prior to lease relinquishment.

The summary of the areas covered per treatment strategy is listed below with further detail in Table 2.

Growth Media Mitigation & Management Strategy		Placement @ 0.15m	Strip Placement	Hydromulch	Direct Seed to Overburden	Not required
Hectares	**1,181**	**617.9**	**159.1**	**38.4**	**148**	**170.1**
Required Topsoil (m3)	**1,046,175**	**926,850**	**119,325**			
Available Topsoil (m3)	**1,060,994**					
Excess / (Deficiency)	**14,819**					

BACKGROUND

To enable the successful rehabilitation of Blair Athol within the budgeted financial assurance, TerraCom has structured its coal mining activities to efficiently undertake rehabilitation activities during mining. The updated reserves enable coal mining to be undertaken for up to 7 years. TerraCom has executed a *Mining and Rehabilitation Services Agreement* with Link Mining Services to operate the Blair Athol Coal Mine (BACM) and this agreement provides a provision for rehabilitation works to be completed using onsite labour, equipment and supervision.

The BA site has been mined for coal since 1889 when the first underground shaft was sunk. Mining progressed over the next century with 15 underground and three open cut operations on the site, before the current expanded operations started in the early 1980's. Many of these early operations closed suddenly and without proper planning leaving a legacy of unsafe sites and poor environmental outcomes. Overtime, BA has cleaned up these legacy issues through its mining operations and intends to leave the site post closure in a safe and stable condition.

GROWTH MEDIA - MITIGATION & MANAGEMENT STRATEGY

Gathering of information regarding soil and overburden characterisation for rehabilitation programs was undertaken by Dames and Moore in 1983. Using that report as a guideline, rehabilitation commenced onsite in November 1983. Rehabilitation activities were continued in 1984, 1985 and 1989, with a large gap until 1995, then each year through to 2010 with the exception of 1997, 2002 and 2004.

It has been acknowledged that a deficit of growth media exists to cater for the rehabilitation process planned for the mining lease under a standard application process. According to the current Environmental Authority, the proposed next land use is towards native ecosystems that require diversity in landscapes, TerraCom believes its strategy meets the EA requirements using a variety of demonstrated methods applicable to the Blair Athol site (see table 2 for overview).

Figure 1- ML1804



AVAILABLE TOPSOIL ON ML1804

In August 2016, SEAM Surveys Pty Ltd was commissioned by RTCA to survey the topsoil stockpiles to provide a report of the current site volumes. The topsoil stockpiles data was sourced from existing site survey records and further stockpiles were surveyed using RTK GPS. Ramp 4 Rehab topsoil volume was calculated from recent UAV photogrammetry.

TerraCom reviewed and compared the SEAM report and data provided by RTCA, as well as verified mapped or missing stockpiles on the ground. The final volume of topsoil totals 1,060,994 m^3 (Table 1).

In 2012, SKM undertook a Field Validation Program to assess soil and spoil qualities both in-situ as part of rehabilitated sites and where stockpiled. This recent analysis will direct the improvements (fertilizer, gypsum, organics etc) that may be required to increase revegetation success rate.

During the site investigations by SKM (2012), it was noted that the mapped topsoil stockpile locations may be underestimated – *"Based on the site review, it is likely that the soil resource estimations are conservative and that additional unaccounted resources are available. An example of this is in the north-eastern corner of the mine lease area adjacent to the back access road where topsoil (black vertosol horizons) has been randomly pushed into mounds around and between trees" (SKM 2012).*

Table 1 - Site Topsoil Stockpiles

Soil ID	Soil Type	Volume	Ha	X (l)	Y (l)
TS0001	Unknown	35,975.00	1.44	552,818.41	7,490,222.45
TS0002	Unknown	1,950.00	0.13	555,324.60	7,487,824.62
TS0003	Unknown	1,200.00	0.08	555,698.56	7,487,908.75
TS0004	Unknown	1,050.00	0.07	554,308.58	7,491,445.50
TS0912A	Vertasol	6,762.30	0.40	556,136.35	7,492,441.97
TS0912B	Vertasol	171.40	0.29	556,520.45	7,492,500.36
TS0912C	Vertasol	30,221.80	0.79	556,391.49	7,492,467.16
TS0913A	Vertasol	8,965.00	0.40	556,241.14	7,492,297.87
TS0913C	Vertasol	7,305.40	0.40	556,420.43	7,492,358.24
TS0913D	Vertasol	5,130.30	0.19	556,501.77	7,492,331.73
TS0913B	Vertasol	23,018.80	0.94	556,392.39	7,492,306.51
TS0835 TS0806	Vertasol	92,978.30	4.34	556,050.11	7,492,107.65
TS0826	Vertasol	18,899.56	1.22	556,520.87	7,491,642.66
TS0900	Vertasol	69,811.29	2.88	556,410.56	7,491,424.71
TS0822A	Kandasol	2,577.25	0.08	556,245.10	7,491,301.57
TS0822B	Kandasol	3,050.78	0.08	556,263.00	7,491,267.92
TS901A	Vertasol	16,217.00	1.53	556,369.69	7,491,147.92
TS0821	Vertasol	70,886.60	5.35	556,605.10	7,491,147.30
TS0902	Vertasol	1,967.35	0.13	556,605.17	7,491,433.03
TS0824	Vertasol	5,688.40	0.44	556,685.40	7,491,345.52
TS0820	Vertasol	1,013.80	0.10	556,615.43	7,491,294.94
TS0914B	Unknown	880.91	0.07	556,485.47	7,491,055.35
TS0818	Vertasol	1,913.30	0.17	556,718.87	7,491,120.75
TS0903	Vertasol	989.80	0.07	556,765.50	7,491,034.50
TS0005	Unknown	7,770.60	0.57	556,818.00	7,491,049.07
TS0833	Vertasol	54,549.40	2.59	557,032.16	7,490,510.44
TS0920B	Unknown	63.70	0.01	554,746.03	7,493,112.23
TS0920A	Unknown	233.22	0.02	554,714.20	7,493,086.88
TS0914	Unknown	264.90	0.07	554,807.59	7,493,062.05
TS0832	Kandasol	10,813.19	0.61	554,968.25	7,491,300.04
TS0805	Kandasol	11,522.30	0.81	554,741.63	7,490,962.36
TS0834A	Kandasol	1,560.29	0.16	554,488.86	7,490,743.16
TS0006	Unknown	208.95	0.01	554,728.82	7,490,695.01
TS0804	Kandasol	14,560.60	1.06	554,500.74	7,490,396.77
TS0828	Vertasol	38,710.49	2.04	557,352.19	7,489,674.09
TS0909	Vertasol	17,067.67	1.01	555,797.25	7,488,219.65
TS0811	Kandasol	9,564.35	0.82	555,868.70	7,488,349.26
TS0910	Vertasol	148,052.13	1.37	556,045.35	7,488,255.24
TS0911	Kandasol	66,550.57	2.77	556,089.10	7,487,848.29
TS0802	Kandasol	16,526.93	0.83	555,919.84	7,487,882.25
TS0807	Kandasol	3,234.75	0.35	555,567.95	7,487,590.33
TS0007	Unknown	23,349.70	3.99	556,446.13	7,489,094.78
TS0008	Unknown	10,050.00	0.67	556,373.81	7,488,039.55
TS0009	Unknown	31,050.00	2.07	556,312.61	7,487,958.64
TS0906A	Kandasol	5,473.09	0.33	554,596.26	7,489,758.22
TS0904	Kandasol	147,748.13	3.49	555,116.99	7,489,799.62
TS0837	Kandasol	20,740.45	1.85	555,352.45	7,489,736.90
TS0831	Kandasol	7,306.38	0.53	554,903.24	7,489,597.94
TS0803	Kandasol	5,397.97	0.25	555,215.26	7,489,474.71
Total		**1,060,994**	49.87		

MITIGATION STRATEGY

The disturbance categories per Domain as detailed in the 2017 Plan of Operations are listed in Table 2. These areas have been further divided against each of the Mitigation Strategies.

Table 2 - Domain Categories per Mitigation Strategy

		Topsoil Management Mitigation Strategies					
Domains (ha)	**PoO 2017**	**Topsoil at 0.15m**	**Strip Placed**	**Hydro-mulch**	**Direct seed**	**Not required**	**Rationale**
1. INFRASTRUCTURE	**183.2**						
Haul Road	25.7		25.7				
Minor Roads	57.1		57.1				
Reject / ROM	25.9	25.9					
Industrial Area	10.2		10.2				
Topsoil Stockpiles	53.1					53.1	Topsoil layer to remain
Rail [4]	13.2					13.2	Excised from ML 1804
2. TAILINGS	**32.4**						
Tailings Beach	20.4			20.4			
Tailings Top Wall	3.4					3.4	Top of wall to remain clear to enable ongoing monitoring of capping
Tailings Wall Area	8.6	8.6					
3. OVERBURDEN	**754.6**						
Cleared	32.0					32.0	The vegetation has only been cleared - no surface disturbance.
Topsoil Stripped	66.3		66.1				
Deferred Rehab	657.6	509.6			148.0		
Progressive Rehab	43.9	43.9					Advanced face rehabilitation
Future Rehab	0.0					0.0	Topsoil stockpiles are on this area.
4. WATER MGT	**86.4**						
Dams	34.7					34.7	Water voids remaining within rehabilitated land.
Drains	51.7			18.0		33.7	Eastern Diversion only (~3.5km long x 50m wide = 17.5 ha)
5. PITS	**29.9**						
Active Pit	29.9	29.9					
Total Disturbed	**1,181**	**617.9**	**159.1**	**38.4**	**148.0**	**170.1**	
Rehabilitated	**509.2**						
Undisturbed	**718.1**						
Total ML Area	**2,361.0**						
Required Topsoil (m^3)	**1,046,175**	**926,850**	**119,325**	**15cm depth of cover - 50% coverage in strip placement areas**			
Available Topsoil (m^3)	**1,060,994**						
Excess / (Deficiency)	**14,819**						

APPLICATION RATE OF TOPSOIL

The application rate of topsoil to disturbed areas will be 0.15m.

The 0.15m layer was determined to be suitable for the Blair Athol site in accordance with EMOS 1992 as developed from the EIS and subsequent monitoring and auditing assessments (GSS 2008; Land Reclamation Services 1999).

Topsoil is applied to the Domains and activities of:

- 1 Infrastructure
    - ROM / Reject – in and over areas that stored coal and coal washery waste
- 2 Tailings
    - Tailings Wall buttress is made up of overburden moved to location supporting the embankment
- 3 Overburden
    - All deferred rehabilitation (previous mining disturbance)
    - All progressive rehabilitation – that is the advanced face rehabilitation against the TerraCom mining areas.
- 5 Pits
    - Active pits covering the blasting and reshaping of the highwalls and end walls.

References:

RTCA (September 2011) Blair Athol Coal Project - Mine Closure Plan. *The aim of the rehabilitation is to re-establish a native ecosystem on the mining leases after mining operations cease. This is achieved by the re-profiling of the angle of repose dragline spoil piles (overburden) remaining after the completion of the strip mining process. The overburden spoil piles are re-profiled so that they are stable against erosion and are suitable for the re-establishment of native species. Prior to seeding, topsoil is replaced over the re-profiled spoil to a depth of at least 100mm. Contour banks are constructed over the re-profiled landform; the area is deep ripped by a dozer and seeded using native grasses, shrubs and trees.* ***Assumptions for Closure****: Depth of topsoil for rehabilitation – average of 150mm and no less than 100mm.*

Global Soil Systems (2008) *pg 5: "Continued use of a thin 100 mm thick layer of topsoil appears to maximise the advantages of both topsoil and overburden and is strongly recommended for future broad acre areas."*

EMOS (1992) *The EMOS states that topsoil is spread out by dozer to a depth not less than 10cm.*

FA Calculations:

Each domain has had the respective area included for topsoil "Source, Cart and Spread". The topsoil locations and volumes have been allocated to the disturbance area such that the correct variable rate (haulage rate) has been assigned (Appendix A – Topsoil Stockpiles – Allocation and Distance Moved).

In addition, amelioration to the overburden has been costed for each area of disturbance (701.5 ha), such that the topsoil application will be onto treated overburden.

STRIP PLACEMENT

The second mitigation strategy is to lay topsoil in strips of approximately 10 m wide with bare spoil also 10 m wide. This will extend the volume of topsoil available for revegetation onsite by almost double the coverage.

The advantages of strip placement include the ability to seed the topsoil strip with cover crops and native grasses that will reduce erosion and runoff potential, leaving the bare strips to be sown to woody species without the competition of the grasses. The expectation is that grasses and native trees and shrubs will cross-propagate into the adjacent media and the biological components of the soil will also migrate into the original non-soil strips. This methodology has been used at Curragh Mine and South Blackwater (Mulligan 1996). Toni Ward (TerraCom Environmental Superintendent) also used this technique at Collinsville Coal mine in 1999.

Strip placement of topsoil has been allocated to the Domains and activities of:

- 1 Infrastructure
    - Haul Roads
    - Minor Roads
    - Mine Industrial Area
- 3 Overburden
    - Topsoil Stripped

The placement of topsoil as strips will be trialed in 3 locations as identified in Figure 2. Two areas cover hardstands that were laydown areas for the scrap tyres and the former helipad. Also, adjacent to the helipad is a light vehicle road that is no longer required.

To the south of the lease, areas of disturbance classified as 'Topsoil Stripped' will be revegetated after strip placement of topsoil.

The trials on these areas are proposed to be established within the current Plan of Operations period ending June2018.

FA Calculations:

Each domain has had the respective area included for topsoil "Source, Cart and Spread". The topsoil locations and volumes required for the area (50%) have been allocated to the disturbance area such that the correct variable rate (haulage rate) has been assigned (Appendix A – Topsoil Stockpiles – Allocation and Distance Moved).

In addition, amelioration to the overburden has been costed for each area of disturbance, such that the topsoil application and direct seeding will be onto treated overburden.

Figure 2 - Revegetation Trial Locations



HYDROMULCH

Hydromulching is widely recognised as one of the most efficient and cost-effective solutions for establishing vegetation in difficult and remote areas. This seeding process that is especially effective on large, hard-to-reach or sloping areas utilises specially designed equipment to spray a slurry of water, seed, fertiliser, organic mulch fibres and a binder/tackifier onto the seedbed. Specialized hydroseeders agitate the hydromulch mixture during application to ensure an even and constant distribution. The even application of the mix, protects the soil surface from erosion and promotes faster, more unified seed germination.

The application of hydromulch is scheduled for the Tailings Storage Facility – beached tailings area and the Eastern Diversion where modifications are required to meet relinquishment criteria.

Hydromulching has been allocated to the Domains and activities of:

- 2 Tailings
    - Tailings Beach
- 4 Water Management
    - Diversion maintenance

Tailings Storage Facility

The TSF capping process will use the boxcut overburden excavated out of Ramp 2 and stockpiled adjacent to the CHPP (Lookout Hill). It will be progressively laid over the beached tailings in a method to manage the potential strength issues of the tailings and enable adequate compaction of the spoil.

The application of hydromulch over the TSF Beach will meet several remediation objectives being:

- Rapid establishment of grass layer to reduce dust and manage any potential runoff and erosion.
- Reduce equipment traffic during the stabilisation process of capping due to the ability to spread hydromulch a significant distance.
- Seed and fertilizer held in place until sufficient moisture triggers germination.

Eastern Diversion Upgrade

Improvements to the Eastern Diversion are required to meet the expected criteria for relinquishment. For a portion of the diversion, the natural ground is structurally poor, easily eroded and difficult to revegetate when sloped. The use of a specific stablising mulch can be applied as sections of the upgrade are completed and will hold the surface together until sufficient rain / moisture triggers germination of the encapsulated seed.

This technique has been used in the recent past for mine creek diversions such as Cockatoo Creek at Foxleigh Mine, Coral Creek at Sonoma Mine, Blackwater Creek at Curragh Mine, Caval and Horse Creeks at Caval Ridge Mine and Phillips Creek at Lake Vermont.

FA Calculations:

Each domain has had the respective area included for Hydromulch treatment using existing FA rates.

DIRECT SEEDING INTO OVERBURDEN

The Blair Athol operation recognized early on that the historical activities in the region had impacted the soil reserves for re-use in rehabilitation activities. This includes the original underground mining activities and the location of the Blair Athol township and associated power, road and rail easements.

Trials into the need for a topsoil layer were undertaken most recently onsite in 2007 by GSS. Successful revegetation has occurred onsite following direct seeding into the overburden. Due to the period of time the site has been on care and maintenance, further weathering of the overburden has occurred and the resultant changes in physical and chemical composition will be assessed through regular analysis.

Direct seeding into Overburden has been allocated to Deferred Rehab.

The 148 hectares is proposed to have direct seeding into treated overburden (gypsum and organic application). The areas chosen in Figure 2 show the available locations (~180ha) on the proposed final landform that is at or below 8% grade as areas appropriate for direct seeding. The highlighted block will have a 5 ha trial area, that will cover the sowing of native trees, shrubs and grasses. The trial objective is to demonstrate an area of recent revegetation process and subsequent success rates.

FA Calculations:

The treatment of the overburden to revegetation status includes the application of gypsum and organics prior to seeding.

References

Dames and Moore (1983) *'Detailed overburden and interburden characterisation showed that sediments at Blair Athol do not contain significant amounts of chemically toxic materials. Highly acid forming material was not identified and there are no potential problems associated with heavy metal released. In unweathered rocks the sodic and salinity hazards are low. However, in the weathered section there are potential salinity and sodic problems.*

Rehabilitation Monitoring – Site Reports: *rehabilitation directly into overburden occurred onsite in 1985.*

Miller (April 1986) *Memorandum pg 2. "Topsoil will also assist tree growth but is not essential".*

Rosewood Trial (1990) *Rosewood (Acacia rhodoxylon) occurs through coastal and subcoastal parts of central Queensland, from Eidsvold to a little north of Clermont. Rosewood is renowned as an excellent source of timber for fence posts, and Blair Athol Coal established a trial (July / October 1990) to assess the potential for growing and harvesting this species in a plantation situation. The trial rosewood plantation area was established north of Ramp 2 TSF in a 2.2 ha area at a 2m x 2m spacing (ie. 2500 trees/ha) and drip-irrigated to aid establishment. No topsoil was spread prior to planting and no other seed was applied. A brief study was undertaken in August 1997 to assess tree survival and growth rates. In the report discussion, it was noted that very little monitoring data existed on the trial and that the effect of the severe drought in the region (1992-1995) could account for the approximately 50% survival rate and higher soil salinity levels.*

Topsoil Comparison Trial (2007) *In reviewing rehabilitation processes onsite, reasons that could be attributed to failure of successful or expected revegetation levels were noted as:*

- *Grass / weed competition transported in topsoil rom weed contaminated stockpiles*
- *Variable topsoil quality and the lower suitability of tome topsoil types (e.g. cracking black clays) for tree establishment*
- *Species selection and sowing rates*
- *Site preparation techniques.*

Following the review, two trial sites (Ramp 3 North and Ramp 4 East) were established in December 2007 to examine a range of alternative topsoiling, site establishment, and seed specification options (GSS 2007). In addition, a failed 0.5 ha area, rehabilitated in 2005, was scalped (grass removed), deep ripped and tree seeded with the same species mix used at

the Ramp 3 North and 4 East trial sites. The trial compared red, black and grey topsoil as well as "raw" overburden. The topsoil as applied at 10 cm depth.

Table 3 - Estimated Stem Densities Ramp 3 (North) Trial Site

Topsoil Type	Stems / 100 m^2	Estimated Stems / ha	**EA Criteria** Table F2	
			Species / ha	**Stems/ha (min)**
Red Soil	25	2,500	2 (Trees) / 4 (Shrubs)	150 (Trees) / 500 (Shrubs) 50-70% (Groundcover)
Grey Soil	36	3,600	2 (Trees) / 4 (Shrubs)	150 (Trees) / 500 (Shrubs) 50-70% (Groundcover)
Black Soil	71	7,100	1 (Trees) / 2 (Shrubs)	40 (Trees) 500 (Shrubs) 50-70% (Groundcover)
Overburden	**47**	**4,700**		

In addition to the results in Table 5, observations of the trial showed that

- *Good species diversity, including most eucalypt species sown, was observed on the red and grey topsoils and on the overburden.*
- *Most of the species observed on the black soil were* Acacia *or* Dodonaea *with few eucalypts - fine seeded eucalypt species were generally not successful on the black soil.*
- *Tree germination on the adjacent broadacre rehabilitation area varied considerably and stem densities were often much lower than the 1,900 stems per hectare noted.*
- *Many sections of the broad acre area there were few, if any, eucalypts with the most commonly observed species being* Dodonaea.

Table 4 - Estimated Stem Densities Ramp 4 (East) Trial Site

Topsoil Type	Stems / 100m^2	Estimated Stems / ha	**EA Criteria** Table F2	
			Species / ha	**Stems/ha (min)**
Red Soil	101	10,100	2 (Trees) / 4 (Shrubs)	150 (Trees) / 500 (Shrubs) 50-70% (Groundcover)
Black Soil	64	6,400	1 (Trees) / 2 (Shrubs)	40 (Trees) / 500 (Shrubs) 50-70% (Groundcover)
Grey Soil	100	10,000	2 (Trees) / 4 (Shrubs)	150 (Trees) / 500 (Shrubs) 50-70% (Groundcover)
Overburden	**123**	**12,300**	-	-

Combining the results of both trial sites suggests that red, grey or raw overburden are the preferred surface materials. While black soil exhibited some plants both stem density and species diversity were inferior to other surface materials, and species consisted of mostly Acacias *and/or* Dodonaea *on this material.*

It should be highlighted that while two distinct overburden types were tested in this trial, overburden characteristics vary widely across the mine site and further prior testing of the suitability of each overburden encountered is recommended if a decision is made not to use available topsoil on particular areas. While black soil is clearly less suitable for tree establishment, its use in the swales of contour drains in conjunction with sowing pasture species is recommended.

Continued use of a thin 100 mm thick layer of topsoil appears to maximise the advantages of both topsoil and overburden and is strongly recommended for future broad acre areas.

TOPSOIL NOT REQUIRED

Areas on the mining lease exist that do not require topsoil to be reapplied and these have been detailed below.

The areas where topsoil is not being applied is within the Domains and activities of:

- 1 Infrastructure
    - Topsoil stockpiles – a layer of soil will remain at the base of the stockpile location
    - Rail Infrastructure – the rail easement through ML1804 has been excised from the surface area.
- 2 Tailings
    - Tailings Top of Wall – the top of the embankment will be capped with spoil and compacted via machinery traffic and designed to drain off the wall. It will remain clear of vegetation so that monitoring and surveillance of the capping and buttress material can be undertaken.
- 3 Overburden
    - "Cleared" areas have had the larger vegetation portions removed with the soil profile left intact and will only require ripping and some additional seeding.
- 4 Water Management
    - Dams – includes the existing water storages currently onsite.
    - Diversions and drains (with the exception of the Eastern Diversion) are in a stable vegetated state that requires minimal maintenance.

FA Calculations:

Each domain has had the respective treatment (minor reshaping, ripping, fertilising and seeding) included to the meet the requirements for revegetation using existing FA rates.

SOIL IMPROVEMENTS

Across the Domains, soil ameliorants have been costed to increase the success rate of revegetation (Table 3). The intent of adding soil improvements includes:

- Address the potential sodicity problem with the overburden by reducing the Exchangeable Sodium Percentage with the increased levels of calcium (gypsum) (SKM 2012; SSA 2013)
- Provision of pH correction to reduce any acidic formation (tailings / rejects); (ATC Williams 2013)
- Increase the quality of growth media (biosolids / organics) by increasing the organic content of the upper horizon, increasing soil carbon levels, enhancing moisture holding capacity; (Dames & Moore 1983; Miller 1986; SKM 2012; SSA 2013)

Table 5 – Soil Amelioration

Seed Bed Improvements	Hectares	FA Rate	Total Allocation
Amelioration - gypsum	873.76	$ 250 / ha	$ 218,440
Amelioration - lime	97.2	$ 860 / ha	$ 83,592
Amelioration – biosolids / organics	699.75	$ 1,015 / ha	$ 710,246
TOTAL			**$1,012,278**

EXTERNAL SOURCES OF GROWTH MEDIA

Importation of growth media has been costed to deliver a specialist product need. This has been allocated to two areas being the Ramp 2 Tailings Storage Facility beach and the Eastern Diversion around for the upgraded area.

Biosolids / Organic Supplements

Technically biosolids refers to the sewage sludge that remains after treatment processes. An investigation into the disposal process from the Clermont Township treatment plant will be undertaken. The sources of other organic material will be reviewed such as green waste, feedlot wastes and horticultural wastes.

OPPORTUNITIES

Areas for potential improvements to the strategies outlined above are summarised below:

- Investigate the SKM (2012) noted areas for additional stockpiles or insitu collection areas.
- Update the site Rehabilitation Plan to cater for the recommendations to improve specific topsoil types through additives.
- Revisit previous trial areas to enable assessment, where possible.
- Investigate the sources of organic material (including Biosolids) existing within the Clermont region i.e. cattle feedlots and review the establishment of a composting compound onsite.
- Where practicable onsite, preliminary cleanup activities prior to bulk earthworks will “scalp” existing natural regrowth that occurs across the site.
- Quarterly assessment of overburden characteristics to build on the existing data base.

References & Abstracts

ATC Williams (April 2013) **Blair Athol Coal – Ramp 2 TSF – Technical Specification for Rehabilitation and Closure Civil Works**.

ATC Williams (July 2010) **Blair Athol Coal – Ramp 2 TSF – Rehabilitation and Closure Design**.

BAC Internal Report (December 1974 – Revised August 1976) Blair Athol Coal Project Environmental Impact Study –**EIS Volume 1 and 2**.

BAC Internal Report (December 1992) Blair Athol Coal Project. **Environmental Management Overview Strategy.** Mining Lease Nos. 1804, 1881.

BAC Internal Report (January 2002) **Rehabilitation Monitoring 1997-2002 Rehab Treatment Records**.

BAC Internal Report (March 1994) **Blair Athol Coal Project Environmental Research Report to March 1994**. Post mining landscape parameters for erosion and water quality control. Success criteria for rehabilitated vegetation and soils. Further develop existing koala research program into long term species habitat study

Bell, L.C. and Mulligan, D.R. (1991) **Tree and shrub growth on land rehabilitated after mining at Blair Athol Coal Mine**. Department of Agriculture, University of Queensland.

Bellairs, S. and Clowes, P. (March 1996) **Germination characteristics of species of Acacia and Eucalyptus to be broadcast onto rehabilitation areas at the Blair Athol Coal Mine.** Centre for Mined Land Rehabilitation and Department of Agriculture. The University of Queensland.

Bellairs, S. and Gravina, A.J. (March 2002) **Success of rehabilitation at Blair Athol Coal Mine and compliance with EMOS criteria.** Centre for Mined Land Rehabilitation and Department of Agriculture. The University of Queensland.

Bellairs, S. and Murray, M. (February 1997) **Eucalyptus seeding growth on media from the Blair Athol Coal Min**e. Centre for Mined Land Rehabilitation and Department of Agriculture. The University of Queensland.

Bellairs, S.; Beavis, C and Mulligan, D. (1995) **Soil and Vegetation characteristics of rehabilitation areas and native vegetation communities at the Blair Athol Coal Mine.** Centre for Mined Land Rehabilitation and Department of Agriculture. The University of Queensland.

Coffey Partners International Pty Ltd (1989) **Spoil Pile Infiltration / Runoff Assessment – Blair Athol Coal Mine**.

Dames and Moore (1983) Blair Athol Coal Company – **Waste Management and Rehabilitation Programme; Soil and Overburden Characterisation**.

Environmental Geochemistry International (September 2006)) **Geochemical Assessment of overburden from 4 drill holes – Blair Athol Mine.**

Envirosciences (1993) **Blair Athol Coal Project Soil Survey**

Global Soil Systems (December 2007) **Establishment of Direct Tree Seeding and Topsoil Trials at Blair Athol Mine**.

Global Soil Systems (July 2008) **Assessment of direct tree seeding trials at Blair Athol Mine approximately seven months after sowing.**

Houston, W; Melzer, A; Tangey, B; Cooper, A; Lobegeier, V (2000) **Comparison of vegetation and invertebrate assemblages of a naturally revegetated spoil heap and an active rehabilitation site with native habitats at Blair Athol, Central Queensland**. Industrial Land Management Programme – Centre for Land and Water Resource Management, Faculty of Arts, Health and Sciences, Central Queensland University.

Land Reclamation Services (October 1999) **Supplementary Audit Statement** – Extend Current plan of Operations from 31 December 1999 to 29 February 2000.

Landloch (April 2010) **Final Report - Rehabilitation Monitoring** on Blair Athol Coal Mine, Queensland.

Landloch (September 2011) **Recommendations for remediation of poorly performing rehabilitated areas** on Blair Athol Coal Mine, Queensland.

Landloch Pty Limited (July 2011) Rio Tinto. Blair Athol Coal Mine. **Top Soil Stockpile Sampling**.

Miller and Associates Pty Ltd (April 1986) Memorandum to Blair Athol Coal Company – **BAC Rehabilitation - Report on site visit.**

Miller and Associates Pty Ltd (August 1985) Blair Athol Coal Company – **Mine Rehabilitation Plan**

Mulligan, D. R. (Ed.) (1996) **Environmental Management in the Australia Minerals and Energy Industries – Principles and Practices.** Australian Minerals & Energy Environment Foundation.

Mulligan, D.R. and Bell, L.C. (October 1991) **Tree and shrub growth on land rehabilitated after mining at Blair Athol Coal Mine.** A report to Blair Athol Coal Project based on the results of a survey of tree trials undertaken by the Department of Agriculture, The University of Queensland.

RTCA (September 2011) Blair Athol Coal Project - **Mine Closure Plan**.

Seams Surveys (August 2016) **Topsoil stockpile volume report for Blair Athol Mine**.

SKM (November 2012) **Landform Review, Testing and Design Parameters** – Blair Athol Mine

Soil Systems Australia (2013) Blair Athol **Soil Management Programme.**

URS (August 2006) **Geochemical Characterisation of Spoil from Ramp 3 and Ramp 4 Rehabilitation Areas.** Results of soil sampling program to assess geochemical characteristics of spoil from disturbed and rehabilitated areas

URS (June 2008) **Site History and limited Phase 2 Environmental Site Assessment**.

URS (September 2008) **Post Phase 2 Environmental Site Assessment**.

APPENDIX A – TOPSOIL STOCKPILES – ALLOCATION AND DISTANCE MOVED

Year	Map No.	Pit	ID	AREA (ha)	Required m3 @ 0.15m	Stockpile ID	Media Type	Applied m3 @ 0.15m	FA Cost	FA Calc Line #	Explanation
Growth Media application											
2018	#7	FAR WEST	Far west DL	16.2	24,300	TS0001	Unknown	24,300	$99,630	Domain 3 - 29	Topsoil placement - distance >1km <2km
2018	#8	FAR WEST	Far west	20	30,000	TS0001	Unknown	11,675	$47,868	Domain 3 - 29	Topsoil placement - distance >1km <2km
						TS0906A	Kandasol	5,473	$22,440	Domain 3 - 29	Topsoil placement - distance >1km <2km
						TS0831	Kandasol	7,306	$29,956	Domain 3 - 29	Topsoil placement - distance >1km <2km
						TS0803	Kandasol	5,398	$22,132	Domain 3 - 29	Topsoil placement - distance >1km <2km
2019	#14	Industrial	Culvert laydown	6.99	10,485	TS0828	Vertasol	5,243	$874	Domain 1 - 59	gypsum amelioration
								5,243	$17,825	Domain 1 - 49	strip placement (Topsoil placement - distance <1km)
2019	#9	FAR WEST	Far West DZ/T&E	22.2	33,300	TS0904	Kandasol	33,300	$136,530	Domain 1 - 49	Topsoil placement - distance >1km <2km
2019		Ramp 1	Edges	58	87,000	TS0904	Kandasol	87,000	$356,700	Domain 1 - 49	Topsoil placement - distance >1km <2km
2020	#1	Ramp 1	NW of Substation	4.39	6,585	TS0909	Vertasol	6,585	$26,999	Domain 1 - 49	Topsoil placement - distance >1km <2km
2020	#17	Area 53	A53 West	28.7	43,050	TS0904	Kandasol	27,448	$112,537	Domain 1 - 49	Topsoil placement - distance >1km <2km
						TS0837	Kandasol	15,602	$63,968	Domain 1 - 49	Topsoil placement - distance >1km <2km
2020	#2	Ramp 1	South	6.65	9,975	TS0811	Kandasol	9,564	$39,214	Domain 1 - 49	Topsoil placement - distance >1km <2km
2020	#3	Ramp 1	R1W-3	1.1	1,650	TS0002	Unknown	1,650	$6,765	Domain 1 - 49	Topsoil placement - distance >1km <2km
2020	#4	Ramp 1	NW Spoil Road side	2.59	3,885	TS0002	Unknown	300	$1,230	Domain 1 - 49	Topsoil placement - distance >1km <2km
						TS0003	Unknown	1,200	$4,920	Domain 1 - 49	Topsoil placement - distance >1km <2km
						TS0909	Vertasol	2,385	$9,779	Domain 1 - 49	Topsoil placement - distance >1km <2km
2021	#11	Industrial	Tyre Laydown	4	6,000	TS0005	Unknown	3,000	$20,550	Domain 1 - 49	strip placement (Topsoil placement - distance >5km)
									$500	Domain 1 - 59	gypsum amelioration
2021	#12	Industrial	Heli Laydown	6.52	9,780	TS0005	Unknown	4,771	$32,679	Domain 1 - 49	strip placement (Topsoil placement - distance >5km)
									$815	Domain 1 - 59	gypsum amelioration
2021	#16	Area 53	A53 East	23.5	35,250	TS0833	Vertasol	35,250	$144,525	Domain 3 - 29	Topsoil placement - distance >1km <2km
2022	#15A	RAMP 5	T&E Void	30.4	45,600	TS0828	Vertasol	33,468	$137,219	Domain 3 - 29	Topsoil placement - distance >1km <2km
						TS0007	Unknown	12,132	$49,741	Domain 3 - 29	Topsoil placement - distance >1km <2km
2023	#15B	RAMP 5	T&E Void	30.4	45,600	TS0007	Unknown	11,218	$45,993	Domain 3 - 29	Topsoil placement - distance >1km <2km
						TS0802	Kandasol	16,527	$67,760	Domain 3 - 29	Topsoil placement - distance >1km <2km
						TS0909	Vertasol	8,098	$33,200	Domain 3 - 29	Topsoil placement - distance >1km <2km
						TS0008	Unknown	10,050	$41,205	Domain 3 - 29	Topsoil placement - distance >1km <2km
2023	#31	Tailings Dam	Tailings wall batter	8.6	12,900	TS0804	Kandasol	9,420	$38,622	Domain 2 - 26	Topsoil placement - distance <1km
2024	#23	Ramp 3	Peanut	34.8	52,200	TS901A	Vertasol	16,217	$66,490	Domain 3 - 29	Topsoil placement - distance >1km <2km
						TS0821	Vertasol	35,983	$147,530	Domain 3 - 29	Topsoil placement - distance >1km <2km
2024	#24	Lookout	T&E OB	8.82	13,230	TS0805	Kandasol	11,522	$47,241	Domain 3 - 29	Topsoil placement - distance >1km <2km
						TS0004	Unknown	1,050	$4,305	Domain 3 - 29	Topsoil placement - distance >1km <2km
2024	#25	Lookout	Toe of tailing dam	9.66	14,490	TS0804	Kandasol	5,141	$26,474	Domain 3 - 29	Topsoil placement - distance >2km <5km
						TS0837	Kandasol	5,139	$26,464	Domain 3 - 29	Topsoil placement - distance >2km <5km
						TS0826	Vertasol	4,211	$21,686	Domain 3 - 29	Topsoil placement - distance >2km <5km
2024	#26	Lookout	DZ Tailings	7	10,500	TS0832	Kandasol	10,813	$44,334	Domain 3 - 29	Topsoil placement - distance >1km <2km

GROWTH MEDIA - MITIGATION & MANAGEMENT STRATEGY

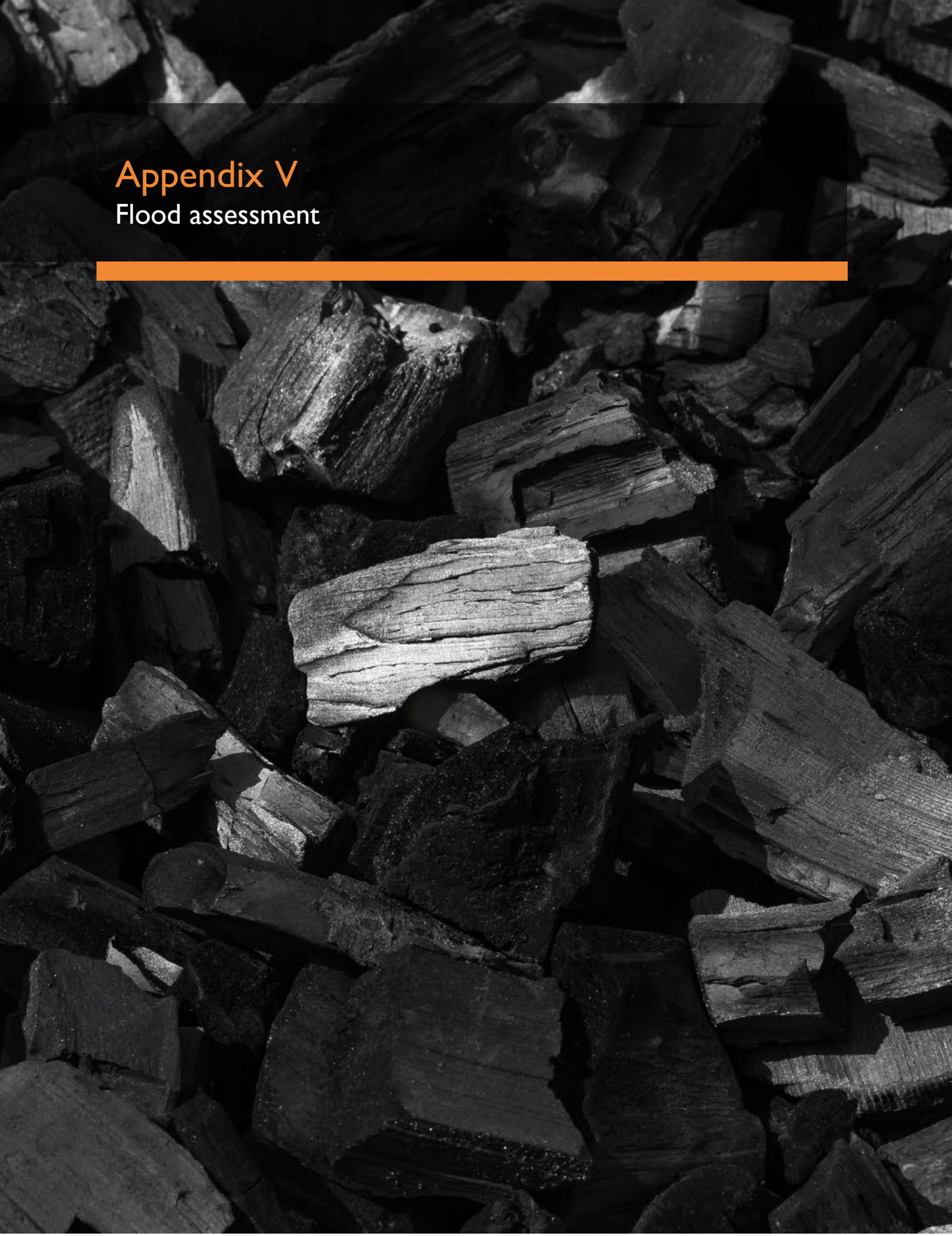
Year	Map No.	Pit	ID	AREA (ha)	Required m3 @ 0.15m	Stockpile ID	Media Type	Applied m3 @ 0.15m	FA Cost	FA Calc Line #	Explanation
2024	#27	Lookout	Tailings wall west	1.45	2,175	TS0826	Vertasol	2,175	$11,201	Domain 3 - 29	Topsoil placement - distance >2km <5km
2024	#29	Radio Hill	T&E OB	7.21	10,815	TS0826	Vertasol	10,815	$55,697	Domain 3 - 29	Topsoil placement - distance >2km <5km
2025	#10	FAR WEST	West of R0W Near Water	16.7	25,050	TS0009	Unknown	25,050	$129,008	Domain 3 - 29	Topsoil placement - distance >2km <5km
2025	#13	Industrial	Cherry Picker Shed	7.34	11,010	TS0009	Unknown	6,000	$30,900	Domain 1 - 49	Topsoil placement - distance >2km <5km
						TS0911	Kandasol	5,010	$25,802	Domain 1 - 49	Topsoil placement - distance >2km <5km
2025	#18	Ramp 3	North east voids	44	66,000	TS0900	Vertasol	66,000	$270,600	Domain 3 - 29	Topsoil placement - distance <1km
2025	#19	Ramp 3	South of void	14.2	21,300	TS0911	Kandasol	21,300	$145,905	Domain 3 - 29	Topsoil placement - distance >5km
2025	#20	Ramp 3	West of Void	5.98	8,970	TS0822B	Kandasol	3,051	$12,508	Domain 3 - 29	Topsoil placement - distance >1km <2km
						TS0824	Vertasol	5,688	$23,322	Domain 3 - 29	Topsoil placement - distance >1km <2km
2025	#21	Ramp 3	South East Void	42.4	63,600	TS0821	Vertasol	34,904	$143,105	Domain 3 - 29	Topsoil placement - distance >1km <2km
						TS0900	Vertasol	3,811	$15,626	Domain 3 - 29	Topsoil placement - distance >1km <2km
						TS0911	Kandasol	3,340	$13,694	Domain 3 - 29	Topsoil placement - distance >1km <2km
						TS0833	Vertasol	19,299	$79,128	Domain 3 - 29	Topsoil placement - distance >1km <2km
						TS0822A	Kandasol	2,577	$10,567	Domain 3 - 29	Topsoil placement - distance >1km <2km
2025	#22	Ramp 3	Pipeline	16	24,000	TS0912C	Vertasol	24,000	$98,400	Domain 3 - 29	Topsoil placement - distance >1km <2km
2025	#28	Radio Hill	DZ Push	17.9	26,850	TS0911	Kandasol	26,850	$138,278	Domain 3 - 29	Topsoil placement - distance >2km <5km
2025	#5	Ramp 1	R0E Access	3.18	4,770	TS0911	Kandasol	4,770	$24,566	Domain 3 - 29	Topsoil placement - distance >2km <5km
2025	#6	Ramp 1	NW Spoil pit side	3.52	5,280	TS0911	Kandasol	5,280	$27,192	Domain 3 - 29	Topsoil placement - distance >2km <5km

Post Mining Allocation

Year	Map No.	Pit	ID	AREA (ha)	Required m3 @ 0.15m	Stockpile ID	Media Type	Applied m3 @ 0.15m	FA Cost	FA Calc Line #	Explanation
		Ramp 1	Advanced face rehab strips (total)	200	300,000	TS0910	Vertasol			Domain 3 - 29	Not yet disturbed (148052.13 m3)
										Domain 3 - 29	Reclaimed from Dehab & Cemetary blocks (185310m3)
2026			Dragline Laydown area	15	22,500	TS0913C	Vertasol	7,305	$50,042	Domain 3 - 29	Topsoil placement - distance >5km
						TS0912C	Vertasol	6,222	$42,619	Domain 3 - 29	Topsoil placement - distance >5km
						TS0902	Vertasol	1,967	$13,476	Domain 3 - 29	Topsoil placement - distance >5km
						TS0826	Vertasol	1,699	$11,636	Domain 3 - 29	Topsoil placement - distance >5km
						TS0818	Vertasol	1,913	$13,106	Domain 3 - 29	Topsoil placement - distance >5km
						TS0834A	Kandasol	1,560	$10,688	Domain 3 - 29	Topsoil placement - distance >5km
						TS0006	Unknown	209	$1,431	Domain 3 - 29	Topsoil placement - distance >5km
						TS0820	Vertasol	1,014	$6,945	Domain 3 - 29	Topsoil placement - distance >5km
						TS0903	Vertasol	990	$6,780	Domain 3 - 29	Topsoil placement - distance >5km
2026		Industrial	Sewage Effluent Pond / Industrial Dam	2.97	4,455	TS0835 TS0806	Vertasol	1,853	$12,695	Domain 1 - 49	Topsoil placement - distance >5km
									$743	Domain 1 - 59	gypsum amelioration
2026		Industrial	CHPP – Decant cells – ROM	25	37,500	TS0913A	Vertasol	8,965	$61,410	Domain 1 - 49	Topsoil placement - distance >5km
						TS0913B	Vertasol	23,019	$157,679	Domain 1 - 49	Topsoil placement - distance >5km
						TS0913D	Vertasol	5,130	$35,143	Domain 1 - 49	Topsoil placement - distance >5km
						TS0914B	Unknown	881	$6,034	Domain 1 - 49	Topsoil placement - distance >5km
2026		Industrial	Haul roads and minor roads	82.8	124,200	TS0835 TS0806	Vertasol	62,100	$425,385	Domain 1 - 49	Topsoil placement - distance >5km
									$20,700	Domain 1 - 59	gypsum amelioration
2026		Industrial	MIA Buildings	10.2	15,300	TS0835 TS0806	Vertasol	15,300	$104,805	Domain 1 - 49	Topsoil placement - distance >5km

External or no growth media required

	#30	Tailings Dam	Tailings top wall	3.4	-						Top of Tailings Storage Facility embankment will be left clear to enable clear access to monitor changes in the surface capping.
2020	#32	Tailings Dam	Tailings beach	20.5	205000	External	Hydromulch		$369,000	Domain 2 -34	Application of hydromulch to reduce traffic and quickly reduce dust with rapid stabilisation.
2018-2020		Water Mgt	Upgrade of Eastern Diversion	18	180000	External	Hydromulch		$324,000	Domain 4 -45	Expect that this application and costs are included within the Diversion repair works (Domain 4 - 28)
		Ramp 1	Ramp 1 Transfer Dam	62	-						Water void
		Ramp 3	Ramp 3 Void	10	-						Water void
		Ramp 1	Environmental Dam	6	9,000	TS0807	Kandasol	3,235	$30,600	Domain 4 - 33	Strip placement (Topsoil placement - distance ~ 500m)
		Lease	Topsoil stripped areas	66.3					$78,459	Domain 1- 61	Application of biosolids to topsoil stripped areas prior to ripping and seeding.
		Lease	Topsoil stockpile areas	50	-				$48,000	Domain 1 - 47	Areas where topsoil was stockpiled will be lightly ripped when all material has been extracted.



Appendix V
Flood assessment

This page is intentionally blank.

Blair Athol Coal Mine

Flood Assessment for the Progressive Rehabilitation and Closure Plan

TerraCom Resources

Doc. Ref.: BAC-004-B1

Date: 12 September 2025

Rev. No.	Doc Ref.	Report Date	Report Author	Reviewer
0 [DRAFT]	BAC-004-B	5 September 2025	AH	MGB
1	BAC-004-B1	12 September 2025	AH	MGB

For and on behalf of **HydroBalance**
Environmental and Mine Water Management Solutions



Ashleigh Hackett
Senior Engineer

HydroBalance
Environmental and Mine Water Management Solutions
HydroBalance.au

Matthew Briody (Principal Engineer) E: Matt@HydroBalance.au M: 04 0614 4514
Ashleigh Hackett (Senior Engineer) E: Ashleigh@HydroBalance.au M: 04 6699 2924

Contents

1 Introduction 4

1.1 Background 4

1.2 Purpose of the report 4

2 Regional and local catchments 7

2.1 Regional topography and catchments 7

2.2 Site drainage 7

2.3 Relevant watercourses 7

3 Available data 11

3.1 Topographic data 11

4 Estimation of discharges 12

4.1 Overview 12

4.1.1 URBS subcatchment parameters 14

4.1.2 Dam configuration 15

4.1.3 Design rainfalls 15

4.1.4 Design losses 16

4.1.5 Areal reduction factor 16

4.1.6 Temporal patterns 16

4.1.7 Model discharges 17

4.2 Model validation 18

4.3 Local catchment design discharges 19

4.3.1 Climate change factors 19

4.3.2 Adopted peak discharges 21

5 Hydraulic model development 22

5.1 Overview 22

5.2 Model extent and configuration 22

5.3 Topography 22

5.4 Inflow and outflow boundary conditions 22

5.5 Adopted Mannings 'n' values 23

5.6 Hydraulic structure 23

6 Hydraulic model results 26

7 Summary of findings 29

8 References 30

Appendix A. PMF final landform flooding results 31

List of Figures

Figure 1.1 –Locality 5
Figure 1.2 –PRC Plan rehabilitation areas 6
Figure 2.1 – Local catchments and Strahler stream order classification 10
Figure 4.1 – URBS hydrologic model configuration 13
Figure 4.2 – Distribution of 1% AEP design peak discharges at the Bath Creek outlet 18
Figure 4.3 – Annual exceedance probability for the estimated Bath Creek flows 19
Figure 5.1 – TUFLOW hydraulic model configuration 25
Figure 6.1 – Final landform flood depths and extents, 0.1% (1 in 1,000) AEP 27
Figure 6.2 – Final landform flood velocity, 0.1% (1 in 1,000) AEP 28
Figure A.1 - Final landform flood depths and extents, PMF 32
Figure A.2 - Final landform flood velocity, PMF 33

List of Tables

Table 2.1 – Observed site drainage characteristics onsite 8
Table 4.1 – Adopted URBS model subcatchment parameters 14
Table 4.2 – Adopted design rainfall depths at the Bath Creek outlet 16
Table 4.3 – Peak discharges at the Bath Creek outlet (critical duration is highlighted) 17
Table 4.5 – URBS model predicted PMP flood peak discharges for WDD and EDD 21
Table 5.1 – Design rainfall climate change factors 22
Table 5.2 – Adopted hydraulic resistance coefficients 23
Table 5.3 – Adopted hydraulic resistance coefficients 24

1 Introduction

1.1 Background

HydroBalance was engaged by SGM Environmental (on behalf of Terracom Resources) to undertake a final void flood study to support the Progressive Rehabilitation and Closure Plan (PRCP) for the Blair Athol Coal (BAC) Mine. The BAC Mine is operated by Terracom Resources (Terracom). The locality of BAC is presented in Figure 1.1.

HydroBalance has modelled the hydrology and hydraulics of the BAC final void to inform whether the final void would be safe, stable and non-polluting. This report outlines the methodology and assessment of the expected flood behaviour of Bath Creek adjacent to the BAC final void, which has been modelled using URBS (hydrology) and TUFLOW (hydraulics) simulation software.

Figure 1.2 shows the PRCP rehabilitation areas, which includes the Eastern Diversion Drain (EDD) and the Western Diversion Drain (WDD), both of which are classified as 'Diversion' rehabilitation areas and will remain in place post-closure. The intent of the diversions is to divert the upper Bath Creek catchment around the proposed final void, and into the downstream Bath Creek channel. The final void would be a Non-Use Management Area (NUMA), however it is not expected that the water stored in the final void would interact with the receiving environment.

The Department of the Environment, Tourism, Science and Innovation (DETSI) Guideline – Progressive rehabilitation and closure plans (PRC plans) (DES, 2019) require a flood plain model report to be included in the rehabilitation planning part of the PRCP, the intent of which is to:

- represent the flood plain under removal of all temporary structures or features;
- assess the flooding susceptibility and influence across the site; and
- confirm the final landform to be stable.

The PRCP guidelines require flood plain modelling to be undertaken in accordance with the Australian Rainfall and Runoff (ARR) guidelines and exclude artificial features on the site. Artificial features under the PRCP schedule are defined as structures or features that are temporary, that will require a level of maintenance greater than the level of maintenance that would be required had the schedule not been carried out, or that interfere with or affect relevant watercourses of the natural flow of water. Such features will be identified and excluded from the flood modelling.

Section 41C(3) Environmental Protection Regulation (2019) states that:

> *the administering authority must treat the land as a flood plain to the extent the results of the flood plain modelling show that, when all relevant activities carried out on the land have ended, the land is the same height as, or lower than, the level modelled as the peak water level 0.1% AEP for a relevant watercourse under the ARR.*

That is, Terracom are required to demonstrate that the BAC final void will not be located within the 0.1% AEP flood plain extent for a 'relevant watercourse'.

Hydrologic and hydraulic modelling for the 0.1% Annual Exceedance Probability (AEP) and Probable Maximum Flood (PMF) was undertaken to assess flooding characteristics at BAC under final landform conditions as per the DETSI (DES, 2019; 2020) requirements.

1.2 Purpose of the report

This flood modelling report provides a description of the adopted assessment methodology and the key modelling results for the assessment of flooding at BAC. The contents of this report may be used as input to the PRCP.

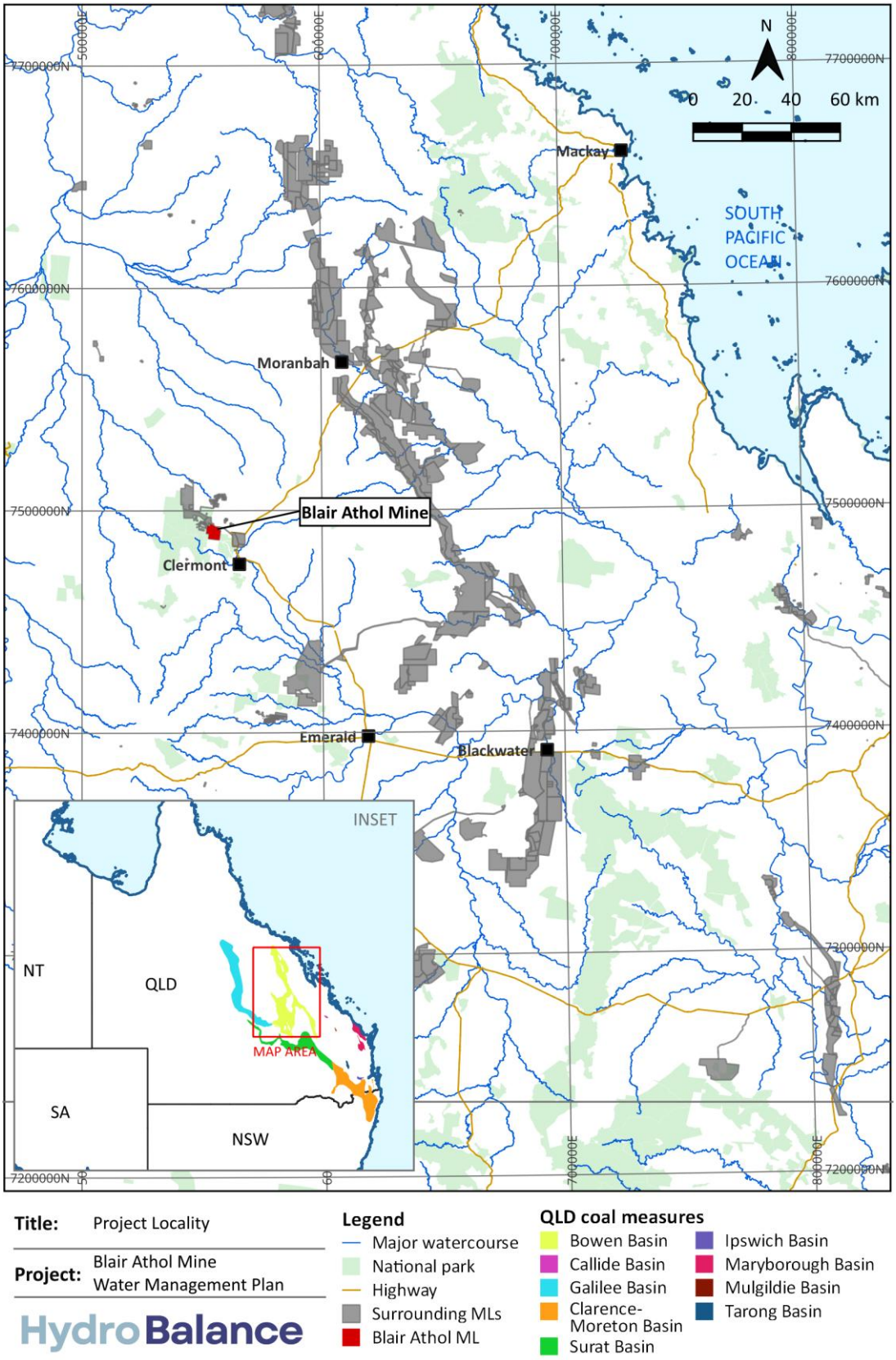


Figure 1.1 –Locality

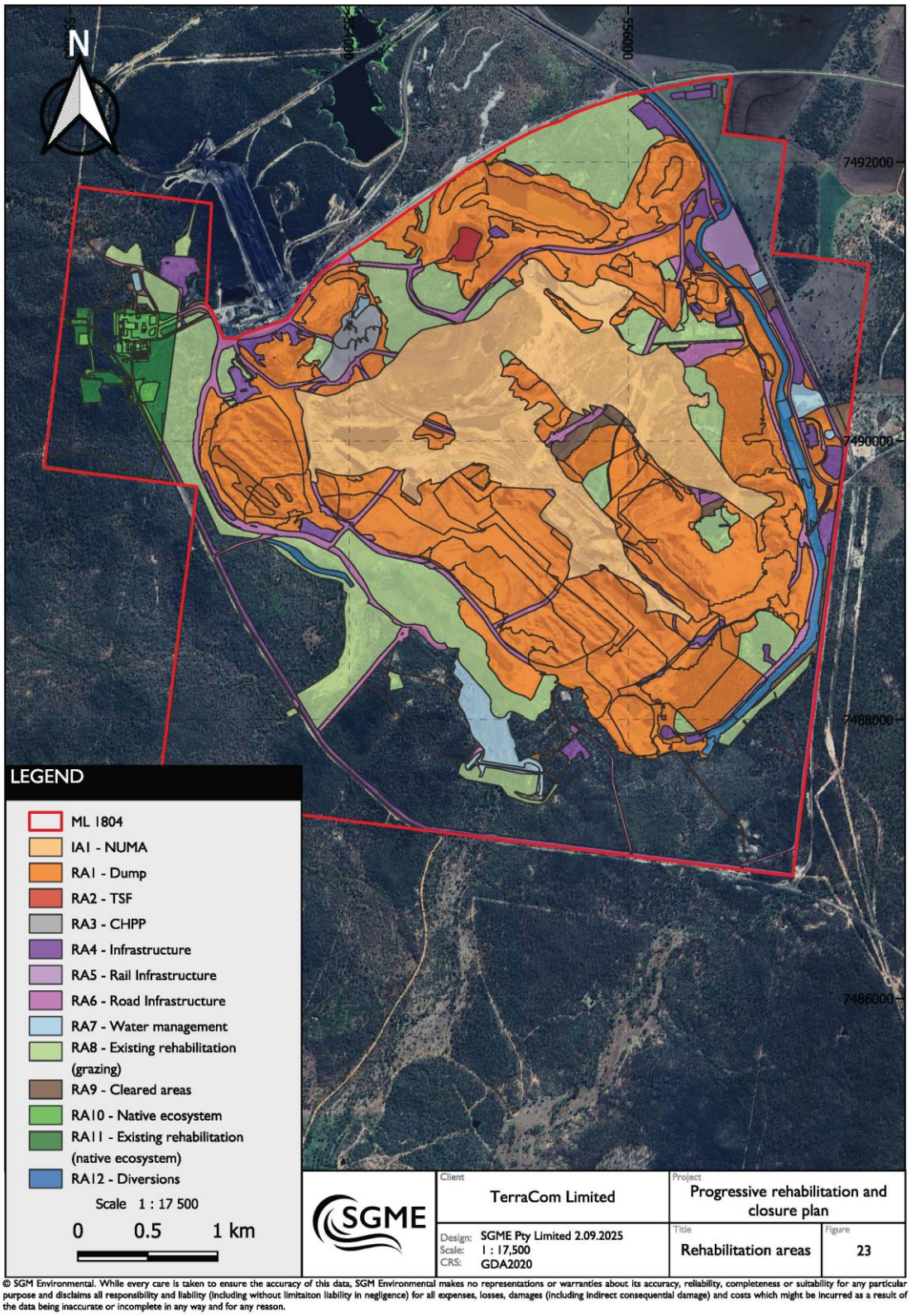


Figure 1.2 –PRC Plan rehabilitation areas

2 Regional and local catchments

2.1 Regional topography and catchments

Figure 1.1 shows the location of the BAC mine. The mine is located approximately 17 km northwest of Clermont, a town in the Isaac Region of Central Queensland in the Bath Creek watershed. Bath Creek is located in the Sandy Creek catchment, a sub-catchment within Theresa Creek, which is tributary of the Nogoa River in the north-western corner of the Fitzroy Basin.

Figure 2.1 shows the BAC mine catchment and local drainage features. The mine is located in the upper catchment of Bath Creek, an ephemeral watercourse with a catchment area of about 122 km^2. Bath Creek has several tributaries, however three are of note as they drain into mine infrastructure or Bath Creek within the mine lease boundary. These are Breaker Creek (west of the mine), Washpool Creek (north of the mine) and Ti Tree Gully (east of the mine). There are no stream gauges located on Bath Creek or its tributaries.

Ti Tree Gully is a first order stream (under the Strahler classification system) at its confluence with Bath Creek. Breaker Creek is a third order stream at its confluence with Bath Creek or mine infrastructure. Bath Creek is a third order stream at its confluence with Sandy Creek and Sandy Creek is a sixth order stream at its confluence with Theresa Creek.

2.2 Site drainage

Figure 2.1 shows the drainage in the vicinity of BAC. There are currently three diversion drains that redirect flow around the BAC mine: the Northern Boundary Drain (NBD), Eastern Diversion Drain (EDD) and Western Diversion Drain (WDD). NBD, EDD and WDD are proposed to remain post-closure to manage drainage. The following is of note regarding current and post closure site drainage:

- The NBD diverts a first order section of Breaker Creek around a disused rail loop to Washpool Creek, which drains to West Dam north of the mine. This diversion will remain unchanged after closure.
- The WDD currently diverts a third order section of Breaker Creek around the mine to Bath Creek (west).
- The EDD currently diverts a first order section of Ti Tree Gully around the eastern side of the mine, into Bath Creek (east).

Alluvium undertakes annual inspections of the WDD and EDD to monitor the drain characteristics and conditions. The most recent inspections were undertaken in September 2024. The condition of the site drainage observed by Alluvium (2024a; 2024b) is summarised in Table 2.1.

2.3 Relevant watercourses

The Department of the Environment, Tourism, Science and Innovation (DETSI) *Information Sheet – Voids in Floodplains* states the following in relation to 'relevant watercourses':

> *Relevant watercourse means—*
>
> > *(a) a watercourse classified as stream order 4 or higher under the Strahler stream order classification system; or*
> >
> > *(b) if a watercourse mentioned in paragraph (a) is permanently diverted under—*
> >
> > > *(i) a condition, or proposed condition, of an environmental authority mentioned in the Water Act 2000, section 98; or*
> > >
> > > *(ii) a water licence or proposed water licence under the Water Act 2000.*

Based on the above characterisation, there are no 'relevant watercourses' in the vicinity of the BAC final landform as they relate to voids in the floodplains.

Table 2.1 – Observed site drainage characteristics onsite

Feature	Section	Characteristics and current condition (Alluvium, 2024a; 2024b)	Site photograph
WDD	Upstream reach	Characterised by dense vegetation and low energy (broad floodplain and unchannelised) conditions. Much of the upstream monitoring reach is in good condition.	
	Diversion reach	Characterised by channelised flow due to defined beds and banks throughout the reach. The upstream subreach is largely unvegetated within the channel. However, rehabilitation works in the downstream subreach appear to have been successful with trees and shrubs establishing. Condition of the diversion reach remains moderate overall.	
	Downstream reach	The downstream reach is characterised by stable channels which gradually transitions into flat flood plain. The downstream section is well vegetated. The downstream reach is in good condition and generally does not appear to show negative impact from the diversion.	
EDD	Diversion Reach (upstream subreach)	The diversion is a basalt gorge excavated up to 10 m below natural surface with batters 1:1 or steeper in some sections. The reach is moderately well vegetated. The diversion arrangement is stable through this subreach.	

Feature	Section	Characteristics and current condition (Alluvium, 2024a; 2024b)	Site photograph
	Diversion reach (downstream subreach)	This reach is largely in poor condition and requires rehabilitation (a rehabilitation plan has been developed). The diversion is deeply cut below natural ground, has steep batters and limited vegetation cover.	
	Downstream reach (Bath Creek East)	The reach is characterised by a low capacity channel set in a broad floodplain relative to the channel. Banks are dominated by clayey material and the bed in places is armoured with gravel to cobble size material with occasional bedrock controls. Riparian and floodplain vegetation is in good condition.	

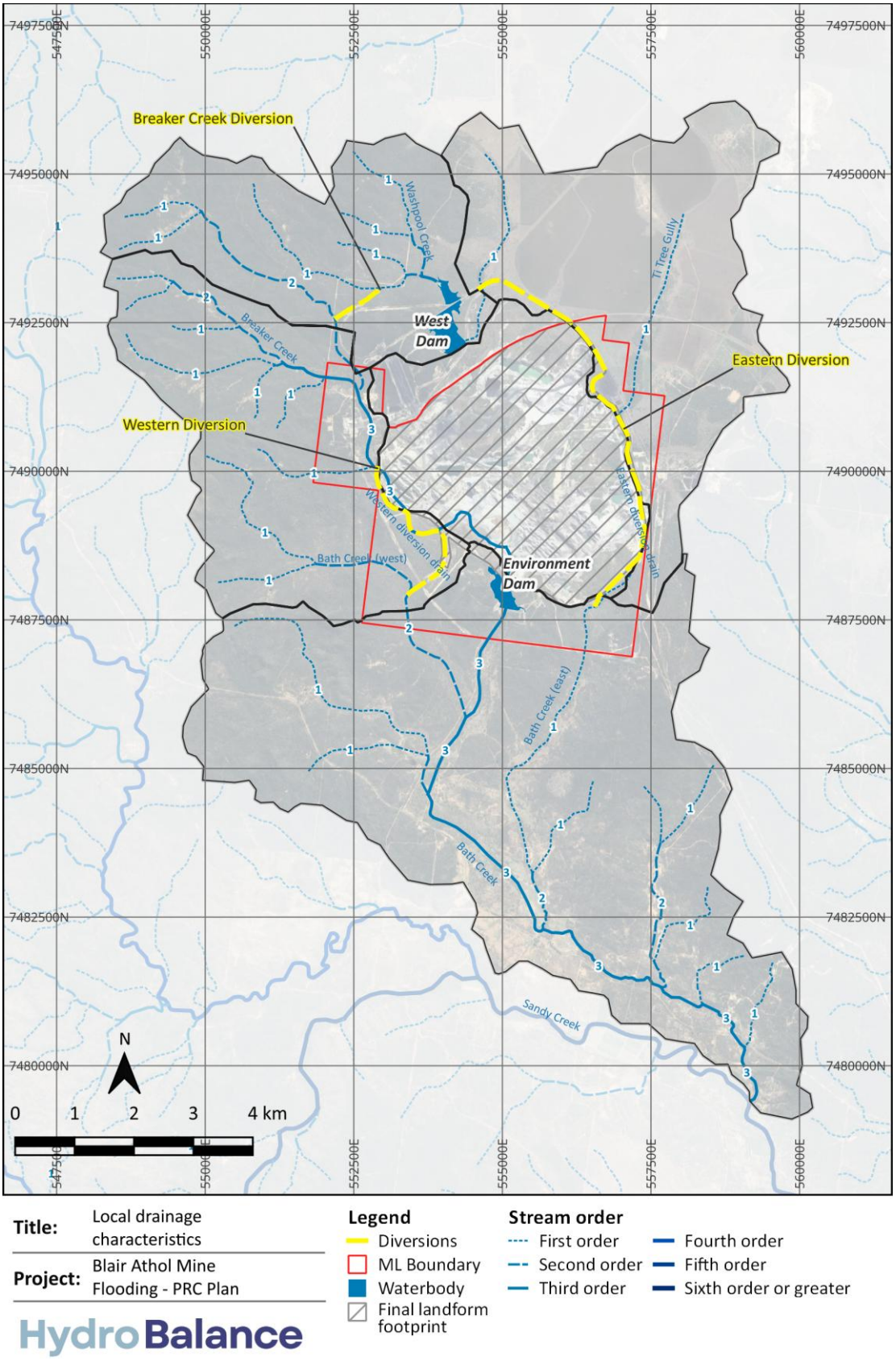


Figure 2.1 – Local catchments and Strahler stream order classification

3 Available data

3.1 Topographic data

A final landform surface was provided by Terracom in August 2025. It is assumed that diversion geometries presented in the final landform will be achieved prior to closure.

1 m Light Detection and Ranging (LiDAR) data was provided for the area within the mine lease (ML) boundary. 5 m Hydro-enforced SRTM data was used for areas of the hydrologic model that were not covered by the final landform surface or the 1 m LiDAR.

The 1 m and 5 m topographic data was used to develop an URBS (Unified River Basin Simulator) model to determine the rainfall runoff values for the Bath Creek catchment. Only the final landform surface data was used to develop a Two-Dimensional Unsteady Flow (TUFLOW) hydraulic model for this study as the boundary of the TUFLOW model did not extend beyond the final landform surface extent.

4 Estimation of discharges

4.1 Overview

An URBS rainfall runoff model was developed to estimate design discharges for the entire Bath Creek catchment as well as subcatchments located within the model for the 0.1% (1 in 1,000) AEP and PMF (Probable Maximum Flood) design flood events. The Washpool Creek catchment was not included in this model as Washpool Creek discharges into West Dam which is owned and operated by the Clermont Open Cut Coal Mine and is assumed to remain post mining.

There was no historic flow data available for Bath Creek, therefore a 1% (1 in 100) AEP design flood event was developed to validate the URBS model a Flood Frequency Analysis (FFA) for the Sandy Creek gauge (see Figure 2.1), which was scaled to represent flows in Bath Creek downstream of the mine.

The validated URBS model was then used to estimate design discharges in the creeks and the local catchments using the Australian Rainfall and Runoff (ARR) 2019 guidelines (Ball et al., 2019) for the 0.1% AEP and PMF design events for a range of storm durations to determine the critical storm durations at key locations (EDD and WDD). The derived hydrographs were used as inputs to the TUFLOW hydraulic model.

Figure 4.1 shows the hydrologic model configuration. The model covers the entire Bath Creek catchment to the Sandy Creek confluence and consists of 42 sub-catchments. Table 4.1 provides a description of each catchment as well as the adopted catchment parameters.

A uniform rainfall depth and temporal pattern were assumed over the entire catchment. Rainfall losses (initial loss /continuing loss) across the catchment were assumed to be uniform.

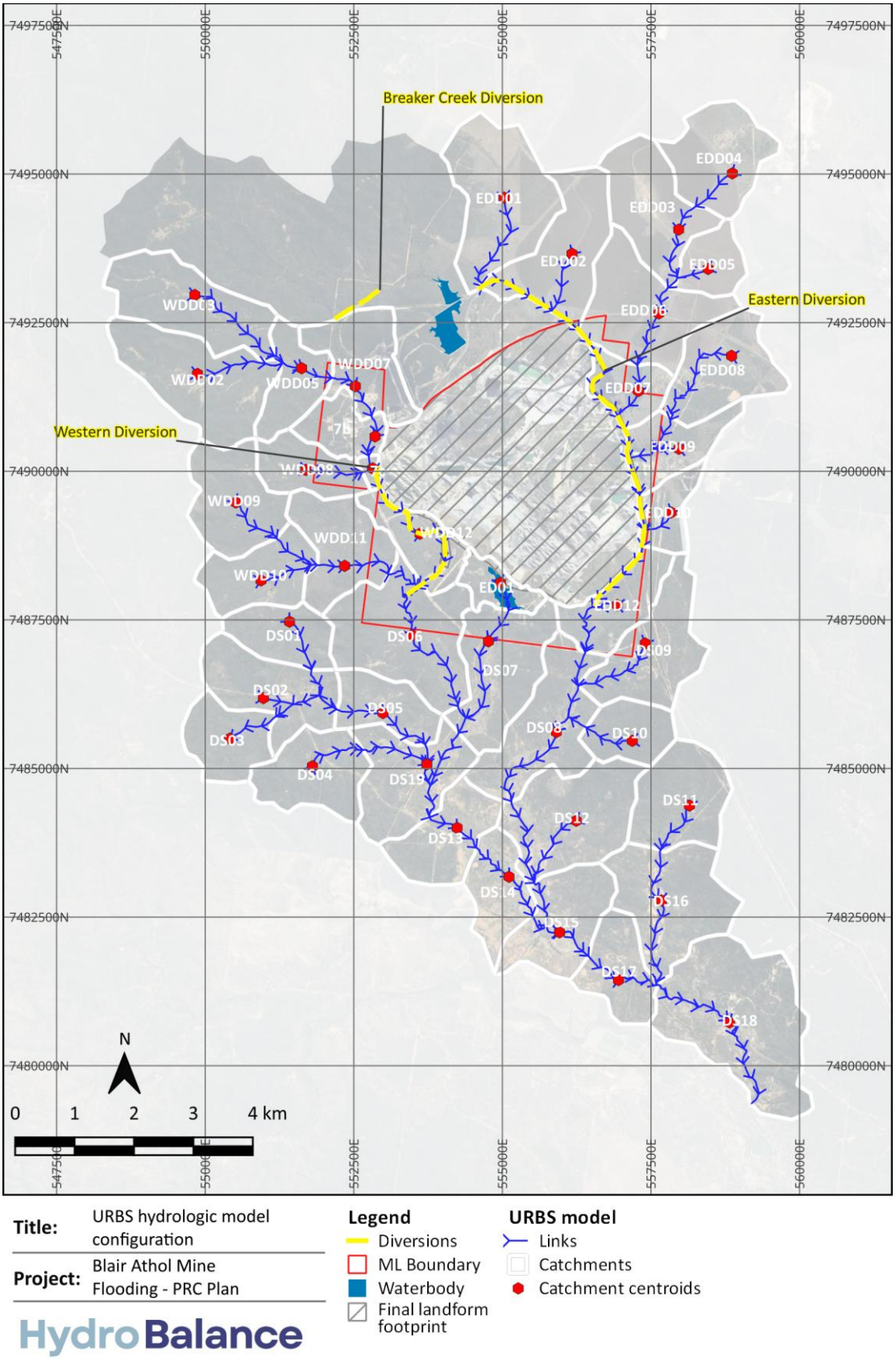


Figure 4.1 – URBS hydrologic model configuration

4.1.1 URBS subcatchment parameters

Table 4.1 shows the adopted URBS model subcatchment parameters. It was assumed that the subcatchments had 0% imperviousness. The subcatchment slopes were determined as area-weighted slopes based on SRTM and confirmed against the higher resolution LiDAR where available.

Table 4.1 – Adopted URBS model subcatchment parameters

Node ID	Description	Area (ha)	Slope (%)	% Impervious
Western Diversion Drain				
2	Breaker Creek	3.4	4.1	0
3	Breaker Creek	2.9	3.8	0
5	Breaker Creek	1.4	3.7	0
7	Breaker Creek	2.9	6.8	0
9	Local inflow	1.4	3.6	0
23	WDD inlet	0.3	4.9	0
24	Unnamed tributary/WDD confluence	0.4	5.4	0
28	Bath Creek (west)	2.4	4.3	0
29	Bath Creek (west)	1.9	3.2	0
30	Bath Creek (west)	2.3	6.1	0
31	WDD outlet	1.6	4.8	0
Environmental Dam				
32	Environmental Dam	0.9	4.1	0
Eastern Diversion Drain				
13	EDD inlet	3	1.4	0
14	Local inflow	3.6	1.9	0
15	Unnamed tributary	2.6	1.3	0
16	Unnamed tributary	2.5	1.6	0
17	Unnamed tributary	1.1	1.1	0
18	Unnamed tributary	3.2	2.8	0
19	Unnamed tributary	1.3	4.9	0
20	Ti Tree Creek	2.5	2.1	0
21	Ti Tree Creek	1.4	3.9	0
22	Local inflow	1.7	5.6	0

Node ID	Description	Area (ha)	Slope (%)	% Impervious
33	EDD outlet	1	4.8	0
URBS subcatchments downstream of the Mine Lease				
39	Bath Creek (west) catchment/WDD confluence	4	6.9	0
40	Environmental Dam outlet/Bath Creek (west) confluence	2.9	6.5	0
34	Bath Creek (west)	1.5	5.6	0
35	Bath Creek (west)	2.5	4.2	0
36	Bath Creek (west)	1.7	3.3	0
37	Bath Creek (west)	2.2	3.5	0
38	Bath Creek (west)	1.5	4.1	0
41	Bath Creek (east)	3	2.4	0
42	Bath Creek (east)	2.7	2.6	0
43	Bath Creek (east)	1.3	2.6	0
44	Bath Creek	2.4	2.7	0
45	Bath Creek (east)	3.3	2.2	0
46	Bath Creek (west)	2	4.6	0
47	Bath Creek (west)	1.6	5.5	0
48	Bath Creek west and east confluence	2.3	4	0
49	Bath Creek	3.2	2.7	0
50	Bath Creek	1.7	3.8	0
51	Bath Creek	5.2	3.7	0
52	Bath Creek (west)	2.7	6	0

4.1.2 Dam configuration

All dams are assumed to be decommissioned post-mining, with the exception of Environmental Dam which is south of the final void and West Dam (owned by Clermont Open Cut Coal Mine). Therefore, the dams within the final void were not a part of the URBS model. West Dam has also been excluded from the URBS model.

Environmental Dam was assumed to be at full storage level (FSL) for the purposes of this assessment.

4.1.3 Design rainfalls

Design rainfall depths were obtained from the Bureau of Meteorology (BoM) intensity frequency duration data system (2016 IFD). For the estimation of design discharges, design rainfalls were obtained for the centroid of the Bath Creek catchment (at -22.70524 latitude and 147.53111 longitude). These design

rainfall depths were then used in the model to estimate the flows at the Bath Creek catchment outlet, EDD catchment outlet and WDD catchment outlet.

Table 4.2 shows the adopted depths for the modelled design events (1% AEP, 0.1% AEP and PMF for durations between 1 hour and 120 hours).

Table 4.2 – Adopted design rainfall depths at the Bath Creek outlet

Storm Duration (hours)	PMP (mm)	0.1% AEP (mm)	1% AEP (mm)
1	370	130	87
1.5	430	152	102
2	480	168	113
3	530	194	130
4.5	611	221	149
6	680	242	163
9	761	275	185
12	825	300	202
18	923	338	227
24	1000	367	247
30	1121	393	263
36	1230	414	275
48	1440	446	297
72	1810	488	326
96	2030	515	348
120	2130	534	364

4.1.4 Design losses

The following is of note for the adopted design rainfall losses:

- For the 1% AEP event, which was only used for validation purposes, an initial loss of 28 mm and a continuing loss of 1.8 mm/hr were adopted based on the validation against the FFA (see Section 4.2); and
- For the 0.1% AEP and PMP events, a 0 mm initial loss and 1 mm/hr continuing loss were adopted.

4.1.5 Areal reduction factor

Areal reduction factors ranging from 0.78 for short duration events to 0.98 for longer duration events were adopted for this assessment.

4.1.6 Temporal patterns

Temporal patterns for the PMP event for durations up to and including six hours were obtained from the Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method (GSDM) (BoM, 2003) as per the recommendation in ARR 2019. Longer duration rainfalls, from 24 hours and longer, were derived from the Revised Generalised Tropical Storm Method (GTSMR) method. Durations ranging between six and twenty-four (24) hours were interpolated logarithmically.

4.1.7 Model discharges

The critical storm duration for each of the modelled events was selected based on the duration which produces the highest average peak discharge at the location of interest. As recommended in the guidelines, the temporal pattern of the duration producing the next higher discharge was selected for analysis.

To illustrate the variation in peak discharges from the ensemble of 10 temporal patterns for each storm duration, Figure 4.2 provides box and whisker plots (box plots) showing the distribution of peak discharges in Bath Creek for the 1% AEP event. For each duration, the rectangle box represents the 25%ile and 75%ile (1st and 3rd quartile, the interquartile range or IQR) bound of the estimate. The horizontal lines at the top and bottom (whiskers) represent the upper and lower estimates for 1.5 times the IQR. The dashed horizontal line within the box is the median value while the dark red horizontal line represents the mean value. The dots represent outliers.

Table 4.3 shows the peak discharges and critical storm duration for the modelled design events.

Table 4.3 – Peak discharges at the Bath Creek outlet (critical duration is highlighted)

Storm Duration (hours)	PMP (m^3/s)	0.1% AEP (m^3/s)	1% AEP (m^3/s)
3	195.7	81.1	33.3
6	457.5	177.0	89.6
9	532.0	202.7	100.5
12	568.4	222.7	112.4
18	610.5	234.1	121.7
24	633.1	232.0	124.5
36	677.2	225.9	108.6
48	703.9	208.4	-
72	732.4	-	-
96	711.7	-	-

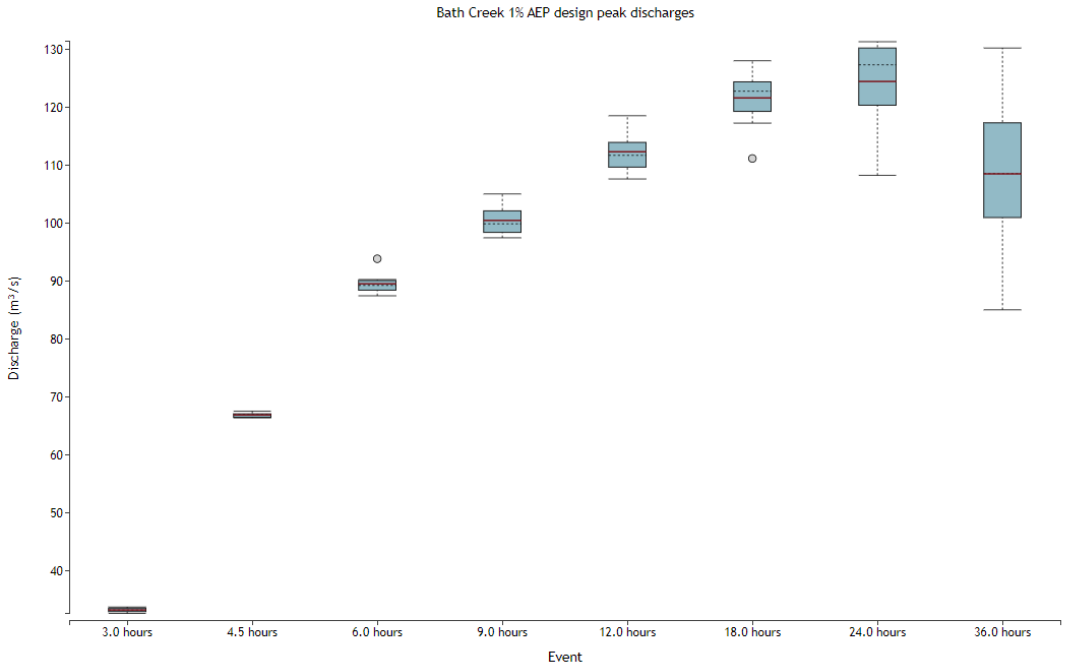


Figure 4.2 – Distribution of 1% AEP design peak discharges at the Bath Creek outlet

4.2 Model validation

Bath Creek is an ungauged catchment, therefore the peak flows for the 1% AEP event at the Bath Creek and Sandy Creek confluence was compared to the FFA for the nearest downstream gauge, Sandy Creek at Clermont (130207A). This gauge has 58 years of streamflow data available from the Queensland Government Water Information Portal (WMIP).

The Bath Creek catchment downstream of the BAC is 122 km^2 and the size of the Sandy Creek catchment to the gauging station is 409 km^2 (WIMP, 2023). Hence, it has been assumed that Bath Creek would contribute to one-third of flows at the Sandy Creek at Clermont gauge. Hence, the Sandy Creek FFA was scaled to one third to represent the Bath Creek catchment. Figure 4.3 presents the results of the Sandy Creek FFA, scaled to represent Bath Creek. The figure also shows the peak discharges from the URBS model for the 1% and 0.1% AEP events.

There is a 9% difference in the modelled 1% AEP peak discharge for Bath Creek compared to the FFA (107 m^3/s). Hence the URBS model is considered to be validated to the FFA. The 0.1% AEP modelled peak discharge is also withing the FFA confidence limits.

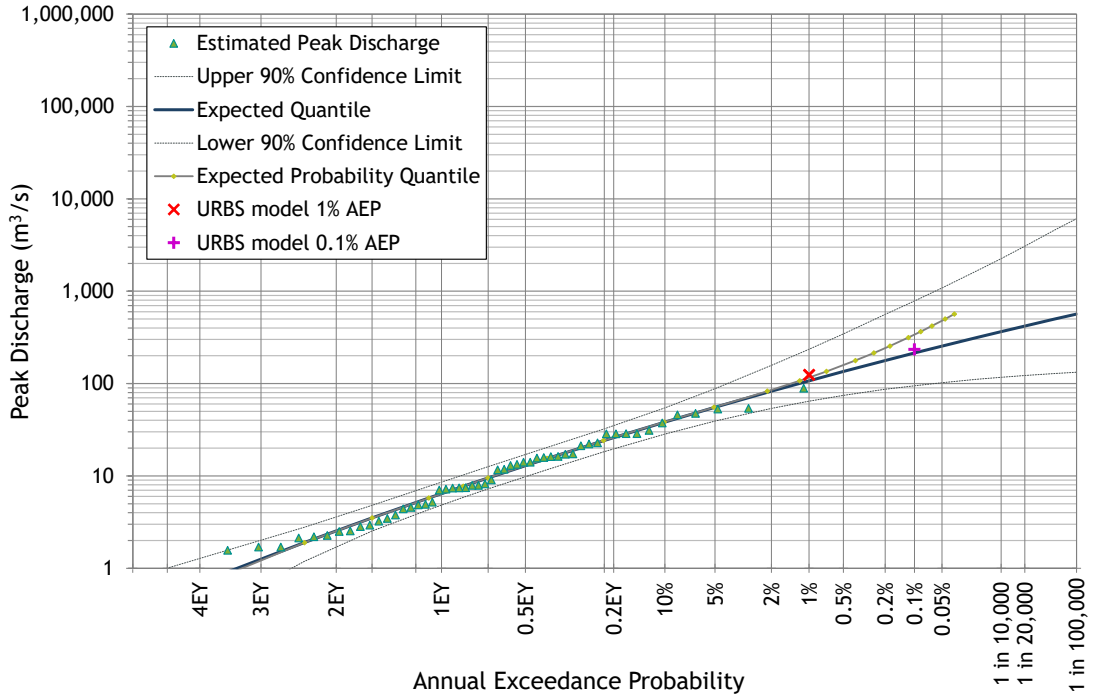


Figure 4.3 – Annual exceedance probability for the estimated Bath Creek flows

4.3 Local catchment design discharges

4.3.1 Climate change factors

Traditionally, design flood estimation has assumed that historical observations are representative of current and future conditions. This is no longer the case. Records on historical flooding or flood drivers (such as extreme rainfall or sea level) can no longer be assumed to provide a direct analogue of current or future flood risk. To account for significant observed and projected changes to the drivers of flooding, it is necessary to account for the non-stationarity of flooding in the assessment of current and future flood risks.

ARR 2019 advises methodology to adjust the following climate-related factors to reflect the changing climate:

- A design storm of a given AEP and duration, usually derived from published IFD data.
- Temporal patterns to distribute the design rainfall over the duration of the event.
- Spatial patterns to represent rainfall variation over a catchment.
- Loss parameters that represent soil moisture conditions in the catchment antecedent to the event and the capacity of the soil to absorb rainfall during the event.

Rainfall

The latest Intergovernmental Panel on Climate Change (IPCC) developed temperature projections based on Shared Socioeconomic Pathways (SSPs) to cover a broad range of potential future development options often referred to as very low (SSP1-1.9), low (SSP1-2.6), medium (SSP2-4.5), high (SSP3-7.0) and very high (SSP5-8.5) emissions pathways. As global temperatures have risen since this period, design rainfall estimates require factoring to account for this temperature increase.

The design rainfalls have been adjusted based on the “Current and near-term (2021-2040)” timeframe for the SSP3-7.0 climate scenario. The SSP3-7.0 climate scenario is the high potential development pathway, and is expected to give a conservatively high estimate of the climate change impacts. The mean SSP3-7.0

factors for a range of event durations are shown in Table 4.4 and will be applied to each of the design rainfall depths.

Table 4.4 – Design rainfall climate change factors

Design event duration (hr)	Mean (average) rainfall climate change factor (SSP3-7.0)
3	1.14
6	1.12
9	1.12
12	1.11
24	1.10
36	1.10
48	1.10
72	1.10
96	1.10

Temporal patterns

Temporal patterns may become slightly more front-loaded with a greater proportion of the storm volume falling towards the start of the storm. While the shift towards more front-loaded storms based on the analysis of historical data is statistically significant, the magnitude of these changes is small and the impact of temporal pattern changes on design flood estimates may be of little practical significance, particularly for those systems where flood levels are largely dependent on flood volume.

Currently there is no published methodology for quantifying the effect of changing temporal patterns on design flood estimates, nor published literature on the implications on their impacts on design flood estimates.

Spatial patterns

Although there is some evidence that climate change will influence spatial patterns of extreme rainfall, there are considerable uncertainties around such changes for localised regions. As such, there is insufficient justification for amending spatial patterns or areal reduction factors.

Losses

The rates of change for initial loss (IL) and continuing loss (CL) are due to climate change are generally positive (losses will generally increase with higher temperatures), which reduces the impact of increased rainfall intensities, particularly for frequent floods or for systems whose performance is dependent on the volume of a flood as well as its peak.

ARR recommends adjusting the IL and CL using a rate (%/°C) based on the spatial location and predicted temperature changes for the selected climate future.

Based on the recommended mean rates for the “East Coast North, and East Coast South” Natural Resource Management Cluster and the SSP3-7.0 climate future, the following adjustment factors have been adopted:

- Initial loss: +2%.
- Continuing loss: +5%

4.3.2 Adopted peak discharges

The URBS model was run for the 0.1% AEP and PMF events from 3 to 48 hour storm durations to determine the catchment design hydrographs. Table 4.5 summarises the predicted peak discharges at key locations for each event from the URBS model.

Table 4.5 – URBS model predicted PMP flood peak discharges for WDD and EDD

Reporting location	Catchment size (km^2)	0.1% AEP		PMF	
		Peak discharge (m^3/s)	Critical duration in hours	Peak discharge (m^3/s)	Critical duration in hours
EDD	23.7	78.1	12	225.9	36
WDD	14.2	48.8	12	132.7	12

5 Hydraulic model development

5.1 Overview

A TUFLOW two-dimensional hydraulic model (BMT, 2019) was developed to simulate the runoff behaviour in the vicinity of the final landform using the discharge hydrographs estimated in URBS as inflows. The TUFLOW hydraulic model was used to estimate peak flood extents, depths and velocities at the EDD and WDD outlets for the 0.1% AEP design events and the PMF.

5.2 Model extent and configuration

Figure 5.1 shows the extent and configuration of the TUFLOW hydraulic model developed for this study.

The model was configured as HPC-GPU (high-performance computing graphics processing unit) model with a 5 m fixed grid resolution and solved using the TUFLOW model version 2020-10-AB.

5.3 Topography

The final landform surface provided by Terracom was used as the basis for the model topography.

5.4 Inflow and outflow boundary conditions

Figure 5.1 shows the locations of the 16 inflow and 3 outflow boundaries. Table 5.1 provides a summary of the inflow and outflow boundaries of the model. Discharge hydrographs produced from the URBS model were applied to these inflow locations. Inflow hydrographs at these locations were applied equally distributed across all active cells within a given subarea, effectively applying runoff to all areas within the model extent. The model results were validated by comparing design discharges against those produced by the hydrologic model. Peak flows were found to be generally similar (less 10% difference). These small differences were expected to occur and were considered acceptable when accounting for storage and breakout flows represented in the hydraulic model that were not represented in the hydrologic model.

Three outflow boundaries were included in the model:

- The Bath Creek West outflow boundary is located approximately 700 m downstream of the WDD outlet;
- The Bath Creek outflow boundary is located approximately 500 m downstream of the Environmental Dam embankment; and
- The Bath Creek East outflow boundary was located approximately 970 m downstream of the EDD outlet.

Table 5.1 – Design rainfall climate change factors

Boundary Name	Boundary Type	Description
EnvDam_Inflow	Local inflow	Environmental Dam
BC_East_Inflow	Local inflow	Subcatchment at EDD outlet
WDD_Inflow	Local inflow	WDD subcatchment
Breaker_Inflow	Upstream inflow	Breaker Creek inflow
EDD01_Inflow	Upstream inflow	EDD inlet
EDD02_Inflow	Local inflow	EDD subcatchment
EDD03_Inflow	Upstream inflow	Unnamed tributary inflow
EDD04_Inflow	Local inflow	EDD subcatchment

Boundary Name	Boundary Type	Description
TTG01_Inflow	Local inflow	Ti Tree Creek inflow
TTG02_Inflow	Local inflow	Ti Tree Creek inflow
BC_West_Inflow	Upstream inflow	Bath Creek (west) inflow
BAC019	Local inflow	EDD subcatchment
BAC023	Local inflow	WDD subcatchment
BAC024	Local inflow	Adjacent to WDD inlet
BAC031	Local inflow	WDD subcatchment
BAC030	Local inflow	WDD subcatchment
BC_West_Out	Outflow	Bath Creek (west) outlet
BC_Out	Outflow	Downstream of Environmental Dam
BC_East_Out	Outflow	Bath Creek (East) outlet

5.5 Adopted Mannings 'n' values

The TUFLOW model uses Manning's 'n' values to represent the hydraulic resistance to overland flow of different ground surface, land use and vegetation types. These inhibitors to overland flow were determined using the available topographic information and aerial imagery.

Table 5.2 – Adopted hydraulic resistance coefficients

Material number	Manning's 'n'	Description
1	0.035	Active channel with light vegetation
2	0.08	Dense vegetation
3	0.06	Medium vegetation
4	0.045	Light vegetation / grass
5	0.025	Exposed dirt/unsealed road
6	0.02	Roads
7	0.02	Water body / dam
8	0.025	Bed channel
9	0.1	Forest
10	0.12	Dense forest
11	0.1	Urban residential
12	0.4	Building structure

5.6 Hydraulic structure

Figure 5.1 shows the locations of key hydraulic structures included in the TUFLOW model. Details of the hydraulic structures are based on information and photographs from (Alluvium, 2019) along with the available topographic information and aerial imagery.

The modelled culverts were represented as 1D structures in the model. Table 5.3 shows the details adopted for the culverts in the TUFLOW model.

Table 5.3 – Adopted hydraulic resistance coefficients

ID	Location	Type	Width or Diameter (m)	Height (m)	No. of barrels	Manning's 'n'	Losses (Entrance/Exit)
I	Breaker Creek	Rectangular	0.5	1	2	0.013	0.5/1
G	Breaker Creek	Rectangular	1	1	14	0.013	0.2/1
Northern Culvert	EDD local inflow	Circular	1.8		5	0.013	0.2/1
Crossing culvert	EDD	Circular	4		1	0.013	0.7/1
Conveyor opening2	EDD	Rectangular	1	6	1	0.013	0.7/1
Conveyor opening	EDD	Rectangular	1	6	1	0.013	0.7/1
Back access crossing culverts	EDD	Circular	4.5		2	0.013	0.7/1
Bath Creek culverts	Unnamed tributary (Bath Creek)	Circular	1.8		15	0.013	0.2/1
C	Unnamed tributary (Bath Creek)	Circular	1		2	0.013	0.9/1
Ti Tree culverts	Ti Tree Creek	Circular	1.8		6	0.013	0.2/1
F	Ti Tree Creek	Circular	1.5		2	0.013	0.9/1
E	Blair Athol Mine Rd	Rectangular	1	1	4	0.013	0.4/1
B	WDD outlet	Rectangular	2	1.2	17	0.013	0.4/1
22*	Railway (south of Ti Tree Creek)	Circular	1.8		6	0.013	0.2/1

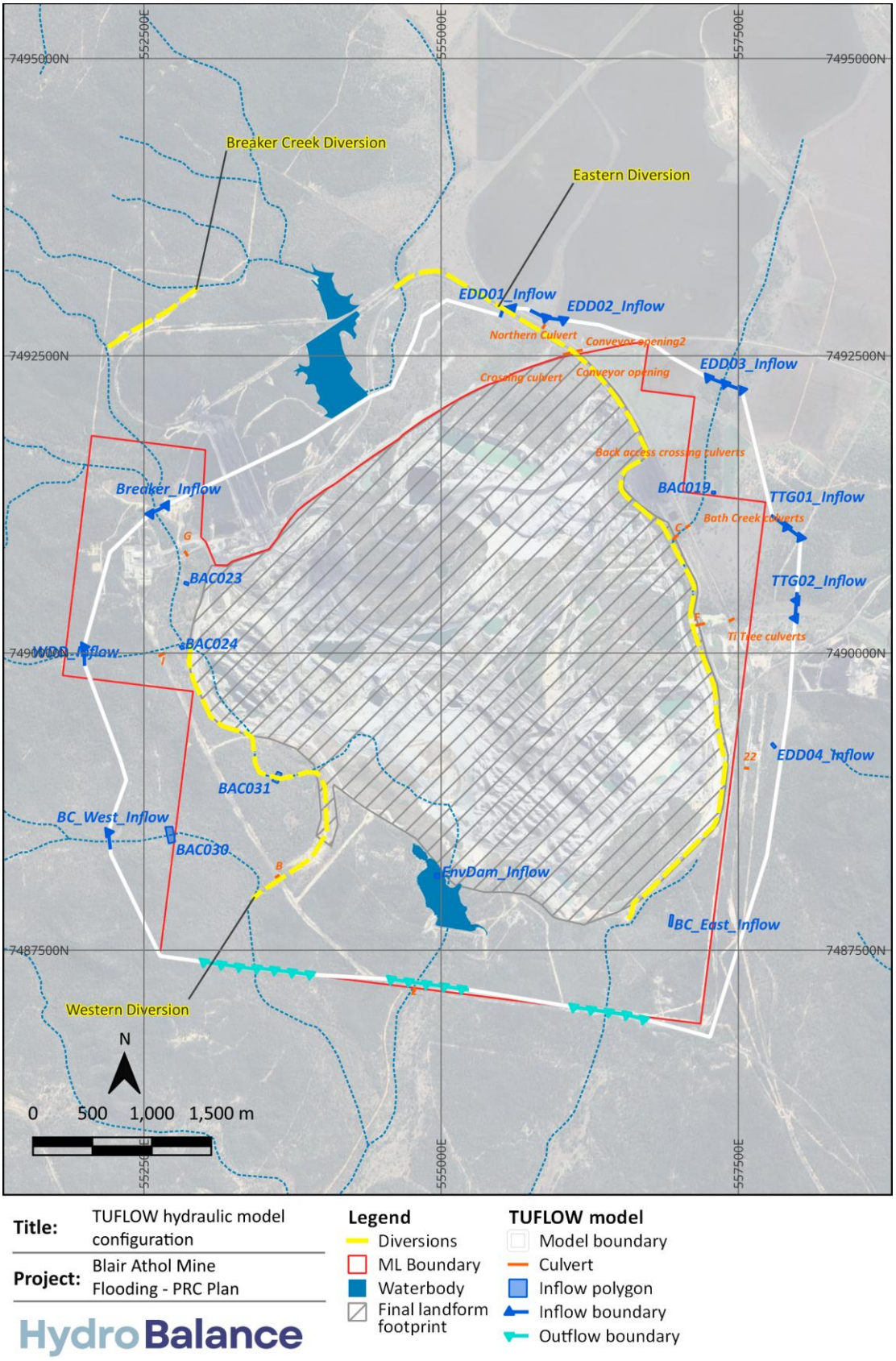


Figure 5.1 – TUFLOW hydraulic model configuration

6 Hydraulic model results

Figure 6.1 shows the TUFLOW model predicted 0.1% AEP peak flood depths and extents in the vicinity of the Mine under the assumed post-mining conditions. Figure 6.2 shows the corresponding peak velocities.

Appendix A shows the TUFLOW model predicted PMF peak depths and extents, as well as peak velocities in the vicinity of the Mine under the assumed post-mining conditions.

In general, the following is of note:

- The final landform at the Mine will not interact with any 'relevant watercourse' as per the DETSI (2020) definition, as discussed in Section **Error! Reference source not found.**. On this basis, the B AC final void is not considered to be within a flood plain of a 'relevant watercourse'. It is noted that lower ordered streams also require assessment against the decision criteria in the EP Act, which is undertaken in this section of the report.
- The diversions will convey the 0.1% AEP flood event, without overtopping into the final landform.
- Flooding in the vicinity of the Mine is generally channelized within the diversions, characterised by deeper flows, particularly in the narrow sections of the diversions.
- Flood velocities are naturally high in streams downstream of the mine due to the stream topography.
- The proposed final landforms will not significantly modify stream catchments downstream of the mine. Hence, the risk of the final landform contributing to flooding or erosion in the downstream environment is low.

The following is of note for the 0.1% AEP event:

- Flood flows in the vicinity of the final landform would generally be contained within the EDD and WDD diversions.
- Peak flows in the EDD are not expected to significantly break out onto the left overbank.
- Flood depths:
    - Predicted peak depth in the EDD would exceed 4.5 m, adjacent to the diversion levee. Ponding was also observed at the confluence between the diversion and Ti Tree Gully, reaching up to 3.4 m.
    - Peak flows in the WDD would break out onto the right overbank at a number of locations along the drain, into the natural floodplain.
    - Predicted peak depths in the WDD are generally much lower, compared to EDD, reaching up to 2.2 m. This is due to the better defined low flow and high flow channels within the WDD.
- Flood velocities:
    - Peak velocities in the EDD very along the length of the diversion:
        - Upstream reach: may reach up to 4.0 m/s. This section is primarily formed by blasted basalt and is therefore expected to be stable despite the high velocities.
        - Downstream reach: velocities are generally at or below 2 m/s with some localised spikes greater than 3 m/s. The EDD rehabilitation plan will be implemented prior to closure which is expected to reduce velocities and improve the stability of this section.
    - Peak velocities in the WDD generally remain below 1.4 m/s and there is expected to be stable, provided that vegetation is established throughout the diversion.

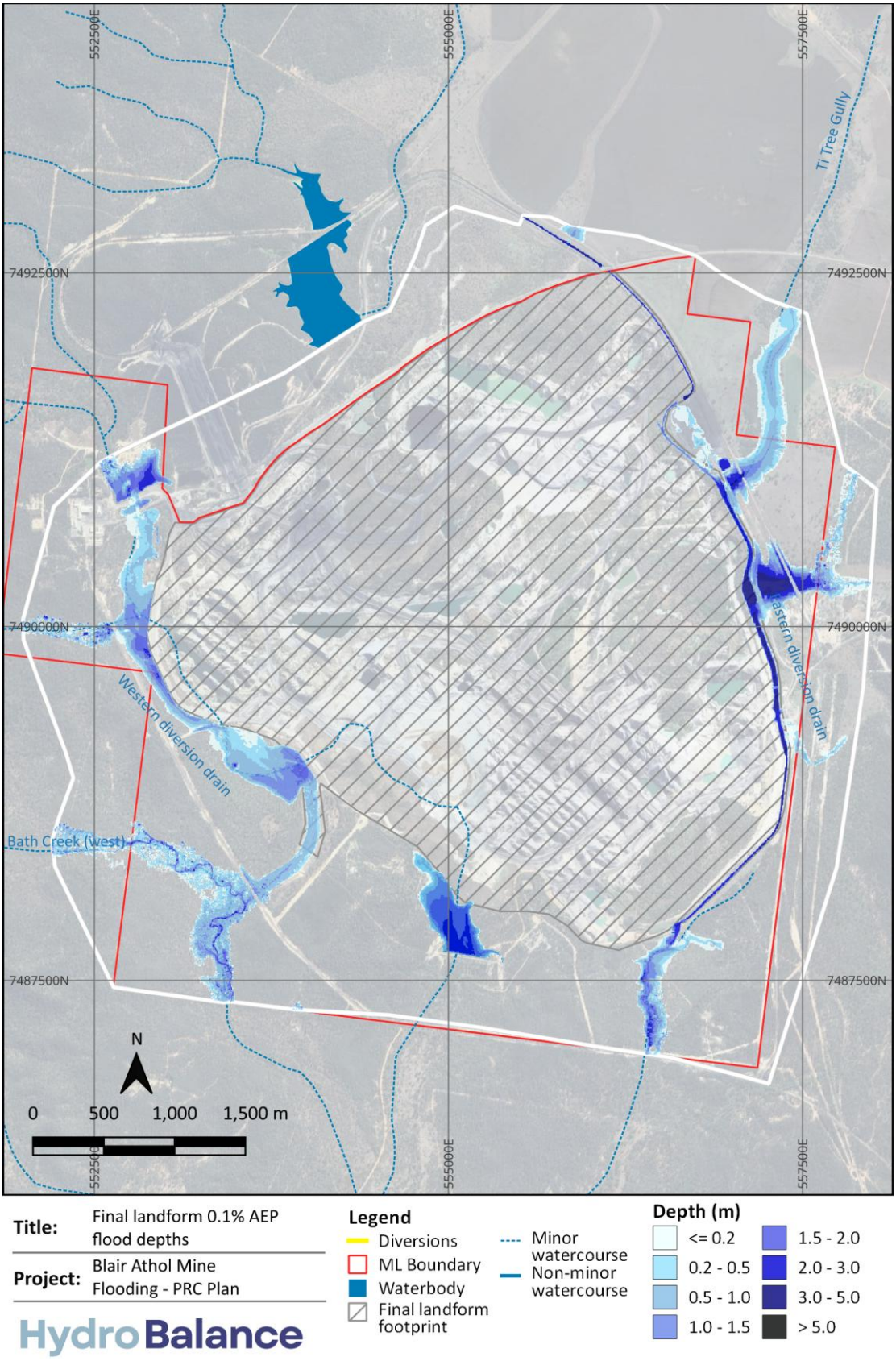


Figure 6.1 – Final landform flood depths and extents, 0.1% (1 in 1,000) AEP

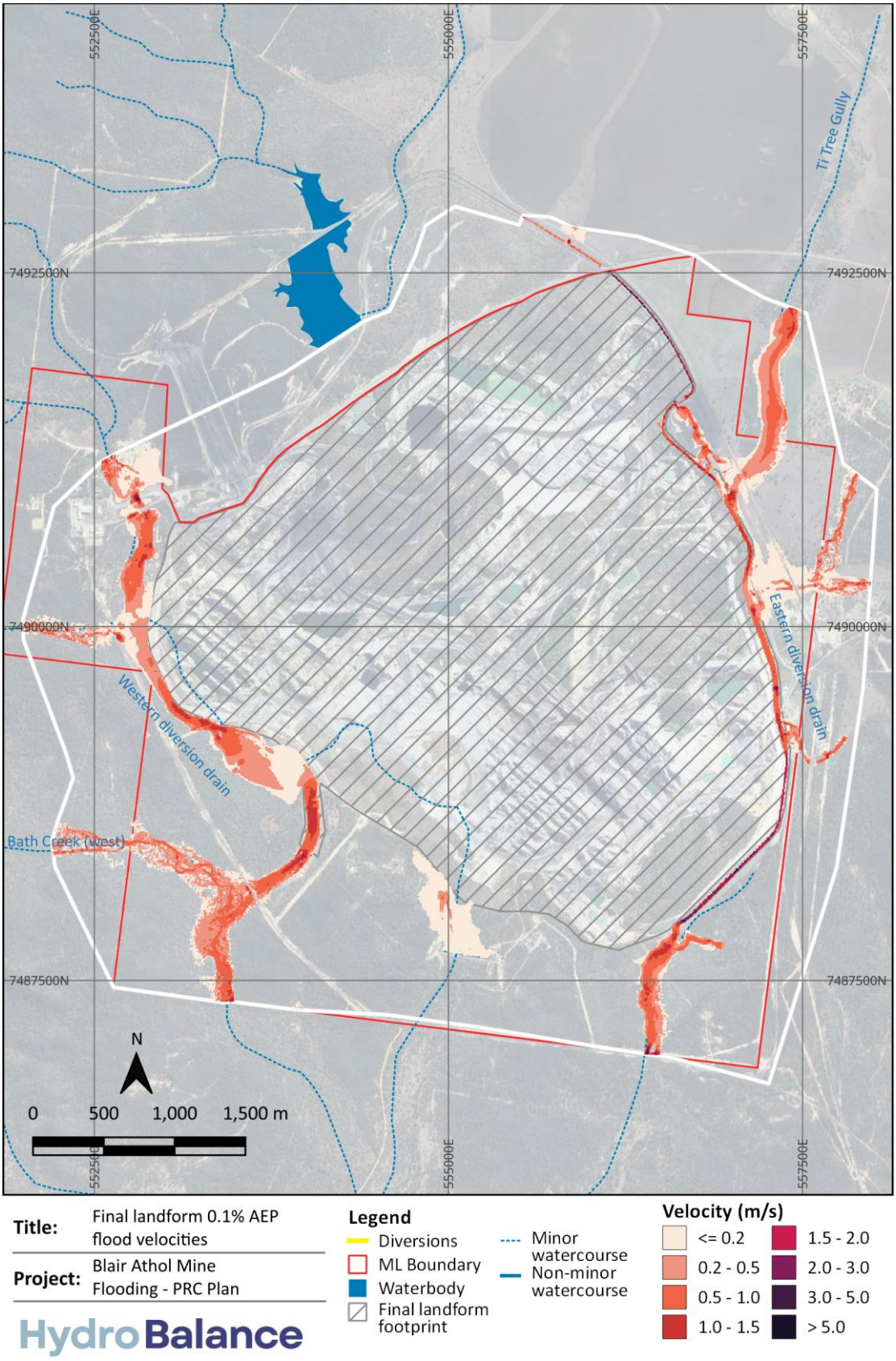


Figure 6.2 – Final landform flood velocity, 0.1% (1 in 1,000) AEP

7 Summary of findings

Hydrologic and hydraulic modelling has been undertaken for Blair Athol Coal Mine to assess the flooding characteristics for the 0.1% AEP design flood event as well as the PMF as per the DETSI (2019; 2020) requirements.

The proposed final landform will not significantly modify stream catchments and flooding behaviour downstream of the mine. The WDD and EDD drains have sufficient capacity to contain the 0.1% AEP flood event, therefore the risk of flood ingress into the final landform is very low. Hence, the risk of the final landform contributing to flooding or erosion in the downstream environment is low and final landform stability will not be impacted from a flooding perspective. The following is of note:

- BAC is not located within the flood extent of a “relevant watercourse” as defined by DES (2019). Notwithstanding this, the EDD and WDD drains are sufficient to prevent the ingress of floodwaters into the final landform.
- Flooding in the vicinity of the Mine is characterized by channelised flows within the EDD and WDD drains, with some overbank flows along the WDD. Flows are generally deep and exhibit high velocities, particularly in the confined sections along the EDD. It is recommended the planned rehabilitation works in EDD are undertaken prior to closure.

8 References

Alluvium, 2019 — *MODELLING AND ASSESSMENT REPORT: Blair Athol Mine Flood Modelling*, Alluvium, August 2019.

Alluvium, 2024a — *Western Waterway Diversion (Breaker Creek) Operations Monitoring – Blair Athol Mine,* Alluvium, September 2024

Alluvium, 2024b — *Eastern Waterway Diversions Operations Monitoring – Blair Athol Mine,* Alluvium, September 2024

Ball et al., 2019 — Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia (Geoscience Australia), 2019.

BOM, 2003 — *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method*, Commonwealth Bureau of Meteorology, Hydrometeorological Advisory Service, June 2003.

BoM, 2016 — *2016 Rainfall IFD Data System*, Bureau of Meteorology

< http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016 >.

BMT, 2019 — BMT Pty Ltd 2019, *TUFLOW User Manual – GIS Based 1D/2D Hydrodynamic Modelling*, Brisbane QLD.

DES, 2019 — Queensland Government Department of Environment and Science, November 2019, *Guideline – Progressive rehabilitation and closure plans (PRC plans)*.

DES, 2020 — Queensland Government Department of Environment and Science, March 2020, *Information sheet – Voids in floodplains*.

ELVIS, 2020 — *ELVIS - Elevation and Depth - Foundation Spatial Data*, Version: 0.6.5, ICSM Anzlic Committee on Surveying & Mapping, obtained on 26 August 2020,

< https://elevation.fsdf.org.au/ >.

Innovyze, 2018 — *XP-Software, 2018,* Innovyze Pty Ltd.

QUDM, 2017 — *Queensland Urban Drainage Manual*, fourth edition, IPWEA Institute of Public Works Engineering Australasia, 2017.

WMIP, 2023 — *Queensland Governmen:t Water Monitoring Information Portal*, <https://water-monitoring.information.qld.gov.au/>

Appendix A. PMF final landform flooding results

Figure A.1 shows the TUFLOW model predicted PMF peak flood depths and extents in the vicinity of the Mine under the assumed post-mining conditions. Figure A.2 shows the corresponding peak velocities.

The following is of note:

- The PMF may overtop the EDD levee in the final landform surface by up to 0.5 m. The EDD levee was artificially raised in the TUFLOW model to prevent overtopping and gain a conservative estimate of depths and velocities in the remainder of the diversion.
- The PMF would be contained within the WDD without overtopping into the void.
- Peak depths would be increased in EDD and WDD, generally by around 1-3 m.
- Peak velocities would be increased in EDD and WDD, generally by around 0.2-1.0 m/s.

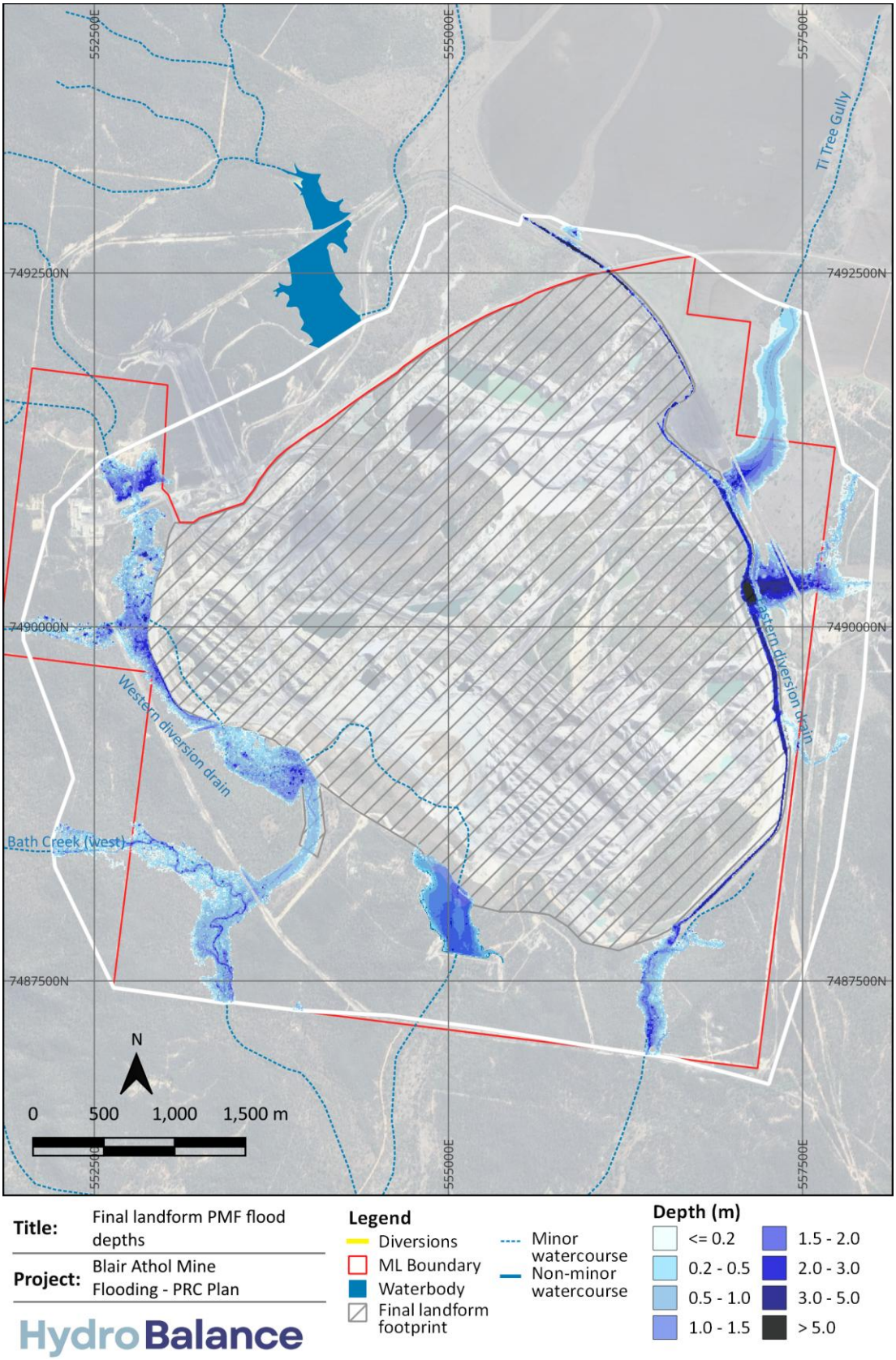


Figure A.1 - Final landform flood depths and extents, PMF

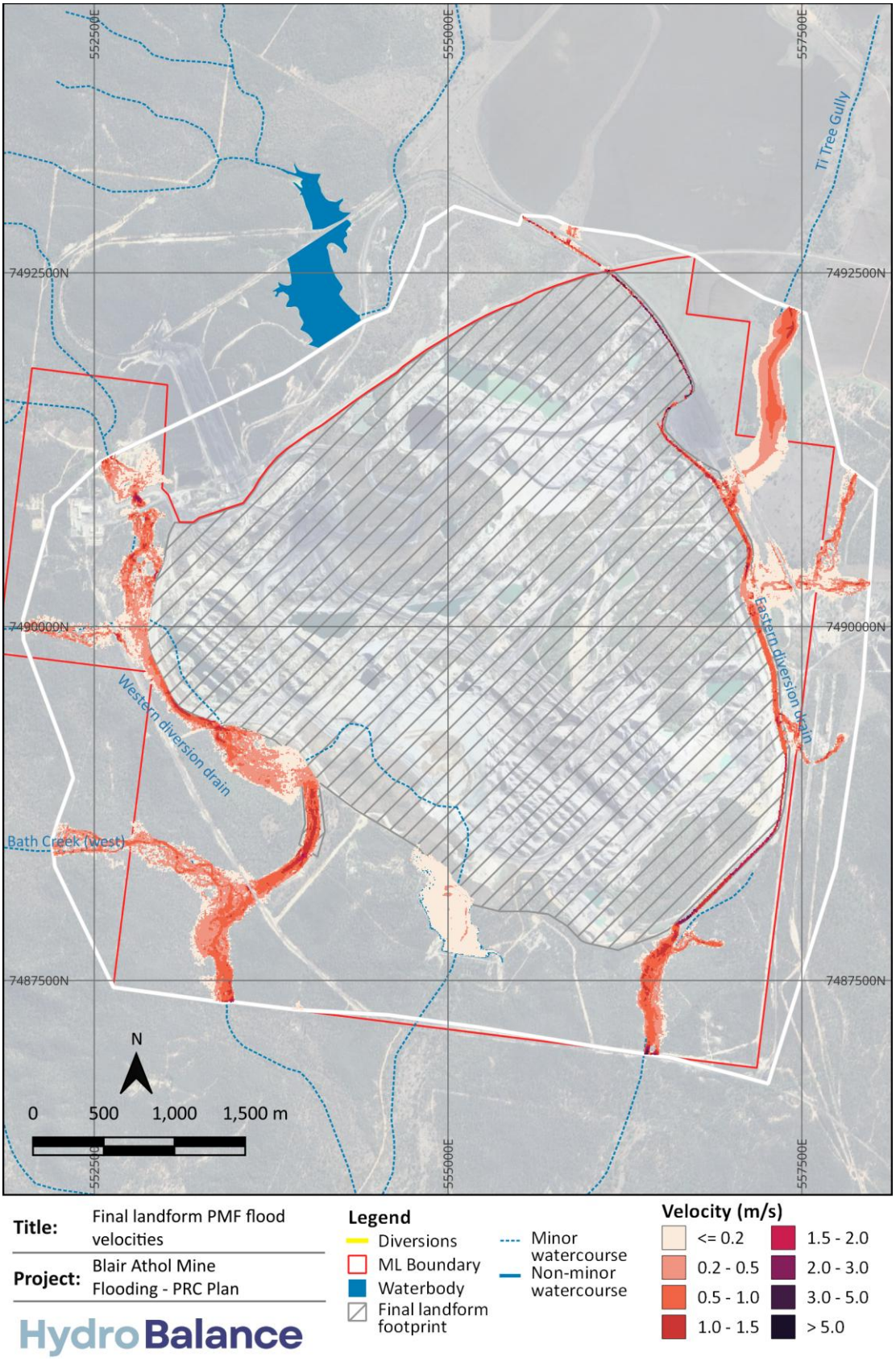
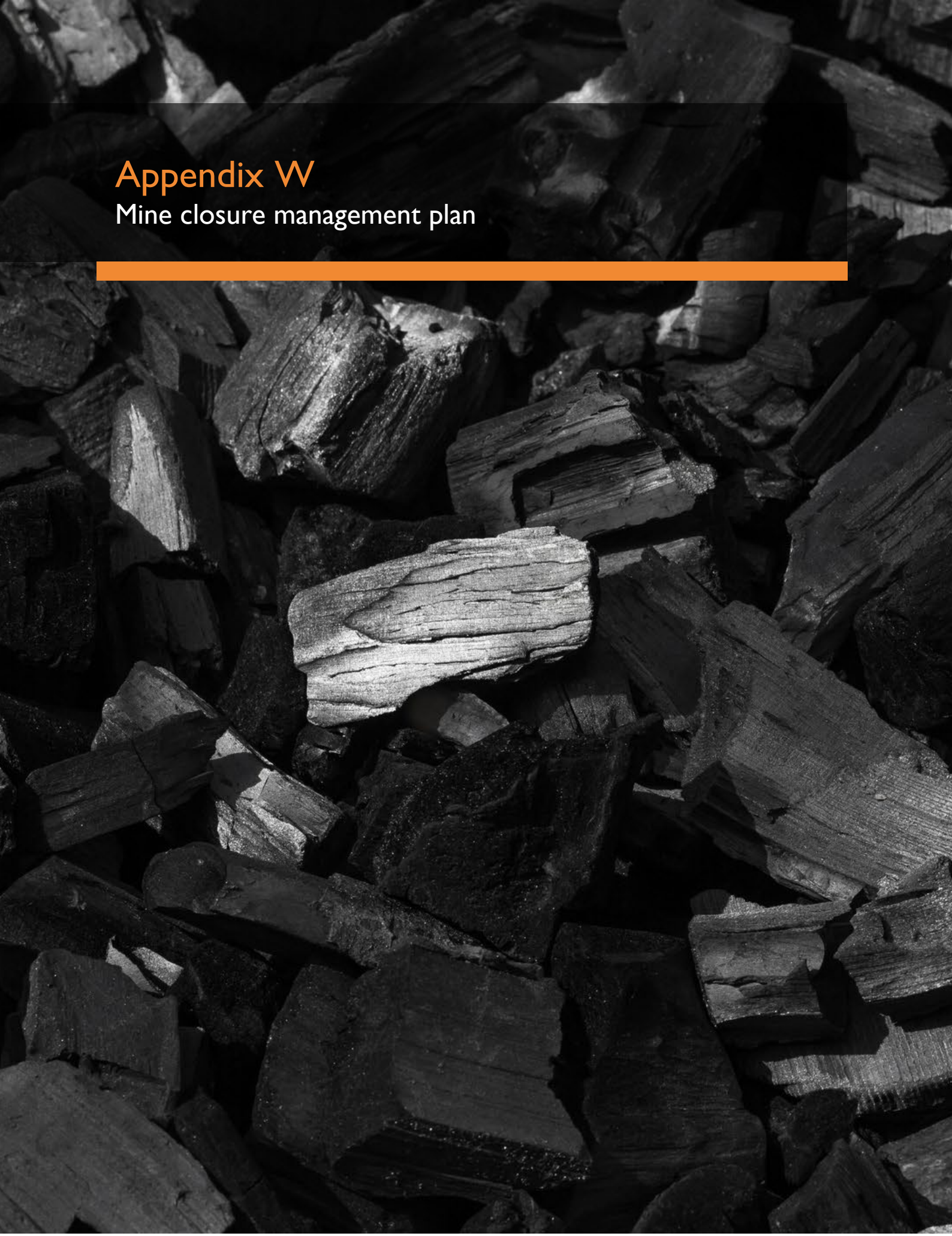


Figure A.2 - Final landform flood velocity, PMF



Appendix W

Mine closure management plan

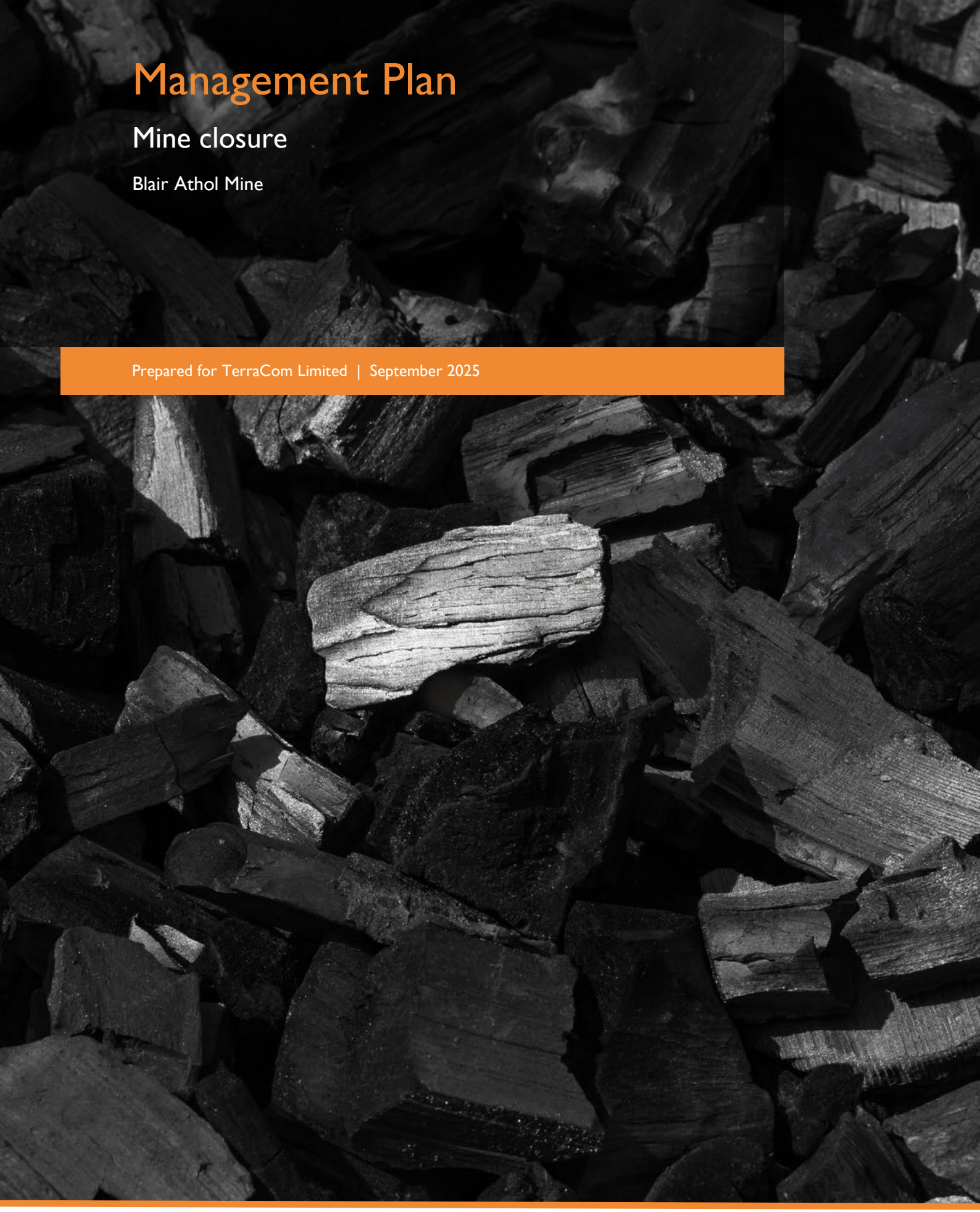
This page is intentionally blank.

Management Plan

Mine closure

Blair Athol Mine

Prepared for TerraCom Limited | September 2025



TERRACOM

SGMenvironmental

This page is intentionally blank

Management Plan

Mine closure

Blair Athol Mine

Prepared for TerraCom Limited | 16 September 2025

Project number:	18014
Document title:	Management Plan | Mine closure
Revision:	V4-1
Date:	16 September 2025
Client:	TerraCom Limited
Project manager:	T Rohde
Author:	C Brownbill / T Rohde

Legal Name:	SGME Pty Limited		
Address:	PO Box 5622, Stafford Heights, Qld 4053		
ACN:	621 989 866	ABN:	65 621 989 866
Representative:	T Rohde	Phone:	+61 7 3148 6288
Email:	trohde@sgme.au		



Honest | Trust | Innovation | Safety

This Report is provided to you the abovenamed Client (Client, you or your) in respect of the above Project and in accordance with our Standard Terms. Capitalised terms that are not specifically defined in this Report have the meanings given to them in our Standard Terms.

© Copyright 2025 SGME Pty Limited. The concepts and information contained in this document are the property of SGME Pty Limited. Use or copying of this document in whole or in part without the written permission of SGME Pty Limited constitutes an infringement of copyright.

Data / confidentiality: This report contains information and data that is confidential and / or subject to restrictions in respect of Intellectual Property Rights (IP). Readers agree to be bound by confidentiality and IP provisions contained in our Standard Terms and the obligation not to cause any damage or hardship to SGM Environmental Pty Limited or the Client.

Document history and status

Revision	Date	Description	By	Review	Approved
V0-1	21/05/18	Draft	T Rohde	TerraCom	T Rohde
V3-1	29/10/20	Final	J Vohland	TerraCom	T Rohde
V4-1	16/09/25	Resubmission	C Brownbill	TerraCom	T Rohde

Table of contents

1.0 Introduction 9
1.1 Context and purpose 9
1.2 Scope 9
1.2.1 Inclusions 9
1.2.2 Framework and report structure 9
1.3 Objectives 10
2.0 Rehabilitation goals and objectives 11
2.1 Goals 11
2.2 Objectives 11
3.0 Final land use closure strategy 13
3.1 Rehabilitation area domains 13
3.2 Final land use 15
3.3 Further studies 17
3.3.1 Water quality criteria 17
3.3.2 Void water balance modelling 17
3.3.3 Flood modelling 17
3.4 Closure strategy 18
3.4.1 Earth structures 18
3.4.2 Voids 18
3.4.3 Facilities and structures 19
3.4.4 Flood and sediment control structures 20
3.4.5 Roads 20
3.4.6 Groundwater infrastructure 21
3.4.7 Structural pads 21
3.4.8 Exploration disturbance 21
3.4.9 Rehabilitated earth structures and undisturbed land 21
3.4.10 Progressive rehabilitation 22
3.4.11 Surrender of ML 22
4.0 Rehabilitation requirements 24
4.1 Rehabilitation milestone and strategies 24
4.2 Reporting and monitoring 24
5.0 Risk assessment 31
5.1 Objectives 31
5.2 Method 31
5.2.1 Framework for assessment 31
5.2.2 Assessment of risk 31
6.0 Reporting and monitoring 42
6.1 Post-mine monitoring 42

6.1.1 Spontaneous combustion and bushfire 42
6.1.2 Surface water quality 42
6.1.3 Groundwater quality 44
6.1.4 Diversions 46
6.1.5 Geotechnical 46
6.1.6 Vegetation monitoring and soil testing 46
7.0 Closure action plan 47
7.1 Progressive rehabilitation 47
7.2 Demolition and decommissioning 47
7.2.1 Scrap and salvage items 47
7.3 Environmental management 48
7.3.1 Soil stockpiling and application 48
7.3.2 Erosion and sediment control 49
7.3.3 Surface water management 49
7.3.4 Groundwater management 49
7.3.5 Contamination management 49
7.3.6 Revegetation 49
7.3.7 Heritage 50
7.4 Health and safety 50
7.5 Landform establishment 50
7.6 Geotechnical assessment 50
7.7 Rehabilitation maintenance 51
References 52

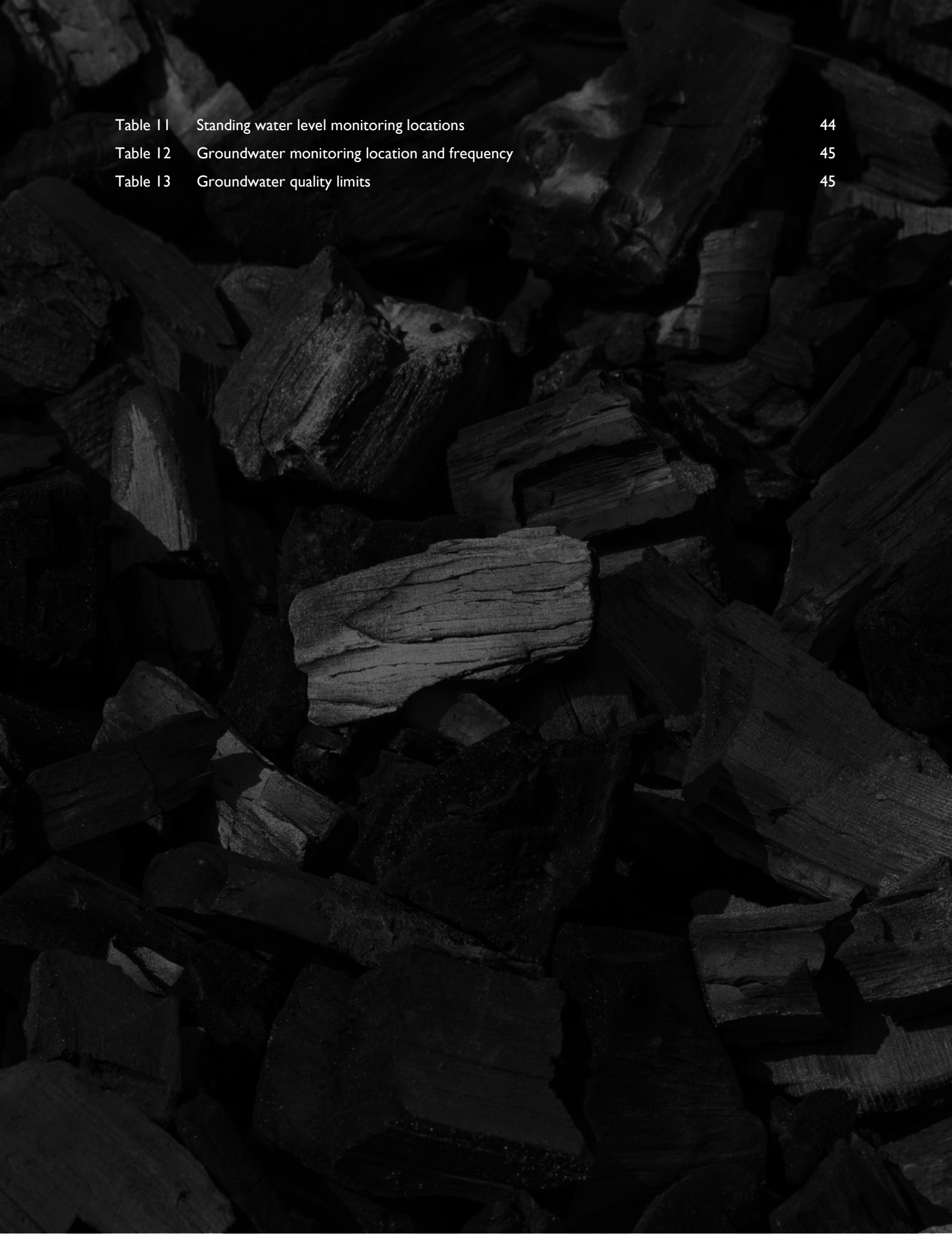
Figure

Figure 1 Rehabilitation area domains post closure 14
Figure 2 Final land uses 16
Figure 3 Waste and resource management hierarchy 48

Table

Table 1 Continuum of objectives 12
Table 2 Progressive rehabilitation area domains 13
Table 3 Summary of final land uses 15
Table 4 Summary of proposed progressive rehabilitation area domains and completion dates 23
Table 5 Rehabilitation milestones and milestone criteria 25
Table 6 Management milestones and milestone criteria 30
Table 7 Risk matrix 32
Table 8 Likelihood ratings and descriptions 32
Table 9 Risk assessment and treatment plan for land with a PMLU not achieving stable condition 33
Table 10 Laboratory parameters for surface water quality 43

Table 11	Standing water level monitoring locations	44
Table 12	Groundwater monitoring location and frequency	45
Table 13	Groundwater quality limits	45



Important note about your report

This Report is provided for the exclusive use of the Client pursuant to the Scope of Works 16 October 2020, which requires us to provide Services relating to preparing a mine closure management plan.

This Report is provided to the Client on the terms and conditions set out in the Standard Terms of SGME Pty Limited (SGME, we, us or our).

We derive data in this Report from information (or confirmation of the absence thereof) sourced from the Client and their subconsultants, designated laboratories and / or information that has been made available in the public domain at the time or times outlined in this Report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the mine closure management plan and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this Report.

SGME has prepared this Report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to any applicable standards, guidelines, procedures and practices outlined in the Scope of Works as at the date of issue of this Report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this Report, to the extent permitted by law.

This Report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by SGME for use of any part of this Report in any other context.

Reporting of the mine closure management plan are based on a desktop assessment of data that has been measured by the Client and their subconsultants and other third parties.

SGME does not accept any Liability whatsoever for, or in respect of, any use of, or reliance upon this Report by any person contrary to the above or our Standard Terms.

1.0 Introduction

1.1 Context and purpose

The Blair Athol Mine (the mine), approved under mining lease (ML)1804 and environmental authority (EA) EMPL 00876713, is owned and operated by Orion Mining Pty Ltd, wholly owned by TerraCom Limited (TerraCom). TerraCom took over ownership in May 2017 and recommissioning activities commences immediately.

The mine is located in Clermont, Central Queensland, approximately 14 kilometres (km) north-west of Clermont, 110 km north-west of Emerald, 320 km south-west of Point Abbot and 240 km south-west of Hay Point.

The mine is located within the Blair Athol Basin, which covers approximately 25 square kilometres (km^2). The surrounding land use at the mine includes state forest, grazing and limited cropping. Blair Athol State Forest adjoins the east, south and west sides of the ML.

The purpose of this *Mine Closure Management Plan* (the plan) is to describe the systems, processes and procedures used at the operation to decommission and rehabilitate affected land (the closure strategy) for the benefit of communities and to minimise environmental risks to the rehabilitated land and the receiving environment.

1.2 Scope

1.2.1 Inclusions

This plan has been prepared to formalise the proposed closure activities, including decommissioning and rehabilitation that are being undertaken — as well as those yet to be done at the mine. This plan is based on a review of documentation provided by TerraCom related to closure planning at the mine. This plan includes:

- gap analysis of areas identified as requiring further consideration or action;
- obligations including statutory and legal;
- alternative land use options; and
- risk assessment of inherent and residual risks to closure.

This plan covers all land within ML1804.

1.2.2 Framework and report structure

This plan has been prepared using a risk-based approach. The objective of a risk-based approach is to reduce both cost and uncertainty of mine closure. The analysis of risk is based on a review of legislation, leading practice standards and obligations and available literature. The risk assessment (Section 4.0) has been used to determine the most effective strategies to close the various operational domains of the mine (Section 3.0) to create a safe, stable, sustainable and non-polluting post-mining land use.

This plan proposes six simple closure risk topics that describe potential root causes of failure in mine closure activities, namely:

- climate and air quality;
- human factors;
- surface and groundwater;
- ecology;
- underlying materials; and
- landform constructability.

The risk categories are used throughout the plan so that the risks listed in Section 4.0 (Risk assessment) are intuitive to the reader.

1.3 Objectives

This plan has been designed and developed to provide a framework for the closure (including decommissioning) and rehabilitation of the mine.

The objective of this plan is to lay the foundation for the establishment of a set of clear indicators that demonstrate the successful completion of the closure process and tasks.

2.0 Rehabilitation goals and objectives

2.1 Goals

The general rehabilitation goals identified by the *Progressive Rehabilitation and Closure Plan* (PRC plan) guidelines (*ESR2019/4964*) include:

- the mine will be safe to humans, livestock and fauna;
- disturbed land will be rehabilitated so that it is non-polluting; and
- rehabilitation will aim to create a landform that is stable and conducive to the post-mining land use.

The nominated post-mining land use goals for the mine are to:

- implement successful design and rehabilitation to ensure the landform is stable and safe to humans, livestock and fauna;
- ensure design and rehabilitation is non-polluting;
- ensure rehabilitation and revegetation is self--sustaining; and
- ensure that disturbed land is generally returned to one of the following land uses:
- grassland rehabilitated area, noting that some old rehabilitation areas have trees on them, these areas are still considered grassland;
- undisturbed woodland;
- native ecosystem (disturbed areas located on State Forest Land); or
- voids (open-pits that are no longer mined and will not be backfilled).

2.2 Objectives

TerraCom intends to return most of the disturbed area to grazing which is consistent with the *Environmental Protection Act 1994* (EP Act) and EA conditions regarding rehabilitation. For areas disturbed by the mine the following overarching objectives will apply:

- the landform will be safe to humans, livestock and fauna in the foreseeable future;
- rehabilitation will aim to create a landform that is stable and conducive to the post-mining land use, unless an alternative next use is pre-determined and agreed;
- mineral waste and disturbed land will be rehabilitated so that they are non-polluting and self-sustaining or to a condition where the maintenance requirements are consistent with the next land use;
- surface water leaving the landform will not be degraded to levels that cause environmental harm, i.e. current and future water quality will be maintained at levels that are acceptable for users downstream of the mine and does not cause environmental harm; and
- rehabilitation will be completed to a standard that is conducive to the post-mine land use.

It is important that this plan recognises the limits of how the described overarching objectives can be applied. Table 1 outlines how the objectives will be achieved in the short, medium and long term.

Table 1 Continuum of objectives

Short term objectives
Progressively reshape and stabilise disturbed areas
Provide ongoing maintenance of rehabilitated areas including erosion control measures
Manage soil to ensure suitability and beneficial reuse
Obtain stakeholder acceptance of proposed land use and criteria
Ameliorate soils as necessary to address physical and chemical constraints to revegetation and erosion stability
Refine rehabilitation methods through continuing review and update of this plan
Medium term objectives
Demonstrate rehabilitation success (or refine as necessary by adapting practices) in comparison with reference sites
Reduce reliance on structural drainage and erosion control methods through landform design and construction that lends itself to the surrounding undisturbed drainage
Long-term objectives
Demonstrate rehabilitation performance against agreed criteria
Relinquish the ML

3.0 Final land use closure strategy

3.1 Rehabilitation area domains

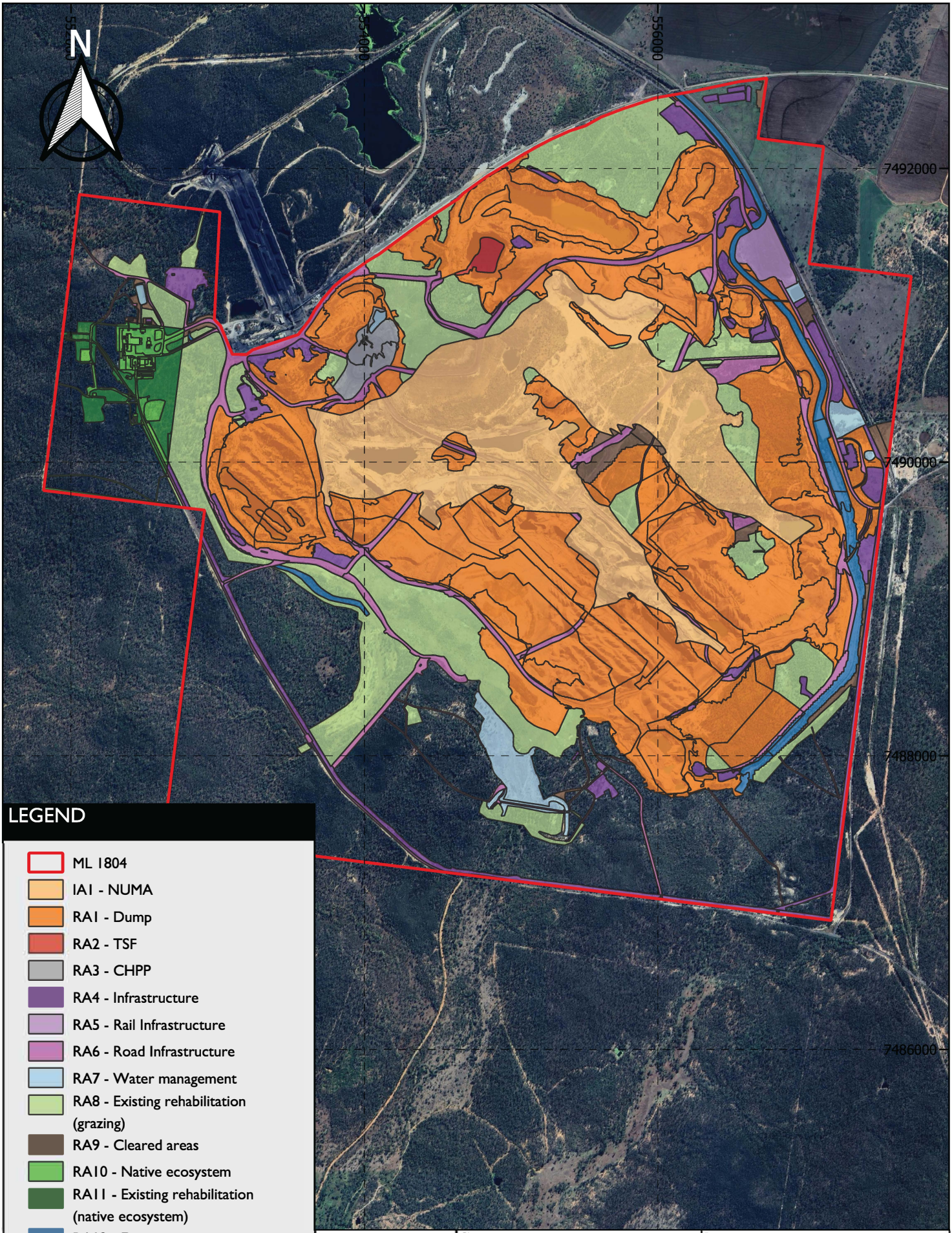
Operational domains are defined based on land management units within the ML, usually with unique operational and functional purpose and therefore similar geophysical characteristics. Sub domains are used to provide further delineation of geophysical characteristics within operational domains.

Figure 1 shows the distribution of the rehabilitation area domains for the mine.

Table 2 summarises the progressive rehabilitation area domains within the ML.

Table 2 Progressive rehabilitation area domains

Rehabilitation area	Relevant activity / domain	Approximate area (ha)
1A1	Residual Void	291.6
RA1	Dump	735.75
RA2	TSF	3.97
RA3	CHPP	12.87
RA4	Infrastructure	73.15
RA5	Rail infrastructure	11.21
RA6	Road infrastructure	104
RA7	Water management	27.08
RA8	Existing rehabilitation (grazing)	289.01
RA9	Cleared area	21.03
RA10	Native ecosystems	20.7
RA11	Existing rehabilitation (native ecosystem)	20.89
RA12	Diversions	34.88
Total		**1,646.14**



LEGEND

- ML 1804
- IA1 - NUMA
- RA1 - Dump
- RA2 - TSF
- RA3 - CHPP
- RA4 - Infrastructure
- RA5 - Rail Infrastructure
- RA6 - Road Infrastructure
- RA7 - Water management
- RA8 - Existing rehabilitation (grazing)
- RA9 - Cleared areas
- RA10 - Native ecosystem
- RA11 - Existing rehabilitation (native ecosystem)
- RA12 - Diversions

Scale 1 : 17 500

0 0.5 1 km

SGME

Client: TerraCom Limited		Project: Mine closure management plan	
Design: SGME Pty Limited 2.09.2025 Scale: 1 : 17,500 CRS: GDA2020		Title: Rehabilitation areas	Figure: 1

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

3.2 Final land use

Mining is a temporary use of land. Upon closure, TCL aims to return all disturbed areas, other than the void, to a PMLU of either grazing or native ecosystem. Rehabilitation will be done in a manner which is consistent with the PRC plan guidelines (*ESR2019/4964*) and EA conditions regarding rehabilitation, ie Conditions F3-F9. The basic strategy for how this will be achieved is described in Section 3.4.

There will be areas of the disturbance footprint, ie voids, where rehabilitation will not be possible, and an alternate land use has been considered.

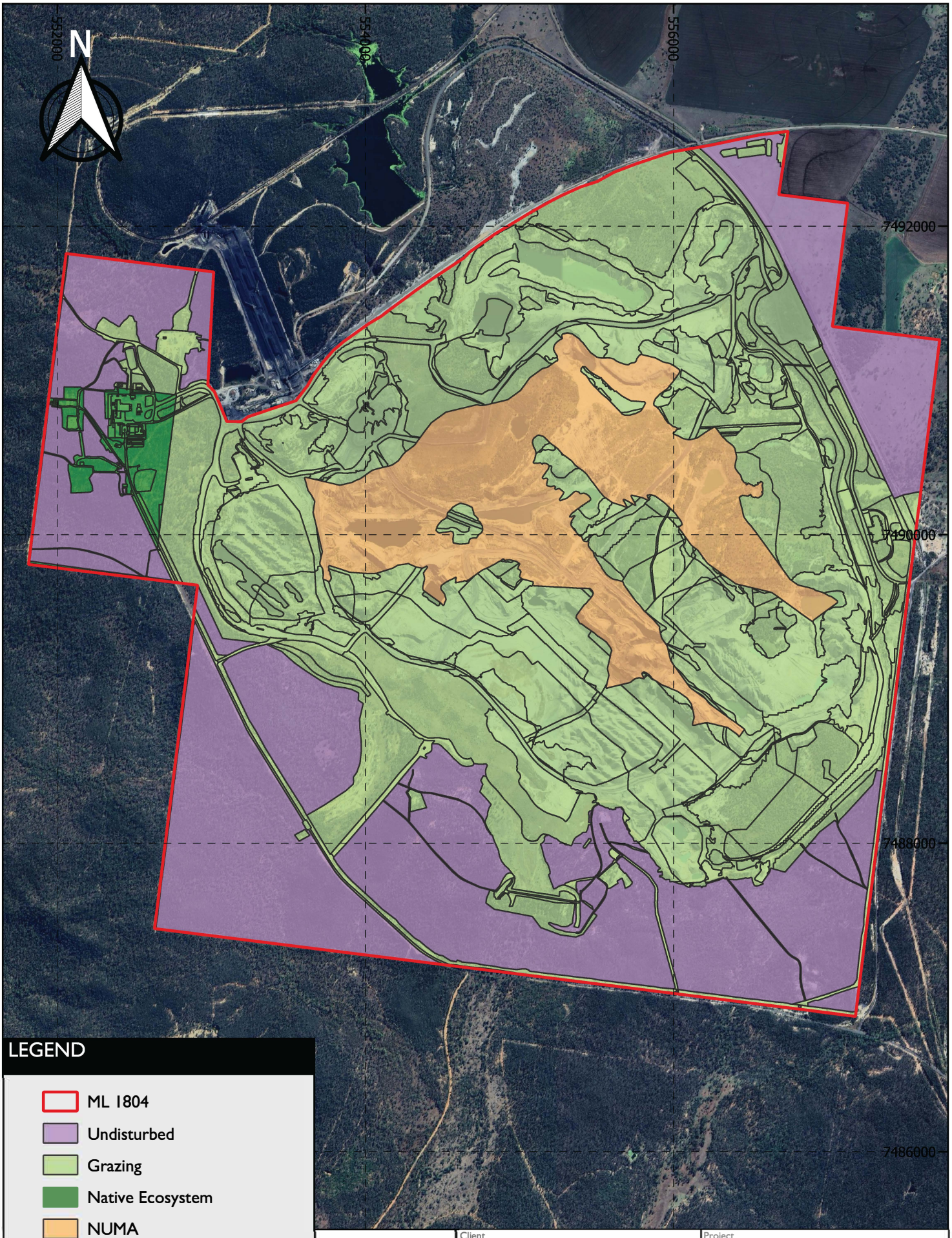
Overall, the final proposed land uses for the mine include:

- grazing;
- native ecosystem (State Forest Land); and
- voids.

The landscape will however be dominated by grazing. Table 3 summarises the area for each proposed final land use, with locations provided in Figure 2.

Table 3 Summary of final land uses

Final land use	Rehabilitation area	Approximate area (ha)
Grazing	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9, RA12	1308.45
Native ecosystem	RA10, RA11	41.59
Voids	1A1	296.1



LEGEND

- ML 1804
- Undisturbed
- Grazing
- Native Ecosystem
- NUMA

Scale 1 : 17 500

0 0.5 1 km

	Client: TerraCom Limited	Project: Mine closure management plan	
	Design: SGME Pty Limited 2.09.2025 Scale: 1 : 17,500 CRS: GDA2020	Title: Final land use	Figure: 2

© SGM Environmental. While every care is taken to ensure the accuracy of this data, SGM Environmental makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability (including without limitaiton liability in negligence) for all expenses, losses, damages (including indirect consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete in any way and for any reason.

3.3 Further studies

Further studies will be conducted during the operational life of the mine which will inform the review and amendment of this plan.

3.3.1 Water quality criteria

The mine has a database of background monitoring samples spanning the duration of the mining operation from several water bodies (on-lease storage and creeks). This data will form the basis of further assessment which will be required to determine appropriate criteria for surface water:

- in the voids;
- water storages; and
- downstream receiving environment surface water monitoring location.

The void water balance modelling for the mine will require review to determine surface water criteria for voids as mining progresses.

3.3.2 Void water balance modelling

The void water balance model may require review to determine surface water criteria. It may also be required to determine if remnant coal in the open-pit walls will be exposed to oxygen and heat. This information is required to evaluate the combustion risk of the coal seams in the voids. If the coal seam in the voids are not inundated with water, they will be covered with a buttress of low-risk mineral waste.

3.3.3 Flood modelling

Flood modelling will be completed for the landform to make sure that voids are protected against inundation and that the landform is protected from erosion damage from flooding to an annual exceedance probability of 0.0003 (1 in 3,000 years). Most recent flood modelling has been completed in August 2025 (HydroBalance 2025).

3.4 Closure strategy

3.4.1 Earth structures

3.4.1.1 Spoil emplacement areas

Where landforms need to be constructed, they will be built by excavating, loading and hauling suitable materials for the landform (mineral waste) and cover (soil). The landform grade will be built by pushing with a dozer to a maximum slope angle of 15%. The mine has generally placed most of the medium-risk mineral waste low in the landform during operations. Notwithstanding, pockets of medium-risk mineral waste may be encountered during reshaping earthworks on historical disturbance.

The final land use of the domain will be biodiversity with a mix of woodland and grassland rehabilitation area and some riparian vegetation along the creek diversions.

3.4.1.2 ROM pad and soil stockpiles

All coal stockpiled on the ROM will be processed prior to executing the sub domain closure strategy.

The ROM area will have at least 300 millimetres (mm) of coal material removed from the surface and hauled to the spoil emplacement area. Remaining coal on the ROM pad will be encapsulated by low-risk mineral waste as part of rehabilitation. Once the coal has been encapsulated, the sub domain will be graded by dozer to a maximum 15% and natural drainage lines will be re-established. Slopes will be designed to drain along established contours created by the surface. The graded surface will be ripped to alleviate compaction and seeded to promote vegetation establishment.

3.4.2 Voids

The remaining voids may or may not be partially backfilled by mineral waste.

Any coal rejects emplacement areas within voids will be covered with a minimum of 5 metres (m) of spoil.

An abandonment bund will be constructed to prevent accidental access to the voids.

A risk assessment will be completed to determine the risk of intentional entry into the voids.

Land around the void perimeters has been cleared as part of the mine operations. Cleared land around the void perimeters will be rehabilitated by selectively spreading soil followed by grading and ripping to remove compaction followed by seeding.

3.4.2.1 Ramp 2 TSF and coal rejects emplacement area

Most of this domain has been covered with low-risk mineral waste. An assessment of the sub domain will be completed prior to closure to determine that the landform is table and can be rehabilitated.

3.4.2.2 Water storages

Water storages, where appropriate and self-filling, will be retained as a mine asset for future landowners if written agreement from the landowner is received. All other water containment facilities will be decommissioned and removed. Associated infrastructure will be removed as part of the demolition contractor works. Any contaminated material and silt within the facilities will be removed and hauled to the voids or to the earthen structures for encapsulation.

Water storage embankment batter slopes will be graded by dozer and shaped to establish drainage away from the toe of the embankments. Soil will be selectively placed over the embankment batters. Contour ripping, and seeding will be selectively completed.

3.4.3 Facilities and structures

3.4.3.1 Heavy industrial

The industrial infrastructure area includes facilities that are required to process coal and support coal handling:

- mine industrial area;
- mine offices, stores and workshop;
- explosives storage area;
- power reticulation;
- train load facility; and
- rail easement.

The closure strategy for this domain includes:

- removing demountable and moveable buildings off mine;
- disconnection, decommissioning, demolition and removal of all large plant items and equipment and infrastructure including but not limited to crushing plant screens, drives, generators, etc;
- removal of any buried services for scrap and recycling including electrical cabling, fluid piping including drained fuel lines and compressed air lines;
- demolition of building foundations, down to 1 m below ground level, and dispose of concrete rubble in the void following DES approval;
- general mine clean-up of contaminated soil which will be disposed of in void or encapsulated in the earthen structures; and
- rehabilitation of all heavy industrial footprints including storage areas and lay downs.

All approvals and permits for demolition will be completed by TerraCom prior to demolition work commencing. Demolition will be completed in accordance with the mine health, safety and environment policies and standards.

Any concrete rubble and steel that is not viable to be removed from the mine will be broken up and placed into the voids. Infrastructure steel, ie sheds and small buildings, will be broken down into a manageable size and removed from the mine for sale if viable. Failing this, scrap metal will also be placed in voids. Approval from DES will be required to place demolition material into the voids.

Fuel storage facilities and other storage tanks not owned by a third party, will be completely emptied of all hazardous materials and decontaminated prior to demolition. During demolition, the decontamination, treatment and disposal of hazardous waste materials will be completed as required and the *Waste Management Plan* will be updated accordingly.

All services including power, compressed air, and water to all buildings, plant and equipment and heavy infrastructure will be isolated and disconnected prior to any demolition works being commenced. Any additional services (power, water, compressed air, communications etc.) required by the demolition contractor will be supplied in isolation to the disconnected services.

The contamination survey will be updated at the end of demolition to determine if further clean-up is required. Remediation of contamination will be undertaken as required.

All disturbed footprints will be graded by dozer to re-establish natural drainage. Soil will be selectively placed (if required) over the footprints. This process will end in contour ripping and revegetation.

3.4.3.2 Light industrial

Light industrial includes:

- mine offices;
- power reticulation; and
- crib huts.

The light industrial infrastructure area consists of all remaining industrial features not included in the heavy industrial area.

All services including power, compressed air, water to buildings, plant and equipment and associated light infrastructure will be isolated and disconnected by suitably qualified personnel or contractors prior to demolition works. A phase 1 contamination investigation will be completed prior to the removal of light industrial infrastructure.

Mobile crib huts will be decommissioned and removed from the mine. Where buildings are unable to be moved, they will be demolished and removed from the mine or, if approval is granted, to the voids. An investigation has identified asbestos material in some buildings which may require removal prior to demolition.

All concrete paths and building foundations will be broken up using a dozer, following approval by DES, hauled to the voids. The office car park will have the bitumen material removed from its footprint which will be hauled to the voids for disposal.

All industrial facilities will require power disconnection prior to removal. Specifically, this will include the decommissioning and removing all switching substations, transformers, reticulation aerials, and powerlines back to the high voltage feeder (owned by power supplier).

Mine power requirements will decline during the closure period, meaning sufficient portable power will be needed. This will be installed and remain active during the closure period to maintain office and workshop operations.

All disturbed footprints will be graded by dozer to re-establish natural drainage. Soil will be selectively placed (if required) over the footprints. This process will end in contour ripping and revegetation.

3.4.4 Flood and sediment control structures

This domain covers the closure and rehabilitation of the creek diversions and drainage control structures including silt traps, and drains.

Creek diversions will remain in place; however, a riparian zone will be established along the sides to improve their ecological value.

Sediment and silt will be removed from silt traps and placed in the voids. A risk assessment will be completed prior to closure to determine what erosion and sediment control must remain in place.

3.4.5 Roads

Domain 5 includes haul roads and light vehicle access.

This domain includes the closure and rehabilitation of all mine access bitumen roads, and tracks.

Earthworks will include relieving compaction by ripping, grading, culvert removal (if any), soil haulage (and placement where required), and revegetation of road footprints.

The mine access road will be rehabilitated at the end of the post-closure monitoring period unless required for the future land owner's use.

Closure activities for the access road surface will include the following:

- removal of any culverts (if required) and road furnishings;
- ripping and scarifying of the sub-base including the bitumen surface in-situ (for burial);
- reshaping the footprint to establish drainage across the road;
- placing soil (sourced from reserves beside the roads and tracks) over the road surface; and
- light ripping followed by seeding.

3.4.6 Groundwater infrastructure

Groundwater infrastructure includes above ground pipelines, and monitoring wells.

Removal of above ground pipeline sections will be completed as necessary as part of the closure process.

Pipeline corridors will be rehabilitated as part of other works around the mine, including the haul roads where pipeline is located.

Monitoring wells will be decommissioned unless required by the future land owner. They will be decommissioned by removing the casing to 1.5 m below ground level and plugging, grouting and capping in accordance with *Minimum Construction Requirements for Water Bores in Australia* (Australian Government 2012). The area around the well or bore will be cleaned-up, graded, ripped and seeded as required.

3.4.7 Structural pads

Hardstand areas will be closed and rehabilitated along with lay down areas. Earthworks will include removal of any contaminated materials, ripping, grading and application of soil and seeding as required.

The clean-up and removal of any remnant infrastructure and scrap that may remain on the hard stand areas will be included in the closure process. The removal of this infrastructure and scrap will be undertaken as a part of the contract demolition works.

Any contaminated material and coal fines to a depth of 0.3 m below ground level will be dug up and removed. The hardstand areas will be graded by dozer so that they are free draining. Soil will be applied as necessary. Light contour ripping, and seeding will be done.

A phase 1 contaminated land investigation will be completed prior to hardstand rehabilitation. If contaminated soil is found, then it will be removed or remediated in-situ.

3.4.8 Exploration disturbance

The closure and rehabilitation of exploration activities including drill holes, sumps, exploration tracks, and gridlines will be undertaken. Any other exploration infrastructure will be closed appropriately. Where appropriate agreements are in place infrastructure may remain and be handed over to the responsible party, such as the land holder.

3.4.9 Rehabilitated earth structures and undisturbed land

An audit of rehabilitated land and undisturbed land will be undertaken to confirm that no rehabilitation works are required.

3.4.10 Progressive rehabilitation

A mine rehabilitation schedule based on current approved dates of mine closure is provided in Table 4 for primary domains.

Many of the decommissioning closure tasks will be undertaken concurrently and the duration shown are indicative of each specific task only. Any infrastructure including dams, and buildings, which has beneficial future use by post-mine landowners, will be left in place.

3.4.11 Surrender of ML

The ML will be surrendered when rehabilitation is complete, and evidence has been acquired to demonstrate the rehabilitation milestones in Section 4.0 have been achieved. Suitable evidence to demonstrate achievement of some criteria will require completion of the post rehabilitation monitoring program described in Section 6.0. This will be done by submission of a *Progressive Rehabilitation Report* to DES for part of the mine or a *Final Rehabilitation Report* for the whole project or a part being surrendered.

DETSI will consider the relevant completion criteria in Section 4.0 when deciding whether to certify progressive rehabilitation or whether to approve a surrender application.

Table 4 Summary of proposed progressive rehabilitation area domains and completion dates

RA	Activities	Total (ha)	Rehabilitation milestones	2032	2038	2043	2048	2049	2050	2055
IA1	Residual void	291.6	MM1,2,3,4			291.6				
RA1	Dump	735.75	RM4, 5, 6, 8, 10				735.75			
RA2	TSF	40.6	RM 3,4,5,6,8,10					3.97		
RA3	CHPP	77.9	RM 1,2,4,5,6,8,10						12.87	
RA4	Infrastructure	104.2	RM 1,2,4,5,6,8,10						73.15	
RA5	Rail infrastructure	11.21	RM 1,2,4,5,6,8,10						11.21	
RA6	Road infrastructure	104	RM 1,2,4,5,6,8,10						104	
RA7	Water management	27.08	RM 1,2,4,5,6,8,10						27.08	
RA8	Existing rehabilitation (grazing)	289.01	RM 6,8,10	289.01						
RA9	Cleared areas	21.03	RM 4,5,6,8,10		21.03					
RA10	Native ecosystem (NE)	20.7	RM 1,2,4,5,7,9,11							20.7
RA11	Existing rehabilitation (NE)	20.89	RM 7,9,11	20.89						
RA12	Diversions	34.88	RM 4,6,8,10				34.88			

Rehabilitation milestones (RMs) are detailed in PRC plan and schedule.

4.0 Rehabilitation requirements

4.1 Rehabilitation milestone and strategies

Rehabilitation milestones identify each significant event or step needed to reach a stable condition. Milestone criteria are used to demonstrate each rehabilitation milestone. Rehabilitation milestones and milestone criteria for each rehabilitation area (PMLU) are in Table 5. Management milestones and milestone criteria for the NUMA are in Table 6.

Amendments to final mine rehabilitation milestone criteria will be subject to regulatory approval. The process for amending final mine rehabilitation requirements is described in PRC plan guidelines (*ESR2019/4964*).

The mine rehabilitation requirements need to demonstrate that the closure objectives in Section 2.2 have been achieved. Determining whether mine rehabilitation requirements have been met depends on the trending of measurements over time.

4.2 Reporting and monitoring

Reporting and monitoring are presented in Section 6.0.

Table 5 Rehabilitation milestones and milestone criteria

Milestone reference	Rehabilitation milestone	Milestone criteria	Rehabilitation area
RM1	Infrastructure decommissioning and removal	a) decommissioning and removing services; b) removing infrastructure; c) decommissioning dams; d) removing all general and regulated waste; and e) decommissioning or converting water or monitoring bores, exploration drill holes.	RA3, RA4, RA5, RA6, RA7 and RA10
RM2	Remediation of contaminated land	a) removing or remediating contaminated land to a PMLU of light grazing pasture or native ecosystem; b) all contaminated sediment is removed; c) all plastic liners are removed and disposed; d) site investigation report is prepared by an AQP; and e) certification from an AQP that all contaminated land has been removed.	RA3, RA4, RA5, RA6, RA7, and RA10
RM3	Cover system installation	a) certification by an AQP that waste products generated from the washing of coal are buried under spoil with a minimum of thickness of five metres.	RA2
RM4	Landform development and reshaping or reprofiling	a) reshaping or recontouring the landform; b) install drainage management structures; c) all major earthworks completed; d) stable landform and slope angles ~15 % average; and e) landform is assessed as geotechnically stable by an AQP. **Diversions (RA12)** f) certification from an AQP that diversions are constructed as per the requirements of the certified design, and in accordance with DNRME's Guideline: *Works that interfere with water in a watercourse for a resource activity — watercourse diversions under the Water Act 2000* (OSW/2019/4599).	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA9, RA10 and RA12

Milestone reference	Rehabilitation milestone	Milestone criteria	Rehabilitation area
RM5	Surface preparation	a) placement of a minimum of 0.15 m of soil; b) contour ripping finished; and c) fertiliser applied at rates of 250 kg/ha.	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA9 and RA10
RM6	Revegetation (light grazing pasture)	a) direct seeding at application rate determined by an AQP; b) seed mix applied contains a suitable range of trees, shrubs and perennial grass species and suitable leguminous species consistent with the surrounding area; and c) stock exclusion fencing installed until achieving surface requirements for grazing pasture.	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9 and RA12
RM7	Revegetation (native ecosystem)	a) Seed mix applied contains species consistent with RE 11.1.11 or RE 11.3.4; b) Species comprise ≥ 20 % of the average number of species described in RE 11.1.11 or RE 11.3.4 technical descriptions; c) Average height of each layer is ≥ 70 % of average layer height described in RE 11.1.11 or RE 11.3.4 technical descriptions; d) Average fractional cover of each layer is ⩾ 50 % of average fractional cover described in RE 11.1.11 or RE 11.3.4 technical description.	RA10 and RA11

Milestone reference	Rehabilitation milestone	Milestone criteria	Rehabilitation area
RM8	Achieving surface requirements (light grazing pasture)	a) species richness and diversity achieved is consistent with the sown seed mix and similar to reference sites; b) revegetation ≥70% comparable to analogue site; c) no active areas of gully erosion and drainage follows appropriate drainage paths; d) certification from an AQP that rehabilitation is resilient to fire; and e) certification by an AQP that weeds and pest species are in densities no greater than at analogue sites. **Diversions (RA12)** f) an AQP prepares an assessment report annually based on the Index of Diversion Condition (IDC) assessment, where: a. the diversions have achieved a target Geomorphic Index score of ≥ 95 % relative to baseline condition. b. the riparian corridor has achieved a target Riparian Index score of ≥ 70 % relative to baseline condition.	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9 and RA12

Milestone reference	Rehabilitation milestone	Milestone criteria	Rehabilitation area
RM9	Achieving surface requirements (native ecosystem)	a) for RE 11.1.11 species richness ≥ 15 native species: – tree species richness ≥ 2 species, including Yellow Jacket (*Corymbia liechhgardtii)*; – shrub species richness ≥ 3 species; – grass species richness ≥ 5 species; and – forb and other species richness ≥ 5 species. b) For RE 11.3.4, species richness ≥ 18 native species: – tree species richness ≥ 3 species, including Forest Red Gum (*Eucalyptus tereticornis);* – shrub species richness ≥ 4 species; – grass species richness ≥ 6 species; and – forb and other species richness ≥ 5 species. c) revegetation ≥ average fractional cover derived from RE technical descriptions for RE 11.1.11: – trees cover ≥ 57.7 %; – shrubs ≥ 36.9 %; and – grasses and forbs cover ≥ 29.3 %. d) revegetation ≥ average fractional cover derived from RE technical descriptions for the RE 11.3.4: – trees cover ≥ 37.1 %; – shrubs ≥ 4.3 %; and – grasses and forbs cover ≥ 61.6 %. e) no active areas of gully erosion and drainage follow appropriate drainage paths; f) certification from an AQP that rehabilitation is resilient to fire; and g) certification by an AQP that weeds and pest species are in densities no greater than at analogue sites.	RA10 and RA11

Milestone reference	Rehabilitation milestone	Milestone criteria	Rehabilitation area
RM10	Achieving PMLU to stable condition (light grazing pasture)	a) certification from an AQP that the area has achieved stable condition; b) certification from an AQP that the landform achieved a factor of safety ≥ 1.5; c) maximum erosion rate of < 10 t/ha/yr; d) total percentage groundcover (vegetation, litter and rock combined) is > 70 %; e) there are no declared Noxious Class 1 or Class 2 weeds; f) native fauna identified at reference sites are present or indicators of these species are recorded; g) water quality complies with *Table C7* of EPML00876713. **Diversions (RA12)** h) prepare assessment report by an AQP certifying that the diversion is operating in accordance with, DNRME Guideline: *Works that interfere with water in a watercourse for a resource activity — watercourse diversions under the Water Act 2000* (OSW/2019/4599) criteria and is in a stable condition. The report will include data from the IDC assessment, showing that Geomorphic Index has maintained a score of ≥ 95 % and the Riparian Vegetation Index has maintained a score of ≥ 70 % for two consecutive years. i) certification from AQP that the diversions have achieved a stable condition, and are able to sustain a 0.1% AEP flood event.	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9, and RA12
RM11	Achieving PMLU to stable condition (native ecosystem)	a) certification from an AQP that the area has achieved stable condition; b) certification from an AQP that the landform achieved a factor of safety ≥ 1.5; c) total percentage groundcover (vegetation, litter and rock combined) is ≥50 %; d) maximum erosion rate of < 10 t/ha/yr; e) there are no declared Noxious Class 1 or Class 2 weeds; f) native fauna at reference sites are present or indicators of these species are recorded; and g) water quality complies with *Table C7* of EPML00876713.	RA10 and RA11

Table 6 Management milestones and milestone criteria

Milestone reference	Management milestone	Milestone criteria	Improvement area
MM1	Conversion of the void into a permanent waterbody	a) all major earthworks finished.	IA1
MM2	Highwall and low wall treatment	a) maximum slope of 30% in competent rock; b) maximum slope of 15% in incompetent rock; c) factor of safety ≥1.5; and d) void complies with condition F17 of EA EPML00876713.	IA1
MM3	Achieving surface requirements	a) fencing of 1.8 m high erected around the perimeter of the void; b) warning signage posted around the perimeter of the void following the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland*: c) safety bund constructed at two metres in height, four metres in base width and 10 m beyond the area which may be affected by void edge instability; and d) direct seeding of low walls with species and application rates determined by an AQP.	IA1
MM4	Achieving enough improvement	a) certification from an AQP that the void will not cause environmental harm outside of the tenure boundary: b) certification from an AQP that the void is safe to humans and livestock; and c) certification from an AQP that the water level in the void will not cause environmental harm to the surrounding environment.	IA1

5.0 Risk assessment

Identifying environmental, social and economic impacts and risks associated with closure is critical for effective closure planning. The following sections present a preliminary risk assessment for the mine based on the review of relevant material.

5.1 Objectives

The overall objective of the closure risk assessment (the assessment) is to identify the inherent risks associated with closure of the mine and threats to achieving relinquishment of the ML.

Specific objectives of the assessment are to:

- identify and define risks from closure and associated rehabilitation activities;
- identify risks which have the potential to adversely affect the environment;
- identify community and other stakeholder risks, eg economic, health and safety, etc;
- identify social risks;
- identify controls currently in place mitigating against identified risks;
- identify additional controls required to mitigate against identified risks; and
- systematically rank the risk magnitudes for closure.

5.2 Method

The following sections outline the approach used for the assessment.

5.2.1 Framework for assessment

The risk assessment has been completed based on a review of relevant literature for the mine. The risk assessment also considered any risks identified from regulation, leading best practice and obligations.

The risk assessment has been structured into six risk categories that can describe potential root causes of failure of mine closure:

- climate and air quality;
- human factors;
- surface and groundwater;
- ecology;
- underling materials; and
- landform constructability.

5.2.2 Assessment of risk

The assessment was conducted using a risk assessment approach that is consistent with *Australian Standard 4360: Risk Management Standards (AS 4360)*, and the mine risk evaluator developed by TerraCom.

In accordance with the risk standard, risk was assessed semi qualitatively via expert judgement for two scenarios:

- without closure control measures and actions in place; and
- with closure control measures and actions in place.

By:

- assessing the consequence of the potential impact as if it had caused a loss; and
- assessing the probability of the impact occurring.

The risk matrix used to evaluate each risk event is in Table 7.

The likelihood ratings and descriptions are in Table 8.

The consequence categories and definitions are in Table 9.

Table 7 Risk matrix

Likelihood	Consequence					
	1	2	3	4	5	6
A	Medium	High	High	Very High	Very High	Very High
B	Medium	Medium	High	High	Very High	Very High
C	Low	Medium	Medium	High	High	Very High
D	Low	Low	Medium	Medium	High	High
E	Low	Low	Low	Medium	Medium	High

Table 8 Likelihood ratings and descriptions

Likelihood	Rating	Description
Almost certain	A	Likely to occur multiple times a year.
Likely	B	Might occur once a year.
Possible	C	Might occur multiple times during the LOM.
Unlikely	D	Might occur once during the LOM.
Rare	E	Unlikely to occur during the LOM.

Table 9 Risk assessment and treatment plan for land with a PMLU not achieving stable condition

Rehabilitation milestone		Risk event	Causes	Impact description	Risk rating	Rationale for risk treatment option	Proposed actions	Resource requirements	Performance measures and constraints	Reporting and monitoring requirements	Timing and scheduling	Responsibility	Residual risk rating
RM1	Infrastructure decommissioning and removal.	Buildings which are not being formally retained by the landholder are not demolished and removed.	Poor communication.	Failure to meet PMLU.	Low (D x 2)	Ensure that all buildings which are not being formally retained by the landholder are demolished and removed.	Contractor and work teams will be made aware of buildings which require demolition and removal.	Written landholder agreement.	Written landholder agreement.	Visual inspection.	During engagement of relevant contractors or work teams.	General manager or senior executive.	Low (E x 2)
		Bitumen and concrete has not been removed and disposed of.	Poor communication.	Failure to meet PMLU.	Low (D x 2)	No proposed risk treatment — all bitumen and concrete will be removed.	-	-	-	-	-	-	-
		Historic exploration boreholes have not been decommissioned or converted to groundwater monitoring bores.	Poor communication.	Failure to meet PMLU.	Low (D x 2)	Ensure that all historic boreholes are decommissioned or converted to groundwater monitoring bores.	Contractor and work teams will be notified.	Monitoring and maintenance program.	Monitoring and maintenance program.	Internal reporting.	During infrastructure decommissioning and removal.	General manager or senior executive.	Low (E x 2)
		Asbestos has not been appropriately removed and disposed of.	Poor removal and disposal of asbestos.	Failure to meet PMLU and potential harm to humans and wildlife.	High (C x 4)	Ensure asbestos is been appropriately removed and disposed of.	Contractor and work teams will be notified and appropriate measures will be implemented and done by an AQP.	Licenced professional for asbestos removal.	Certification by an AQP that all asbestos has been appropriately been removed and disposed.	Internal reporting.	During infrastructure decommissioning and removal.	General manager or senior executive.	Medium (E x 4)
RM2	Remediation of contaminated land.	Residual contaminated land.	Refuelling, spills and leaks or historic notifiable activities.	Soil is unable to support the PMLU and there is potential mobilisation of contaminants to the receiving environment.	Medium (C x 3)	Ensure contaminated land has been removed or remediated.	A contaminated land survey is done by an AQP to verify removal or remediation of contaminated soils.	Contaminated land survey by an AQP.	Contaminated land survey by an AQP.	Contaminated land survey by an AQP.	During remediation of contaminated land.	General manager or senior executive.	Low (E x 2)
						Reduce the risk of land contamination	Managed under the standard operating procedure of	Standard operating procedure for	Reduced risk of land contamination	Internal reporting.	During operation and rehabilitation.	General manager or senior executive.	

Rehabilitation milestone		Risk event	Causes	Impact description	Risk rating	Rationale for risk treatment option	Proposed actions	Resource requirements	Performance measures and constraints	Reporting and monitoring requirements	Timing and scheduling	Responsibility	Residual risk rating
						during mining operations.	hazardous substances.	hazardous substances.	during mining operations.				
							Spill kits are made available.	Spill kits.	Reduced risk of land contamination during mining operations.	Visual inspection.	During operation and rehabilitation.	General manager or senior executive.	
		Effluent irrigation area has been poorly managed.	Dried sewage sludge has not been removed and buried under spoil as per the EA.	Failure to meet condition J1 of the EA and inability to support the PMLU.	Low (C x 1)	Reduce the risk of land contamination.	Operate effluent irrigation area in accordance with condition J1 of the EA.	Monitoring and maintenance program.	Condition J1 of the EA.	Internal reporting.	During operation and rehabilitation.	General manager or senior executive.	Low (C x 1)
		Plastic liners have not been removed or disposed of.	Impervious liners have not been removed with the dried sewage sludge.	Unable to support the PMLU.	Low (C x 1)	No proposed risk treatment — plastic liners will be removed with the dried sewage sludge.	-	-	-	-	-	-	-
RM3	Installation of cover system.	Waste products generated from the washing of coal has not been buried under a minimum cover thickness of 5 m.	Spoil cover thickness is less than 5 m.	Failure to meet condition E9 of the EA.	Medium (C x 3)	Ensure that waste products generated on or after the 30 August 2017 from the washing of coal are disposed of within mine voids and covered with spoil to a depth of at least 5 m.	Certification by an AQP that waste products generated from the washing of coal are buried under spoil with a minimum cover thickness of 5 m.	Certification by an AQP, GPS and survey guidance.	Condition E9 of the EA.	Certification by an AQP, GPS and survey guidance.	Prior to installation of the cover system.	General manager or senior executive.	Low (E x 3)
						Ensure that there is sufficient spoil available to cover rejects to a depth of at least 5 m.	Update reshape modelling if there is a significant change to mine schedule.	Reshape modelling software.	15% grade constraint.	Reshape assumptions report.	If there is a significant change the mine schedule.	General manager or senior executive.	

Rehabilitation milestone		Risk event	Causes	Impact description	Risk rating	Rationale for risk treatment option	Proposed actions	Resource requirements	Performance measures and constraints	Reporting and monitoring requirements	Timing and scheduling	Responsibility	Residual risk rating
RM4	Landform construction and reshaping or reprofiling.	Landform includes excessive slopes.	Landform has not been reshaped in accordance with condition F6 of the EA.	Failure to meet condition F6 of the EA and failure to meet PMLU.	High (C x 4)	Ensure that rehabilitation landform slope angles do not exceed 15% with the exception of Ramp 3 cut through competent rock.	An AQP will verify and audit construction compliance with the final landform design.	Final landform design.	Performance measured against condition F6 of the EA.	LiDAR monitoring.	During landform construction and reshaping or reprofiling.	General manager or senior executive.	Medium (E x4)
		Contour or graded drains have not been installed where required.	Contour or graded drains have not been installed.	Increased risk of erosion and sedimentation to the receiving environment.	Medium (C x 3)	Ensure that contour or graded drains have been installed where required as per the construction design.	Certification by an AQP that contour or graded drains have been installed as required in accordance with the construction design.	Construction design.	Certification by AQP against the construction design.	As built report.	During landform construction and reshaping or reprofiling.	General manager or senior executive.	Low (E x 3)
		Landform is geotechnically unstable	Landform has a geotechnical factor of safety less than 1.5	Failure to meet PMLU	High (C x 4)	Ensure that the landform is geotechnically stable	Assessment of the landform by a suitably qualified geotechnical engineer	Landform geotechnical stability assessment	Geotechnical factor of safety of greater than or equal to 1.5	Landform geotechnical stability assessment	Prior to achievement of landform construction and reshaping / reprofiling	General manager / senior executive	Medium (E x4)
RM5	Surface preparation.	Insufficient or unknown topsoil availability to complete surface preparation.	Historic mining disturbance to topsoil resources, long-term stockpile storage or poor topsoil and subsoil stripping, handling or stockpiling.	Unable to support target vegetation, causing disturbance to undisturbed areas, costs to import topsoil and failure to meet condition F1 of the EA.	Medium (C x 3)	Ensure there is sufficient topsoil or growth media to complete rehabilitation.	Prepare a topsoil and subsoil inventory.	Survey support and inventories of topsoil and subsoil.	Performance measured by survey data and assessed against the completion criteria.	Survey data recorded in topsoil and subsoil inventory.	During construction, operation, closure and rehabilitation.	General manager or senior executive.	Low (E x 3)
							Implement soil stripping and stockpile management procedures.	Soil stripping and stockpile management procedures.	Soil stripping and stockpile management procedures.	Visual inspection and internal reporting.	During construction, operation, closure and rehabilitation.	General manager or senior executive.	
		Unsuitable growth media used in combination with,	Failure to ensure growth media compatibility	Failure to meet condition F2 of the EA, inability to support	Medium (C x 3)	Ensure that growth media used for rehabilitation is	Demonstrate suitability of proposed growth media through	Rehabilitation trials.	Rehabilitation trials.	Rehabilitation trial monitoring.	Prior to surface preparation if there is	General manager or senior executive.	Low (E x 3)

Rehabilitation milestone		Risk event	Causes	Impact description	Risk rating	Rationale for risk treatment option	Proposed actions	Resource requirements	Performance measures and constraints	Reporting and monitoring requirements	Timing and scheduling	Responsibility	Residual risk rating
		or instead of, topsoil.	with rehabilitation vegetation.	target vegetation and failure to meet PMLU.		suitable for rehabilitation through rehabilitation trials.	rehabilitation trials.				insufficient topsoil.		
		Topsoil or growth media depth is too shallow to support target vegetation.	Topsoil or growth media is less than 100 mm.	Unable to support target vegetation.	Medium (C x 3)	Demonstrate the topsoil is applied to a minimum depth of 100 mm.	Survey to show depth of topsoil applied.	Survey to show depth of topsoil applied.	Survey data.	Survey data and internal reporting.	During surface preparation.	General manager or senior executive.	Low (E x 3)
		Topsoil or growth media health is unable to support target vegetation.	Failure to ensure topsoil or growth media health is compatible with vegetation.	Unable to support target vegetation.	Medium (C x 3)	Ensure topsoil or growth media health is able to support target vegetation.	AQP to assess soil health and suitability.	Soil health and suitability assessment.	Soil health and suitability assessment.	Soil health and suitability assessment.	Prior to surface preparation.	General manager or senior executive.	Low (E x 3)
		Ripping of surface has not been completed.	Poor communication.	Unable to support target vegetation.	Medium (C x 3)	Ensure surface ripping has been completed.	Survey to evidence ripping of surface.	Survey to evidence ripping of surface.	Survey data.	Survey data and internal reporting.	During surface preparation.	General manager or senior executive.	Low (E x 3)
		Ameliorants have not been applied.	Poor communication.	Unable to support target vegetation.	Medium (C x 3)	Ensure ameliorants have been applied where necessary.	Survey to evidence application of ameliorants.	Survey to evidence application of ameliorants.	Survey data.	Surface data and internal reporting.	Prior to surface preparation.	General manager or senior executive.	Low (E x 3)
RM6	Revegetation	Poor seed germination rates.	Seed germination rates are unable to support the establishment of target vegetation.	Poor vegetation establishment and potential for increased weed species.	Medium (C x 2)	Ensure the seed germination rates can support the establishment of target vegetation.	Implement rehabilitation trials to verify the seed germination rates.	Rehabilitation trials.	Rehabilitation trials.	Rehabilitation trials.	During operation.	General manager or senior executive.	Low (D x 2)
		Insufficient seed available.	Native seed is not collected or is unable to be sourced from a supplier.	Increased rehabilitation cost and failure to meet PMLU.	Medium (C x 2)	Ensure sufficient seed is available for rehabilitation.	Seed collection, storage and treatment procedures.	Seed collection, storage and treatment procedures.	Seed collection, storage and treatment procedures.	Seed collection database.	During operation, closure and rehabilitation.	General manager or senior executive.	Low (D x 2)

Rehabilitation milestone		Risk event	Causes	Impact description	Risk rating	Rationale for risk treatment option	Proposed actions	Resource requirements	Performance measures and constraints	Reporting and monitoring requirements	Timing and scheduling	Responsibility	Residual risk rating
		Poor seed mix and application rate.	Seed mix and application rate are unable to support the establishment of target vegetation.	Poor vegetation establishment and potential for increased weed species.	Medium (C x 2)	Ensure that the seed mix and application rate can support the establishment of target vegetation.	Implement rehabilitation trials to confirm the seed mix and application rate.	Rehabilitation trials.	Rehabilitation trials.	Rehabilitation trials.	During operation.	General manager or senior executive.	Low (D x 2)
		Insufficient seasonal rainfall.	Rainfall volume is too low for vegetation establishment.	Poor vegetation establishment, potential for increased weed species.	Medium (C x 2)	Ensure compatibility of target vegetation with seasonal rainfall volume.	Complete seeding before the start of the wet season (December).	Data from rehabilitation monitoring.	Inspections and assessment against completion criteria.	Rehabilitation monitoring report.	Ongoing.	General manager or senior executive.	Low (E x 2)
		Damaged or destroyed seed bank from bushfires.	Lightning strike, extended dry season, poor fire management or high fuel load.	Poor vegetation establishment and potential for increased weed species.	Medium (C x 2)	Ensure protection of seeds from bushfires.	Implementation of a fire management plan.	Fire management controls detailed in the fire management plan.	Inspections for the implementation of the fire management plan	Internal reporting and monitoring in accordance with the fire management plan.	Before and throughout rehabilitation.	General manager or senior executive.	Low (E x 2)
RM7	Achievement of surface requirements.	Vegetation is not striking due to insufficient seasonal rainfall.	Insufficient rainfall for vegetation establishment.	Failure to establish vegetation and increased weed species.	Medium (C x 2)	Ensure compatibility of vegetation with the seasonal rainfall.	Complete seeding before the start of the wet season (December).	Data from rehabilitation monitoring.	Inspections and assessment against completion criteria.	Rehabilitation monitoring report.	Ongoing.	General manager or senior executive.	Low (E x 2)
		Vegetation groundcover is not comparable to reference sites.	Poor rehabilitation monitoring and maintenance.	Vegetative groundcover is not self-sustaining and failure to meet PMLU.	Medium (C x 2)	Ensure vegetative groundcover is comparable to reference sites or target REs.	Monitoring and maintenance program.	Monitoring and maintenance program.	Performance measured by inspections and assessed against milestone criteria.	Rehabilitation monitoring report.	Ongoing.	General manager or senior executive.	Low (E x 2)
		Weed and pest species abundance is greater than at reference sites.	No weed or pest management and maintenance.	Failure to meet PMLU, biodiversity loss and increased costs to	Medium (C x 2)	Ensure weed and pest species abundance are similar to	Monitoring to identify pest species presence and abundance.	Data from rehabilitation monitoring.	Inspections and assessment against completion criteria.	Rehabilitation monitoring report.	Ongoing.	General manager or senior executive.	Low (D x 2)

Rehabilitation milestone		Risk event	Causes	Impact description	Risk rating	Rationale for risk treatment option	Proposed actions	Resource requirements	Performance measures and constraints	Reporting and monitoring requirements	Timing and scheduling	Responsibility	Residual risk rating
				undertake remediation.		reference sites or target REs.	Weed and pest management plan.	Weed and pest management plan.	Weed and pest management plan.	Weed and pest management plan.	Prior to construction.	General manager or senior executive.	
		Vegetation is not resilient to fire.	Bushfire while vegetation is too young for fire resilience.	Damage to vegetation and biodiversity loss.	Medium (C x 2)	Ensure vegetation is protected from bushfires until resilience is built.	Exclude rehabilitated areas from planned burns until resilience is built.	Data from rehabilitation monitoring.	Inspections and assessment against completion criteria.	Rehabilitation monitoring report.	Ongoing.	General manager or senior executive.	Low (D x 1)
		Damaged or destroyed juvenile plants from bushfire.	Lightning strike, extended dry season, poor fire management and high fuel load.	Poor establishment of target vegetation and potential for increased weed species and abundance.	Medium (C x 2)	Ensure juvenile plants are protected from bushfires.	Implement a fire management plan.	Fire management controls detailed in the fire management plan.	Performance measured by inspections for the implementation of the fire management plan.	Internal reporting and monitoring completed in accordance with the fire management plan.	During operation and rehabilitation until plant resilience to fire is demonstrated.	General manager or senior executive.	Low (E x 2)
		Areas of rill or gully erosion.	Extreme weather events.	Potential for mobilisation of sediment.	Medium (C x 3)	Monitor for rill or gully erosion.	Monitor for rill or gully erosion.	Data from rehabilitation monitoring.	Performance measured by inspections and assessed against milestone criteria.	Rehabilitation monitoring report.	During operation, closure and rehabilitation.	General manager or senior executive.	Low (E x 3)
		Land is not suitable for grazing.	Contamination of land, low soil health or insufficient soil depth.	Failure to meet PMLU of grazing.	Medium (C x 2)	To sustain a PMLU.	Remediate land contamination, increase soil health or alter PMLU to forestry.	Data from rehabilitation monitoring.	Performance measured by inspections and assessed against milestone criteria.	Rehabilitation monitoring report.	During closure and rehabilitation.	General manager or senior executive.	Low (E x 2)
RM8	Achievement of PMLU to stable condition	Landform is not stable.	Excessive slopes.	Unable to sustain a stable PMLU.	Low (E x 3)	Ensure that the landform is safe for humans and wildlife.	Certification by an AQP that the area is stable.	AQP to assess landform stability.	Inspections and assessment against milestone criteria.	Certification in a report.	Prior to relinquishment.	General manager or senior executive.	Low (E x 2)
		Landform is not safe for humans and wildlife.	Contaminated land unsuitable for the PMLU	Unable to sustain a stable PMLU.	Low (E x 3)	Ensure there is no contamination unsuitable for the PMLU.	Certification by an AQP that there is no land contamination.	AQP to confirm absence of land contamination.	Rehabilitation milestone.	Certification by an AQP that there is no land contamination.	Prior to the achievement of a stable PMLU.	General manager or senior executive.	Low (E x 2)

Rehabilitation milestone	Risk event	Causes	Impact description	Risk rating	Rationale for risk treatment option	Proposed actions	Resource requirements	Performance measures and constraints	Reporting and monitoring requirements	Timing and scheduling	Responsibility	Residual risk rating
		or heating of remnant coal.			Ensure that there is no heating of remnant coal.	Certification by an AQP that there is no heating of remnant coal.	AQP to confirm absence of remnant coal heating.	Rehabilitation milestone.	Certification by an AQP that there is no heating of remnant coal.	Prior to the achievement of a stable PMLU.	General manager or senior executive.	
	The maximum erosion rate is exceeded.	Unfavourable climate or weather events and inappropriate landform design.	Exceedingly high erosion rates which violate condition F16 of the EA.	Medium (C x 3)	To minimise the risk of erosion and comply with condition F16 of the EA.	Monitor erosion and ensure the landform design mitigates climatic and weather risks.	Data from rehabilitation monitoring.	Performance measured by inspections and assessed against milestone criteria.	Erosion and sediment control plan as per condition C25 of the EA.	During rehabilitation.	General manager or senior executive.	Low (E x 2)
	Unable to meet surface water quality requirements.	Contamination of surface water which has not been remediated.	Failure to meet condition C20 of the EA.	Medium (C x 3)	To ensure that surface water quality complies with condition C20 of the EA.	Monitor surface water quality and use treatment plans as per the receiving environment monitoring program (REMP).	REMP and monitoring data.	Performance measured by inspections and assessed against the REMP.	Rehabilitation monitoring report.	Ongoing.	General manager or senior executive.	Low (E x 2)
	Groundwater level is dissimilar to reference sites.	Disruption to groundwater flows.	Inappropriate groundwater levels.	Medium (C x 3)	To ensure groundwater levels are similar to that of reference sites.	Monitor groundwater levels and implement remediation plans where necessary.	Monitoring data.	Inspections and assessment against reference sites, milestone criteria and EA conditions.	Rehabilitation monitoring report.	Ongoing.	General manager or senior executive.	Low (E x 2)
	Unable to meet groundwater quality requirements.	Contamination of groundwater which has not been remediated.	Failure to meet conditions K2, K3 and K5 of the EA.	Medium (C x 3)	To ensure that groundwater quality complies with conditions K2, K3 and K5 of the EA.	Monitor quality and use treatment plans as per the groundwater monitoring program.	Groundwater monitoring program and monitoring data.	Inspections and assessment against milestone criteria, the groundwater monitoring program and EA conditions.	Rehabilitation monitoring report.	Ongoing.	General manager or senior executive.	Low (E x 2)
	Groundcover is dissimilar to reference sites.	Inappropriate groundcover species, soil quality or quantity,	Failure to establish appropriate	Medium (C x 3)	To ensure the establishment of appropriate	Seed before the wet season (December) and have an AQP verify suitability	Monitoring data.	Inspections and assessment against milestone	Rehabilitation monitoring report.	From rehabilitation until relinquishment.	General manager or senior executive.	Low (E x 2)

Rehabilitation milestone		Risk event	Causes	Impact description	Risk rating	Rationale for risk treatment option	Proposed actions	Resource requirements	Performance measures and constraints	Reporting and monitoring requirements	Timing and scheduling	Responsibility	Residual risk rating
			climate or bushfires.	groundcover vegetation.		groundcover vegetation.	of target species, soil quality and soil quantity.		criteria and reference sites.				
		Weed and pest species abundance is greater than at reference sites.	Failure to implement the weed and pest management plan.	An abundance of weed and pest species.	Medium (C x 3)	To ensure weed and pest species abundance is similar to reference sites.	Implementation of a weed and pest management plan.	Monitoring data.	Inspections and assessment against milestone criteria and reference sites.	Weed and pest management plan.	Ongoing.	General manager or senior executive.	Low (E x 2)

Table Y5 Risk assessment and treatment plan for land identified as a NUMA not achieving sufficient improvement

Management milestone		Risk event	Causes	Impact description	Risk rating	Rationale for risk treatment option	Proposed actions	Resource requirements	Performance measures and constraints	Reporting and monitoring requirements	Timing and scheduling	Responsibility	Residual risk rating
MM1	Conversion of the void into a permanent waterbody	Major earthworks are not done	Non-conformance with the landform design plan	Failure to follow the landform design plan	High (C x 4)	To ensure major earthworks are done in accordance with the landform design plan.	Do all major earthworks in accordance with the landform design plan.	Personnel, trucks, excavators and earthmoving bulldozers.	Inspections and assessment against the landform design plan	Certification from an AQP that the surface reflects the landform design plan	After closure and before rehabilitation	GM or senior executive.	Low (C x 4)
MM2	Landform construction and highwall treatment.	Highwalls are battered to a slope greater than the specified angle.	Highwalls are battered incorrectly.	Unable to meet condition F18 of the EA.	Low (C x 3)	To ensure highwalls meet condition F18 of the EA.	Batter highwalls to the angles specified in the residual void management plan.	Residual void management plan and rehabilitation requirements.	Surveyed sections, contour plans and assessment against the residual void management plan.	Rehabilitation report.	At the start of rehabilitation.	Environmental officer.	Low (C x 1)
		The residual void is geotechnically unstable.	The void geotechnical factor of safety is less than 1.5.	The void is geotechnically unstable.	Low (C x 3)	To ensure that the void is geotechnically stable.	Assessment of the void for the geotechnical factor of safety.	Geotechnical assessment.	Achievement of a geotechnical safety factor of 1.5 or greater.	Geotechnical assessment.	During landform construction and treatment of lowwall and highwall.	Environmental officer.	Low (C x 1)
MM3	Achievement of surface requirements.	The residual void is not safe to humans, wildlife and livestock.	Fencing, safety bunds and signage were not installed around the void perimeter.	Humans, wildlife, livestock and vehicles could access the void.	Low (C x 3)	To prevent access and ensure people are aware of the risks.	Bunding is constructed, fencing is installed and warning signs are posted.	Safety bund plan, fencing installation plan and the Australian	Safety bund plan, fencing installation plan and the Australian	Visual inspection.	Prior to achieving surface requirements.	Environmental officer.	Low (C x 1)

Management milestone		Risk event	Causes	Impact description	Risk rating	Rationale for risk treatment option	Proposed actions	Resource requirements	Performance measures and constraints	Reporting and monitoring requirements	Timing and scheduling	Responsibility	Residual risk rating
								Standard for warning signage.	Standard for warning signage.				
MM4	Achievement of sufficient improvement.	The residual void is harming the environment outside of the tenure boundary.	The void harms the regional groundwater aquifers and the surrounding environment.	Unable to achieve sufficient improvement within the NUMA.	Low (C x 2)	To evidence the lack of environmental harm being caused by the void.	Certification from an AQP that the void will not cause environmental harm.	Certification from an AQP.	Certification from an AQP.	Certification from an AQP.	From rehabilitation until relinquishment.	Environmental officer.	Low (C x 1)
		The residual void is not safe to humans, wildlife and livestock.	The void harms the regional groundwater aquifers and the surrounding environment.	Unable to achieve sufficient improvement within the NUMA.	Low (C x 2)	To evidence the lack of potential harm to humans, wildlife and livestock.	Certification from an AQP that the void is safe to humans, wildlife or livestock.	Certification from an AQP.	Certification from an AQP.	Certification from an AQP.	From rehabilitation until relinquishment.	Environmental officer.	Low (C x 1)
			Heating of remnant coal.	Unable to achieve sufficient improvement due to lack of safety.		Ensure there is no heating of remnant coal.	Certification by an AQP that there is no heating of remnant coal.	Certification from an AQP.	Certification from an AQP.	Rehabilitation milestone.	Certification from an AQP.	Environmental officer.	
		The water level in the residual void is harming the surrounding environment.	The void water level differs from, and impacts, the surrounding environment.	Unable to achieve sufficient improvement within the NUMA.	Low (C x 2)	To evidence similar water levels in the void to that of the surrounding environment.	Certification from an AQP that the void water level is appropriate.	Certification from an AQP.	Certification from an AQP.	Certification from an AQP.	From rehabilitation until relinquishment.	Environmental officer.	Low (C x 1)
		Batter slopes have not achieved the specified vegetation cover.	Unsuitable target vegetation, soil quantity or quality, climate or bushfires.	Failure to establish sufficient vegetation cover on batter slopes.	Medium (C x 3)	To ensure the establishment of appropriate vegetation cover.	Certification from an AQP that target species, soil quality and soil quantity are suitable.	Monitoring data and certification from an AQP.	Inspections and assessment against milestone criteria and reference sites.	Rehabilitation monitoring report.	From rehabilitation until relinquishment.	Environmental officer.	Low (E x 2)
		The residual void is unstable.	Excessive slopes or exceeded maximum erosion rate.	Unable to achieve stability.	Low (C x 2)	To ensure stability of the NUMA.	Certification by an AQP that the area is stable.	Certification from an AQP.	Inspections and assessment against milestone criteria.	Certification in a report.	From rehabilitation until relinquishment.	Environmental officer.	Low (E x 2)

6.0 Reporting and monitoring

6.1 Post-mine monitoring

This section describes monitoring that will be undertaken post mining. Information collected during monitoring will demonstrate achievement of the criteria and contribute to satisfying DES decision to progress surrender of the ML.

The post rehabilitation phase will commence when all the activities specified in this plan are completed. Monitoring will be conducted to assess whether the closure objectives and mine rehabilitation requirements are being met. At this stage, the identified monitoring is conceptual and will need to be refined as the strategy develops in the future.

Specific maintenance and monitoring activities will be conducted at time intervals depending on the criteria involved. Monitoring methods must be cost effective, measurable, exchangeable, accurate and repeatable. Components that require post-mining closure include:

- Spontaneous combustion and bushfire (to be completed periodically);
- Rehabilitation monitoring (one, two, five and ten years after seeding);
- Groundwater must comply with the REMP and comply with the Environmental Authority;
- Surface water must also comply with the REMP and comply with the Environmental Authority;
- Diversion monitoring is to be completed annually and must comply with relevant water licence conditions;
- Erosion monitoring is recommended once a year until relinquishment; and
- Geotechnical stability must be assessed and reported as per design criteria.

Details are in the PRC plan and outlined below.

6.1.1 Spontaneous combustion and bushfire

Spontaneous combustion of medium or high-risk mineral waste is a chemical fire which requires oxygen to fuel the fire and moisture to transfer heat, ie spread the fire. Encapsulation of high and medium-risk mineral waste with low-risk mineral waste will reduce the potential for spontaneous combustion because it will reduce available oxygen and water infiltration. The encapsulation will also protect the mineral waste material from radiant heat in a bushfire event.

Monitoring for spontaneous combustion will be undertaken periodically using visual observation and recorded on the observation sheet as contained in the *Disposal Plan | Overburden, Interburden, Spoil, Coal Washery Coarse Rejects and Tailings | Blair Athol Mine*.

6.1.2 Surface water quality

Monitoring of mine affected water will occur during controlled release events. Surface water samples of mine affected water will be collected in accordance with the EA conditions for the mine.

Upstream and downstream water samples will be collected daily during releases. The first sample will be taken within two hours of a release commencing or during a natural flow event and will be analysed for the following parameters:

- pH;
- EC;
- TSS; and
- sulfate.

Following commencement of release and thereafter weekly during release, water quality parameters will be assessed against characteristics in Table 10.

Table 10 Laboratory parameters for surface water quality

Parameter		WQO
Physical	pH	6.5-8.0
	EC (µS/cm)	1,000
	Turbidity (NTU)	50
	Dissolved oxygen (% saturation)	85-110
	Suspended solids (mg/L)	1,000
	Hardness as $CaCO_3$ (mg/L)	-
	Dissolved organic C (mg/L)	-
	Alkalinity (mg/L)	-
Major ions	Sulfate (mg/L)	250
	Fluoride (mg/L)	2,000
	Na (mg/L)	115
Nutrients	Ammonia (µg/L)	900
	Nitrate (µg/L)	2,400
Dissolved metals and metalloids	Al (µg/L)	55
	As (µg/L)	13
	Cd (µg/L)	$0.2\ (\text{Hardness}/30\ (H/30))^{0.89}$
	Cr (µg/L)	1
	Cu (µg/L)	2
	Fe (µg/L)	300
	Pb (µg/L)	$3.4\ (H/30)^{1.27}$
	Hg (µg/L)	0.2
	Ni (µg/L)	$11\ (H/30)^{0.85}$
	Zn (µg/L)	$8\ (H/30)^{0.85}$
	B (µg/L)	370
	Co (µg/L)	90
	Mn (µg/L)	1,900
	Mo (µg/L)	34
	Se (µg/L)	10

Parameter		WQO
	Ag (µg/L)	1
	U (µg/L)	1
	V (µg/L)	10
Petroleum hydrocarbons	C6-C9 (µg/L)	20
	C10-C36 (µg/L)	1,000

The monitoring described above will provide representative surface water samples from Washpool, Bath and Breaker Creeks with enough regulatory, spatial and temporal replication to make statistically valid conclusions about surface water quality.

6.1.3 Groundwater quality

Groundwater samples will be collected in accordance with the EA conditions.

6.1.3.1 Standing water levels

The standing groundwater levels that will be monitored are shown in Table 11.

Table 11 Standing water level monitoring locations

Monitoring point	Hydrogeological Unit	Baseline water level (mAHD)	Standing water level trigger threshold (mAHD)
BA Station (Mayes Bore)	Tertiary Basalt	TBA	TBA
Blair Athol station	Tertiary Basalt	TBA	TBA
Curtis Windmill	Permian Conglomerate	TBA	TBA

1. A groundwater monitoring program to monitor water quality and standing water level in any aquifers likely to be impacted by mining activities must be updated, submitted to the AA for approval by 30 June 2018 and implemented

The standing groundwater level monitoring described in Table 11 will provide representative levels with sufficient regulatory detail and replication to make statistically valid conclusions about the standing groundwater level.

Standing water level monitoring will identify any drawdown at monitoring points and will enable TerraCom to make management decisions to ensure other lawful users of groundwater are not adversely impacted by drawdown.

6.1.3.2 Groundwater quality

Groundwater quality samples will be taken at the locations and frequencies identified in Table 12.

Table 12 Groundwater monitoring location and frequency

Monitoring point	Latitude (GDA94)	Longitude (GDA94)	Hydrogeological Unit	Surface relative level (RL) (mAHD)	Monitoring frequency
Reference bores					
GW04B	-22.69090	147.55675	Permian conglomerate	314	Quarterly
Compliance bores					
BA Station (Mayes Bore)	-22.67855	147.55946	Tertiary Basalt	324	Quarterly
Curtis Windmill	-22.66615	147.56694	Tertiary Basalt	325	Quarterly

Groundwater samples will be taken quarterly and tested for parameters provided in Table 13. Results from groundwater quality from compliance bores identified in Table 12 must not exceed any of the limits defined in Table 13 on more than three consecutive monitoring occasions.

Table 13 Groundwater quality limits

Parameter	Units	Trigger value		Trigger type
		Curtis Windmill	BA Station	
EC	µS/cm	**883**	**631**	**Bore specific**
pH	pH units	6.5-8.5	6.5-8.5	WQO*
Sulfate	mg/L	**19**	**24**	**Bore specific**
Metals (dissolved)				
Aluminium	mg/L	0.055	0.055	ANZG
Arsenic	mg/L	0.013	**0.027**	**ANZG and bore specific**
Boron	mg/L	0.94	0.94	ANZG
Cadmium	mg/L	0.0002	0.0002	ANZG
Chromium	mg/L	0.001	0.001	ANZG
Copper	mg/L	**0.005**	**0.004**	**Bore specific**
Lead	mg/L	0.0034	0.0034	ANZG
Manganese	mg/L	1.9	1.9	ANZG
Mercury	mg/L	0.00006	0.00006	ANZG
Molybdenum	mg/L	0.034	0.034	ANZG
Nickel	mg/L	**0.012**	0.011	**Bore specific** and ANZG

Cadmium	mg/L	0.0002	0.0002	ANZG
Silver	mg/L	0.0005	0.0005	ANZG
Vanadium	mg/L	0.006	0.006	ANZG
Zinc	mg/L	**0.021**	**0.009**	**Bore specific**
Iron	mg/L	Iron is monitored for interpretation purposes		
Major ions	mg/L	Calcium, magnesium, potassium, sodium, chloride, bicarbonate and carbonate are monitored for interpretation purposes		

The method of groundwater sampling will comply with that set out in the latest edition of DES's *Water Quality Sampling Manual 2009* (EHP 2013).

The groundwater quality monitoring program is designed to detect changes in groundwater composition in aquifers potentially affected by previous mine operations and rehabilitation. If a review of groundwater quality monitoring data indicates the potential deterioration in water quality, TerraCom must complete an investigation into the potential for environmental harm.

6.1.4 Diversions

All surface water diversion is required to have a monitoring and evaluation program that demonstrates the performance of a diversion. This program is to be undertaken by a registered professional engineer (RPEQ) annually in accordance with the water licence conditions. The monitoring and evaluation program will be done in accordance with the with the Index of Diversion Condition (IDC) methodology which is outlined in the *Monitoring and Evaluation Program for Bowen Basin River Diversions* (ID&A 2001) to comply with water licence conditions. The IDC is a method of recording and monitoring the condition of diversions and adjacent upstream and downstream reaches. It provides an integrated suite of indicators that measures both geomorphic and riparian condition of a diversion, and its upstream control and downstream reaches.

Monitoring and evaluation program methodology and design is provided in:

- *Monitoring Design Report: Western Waterway Diversion — Blair Athol mine* (Alluvium 2011); and
- *Monitoring Design Report: Eastern Waterway Diversion — Blair Athol mine* (Alluvium 2012).

6.1.5 Geotechnical

Geotechnical monitoring will be undertaken by a qualified geotechnical engineer who will assess the stability of post rehabilitation features in the mine.

To comply with EA conditions, a geotechnical stability assessment must be prepared. The report must propose acceptance criteria to meet EA conditions and must investigate void geotechnical stability and make recommendations for safety management. Water quality analysis for end land uses must also be considered.

6.1.6 Vegetation monitoring and soil testing

Vegetation and soil monitoring and testing will be completed as per the *Rehabilitation Management Plan*.

7.0 Closure action plan

The purpose of this section is to describe key actions that will be undertaken to manage residual risks associated with closure of the mine.

7.1 Progressive rehabilitation

Progressive rehabilitation will be undertaken as per the schedule presented in Section 3.4.10.

7.2 Demolition and decommissioning

All infrastructure will be removed from the mine prior to relinquishment unless a written agreement is obtained from a future land holder stating that they will accept the asset.

Once infrastructure has been removed the mine will be remediated (if required) and rehabilitated. The following decommissioning strategy will be used:

TerraCom will appoint a specialist demolition and decommissioning contractor.

- Prior to commencing demolition, the following will be carried out:
  - identification and removal of any assets suitable for re-use and / or sale;
  - identification of infrastructure to remain post-closure and completion of associated written agreements with the future landholders;
  - review of services plan to ensure all underground services are included;
  - decommissioning, de-pressuring and isolation of all energy sources;
  - all chemical and materials storages and services emptied and decontaminated;
  - completion of an updated contaminated land assessment (phase 1 and phase 2 assessment);
  - emptying of storage facilities; and
  - removal and appropriate re-use, recycling or disposal of all dangerous goods and hazardous substances.
- TerraCom will apply to allow for demolition waste that cannot be practicably sold, re-used or recycled to be disposed and encapsulated in void. Waste will otherwise be trucked off-site for disposal in landfill.
- A report will be completed verifying that potentially contaminated land has been remediated as required.

Issues that impact on the demolition and decommissioning methodology will be further considered in a demolition and decommissioning management plan and may include:

- how to deal with live services that cross the demolition site that are being maintained for operations or adjacent facilities;
- identification of any hazardous materials (such as asbestos);
- safety, environmental and security requirements;
- waste management;
- sale of scrap and salvage of assets;
- lay down and storage areas for scrap; and
- contemporary legislative requirements.

7.2.1 Scrap and salvage items

Where practicable, consideration will be given to the Queensland's *Waste and Recycling Strategy* (EHP 2015) waste and resource management hierarchy, in decreasing order of preference as shown in Figure 3.

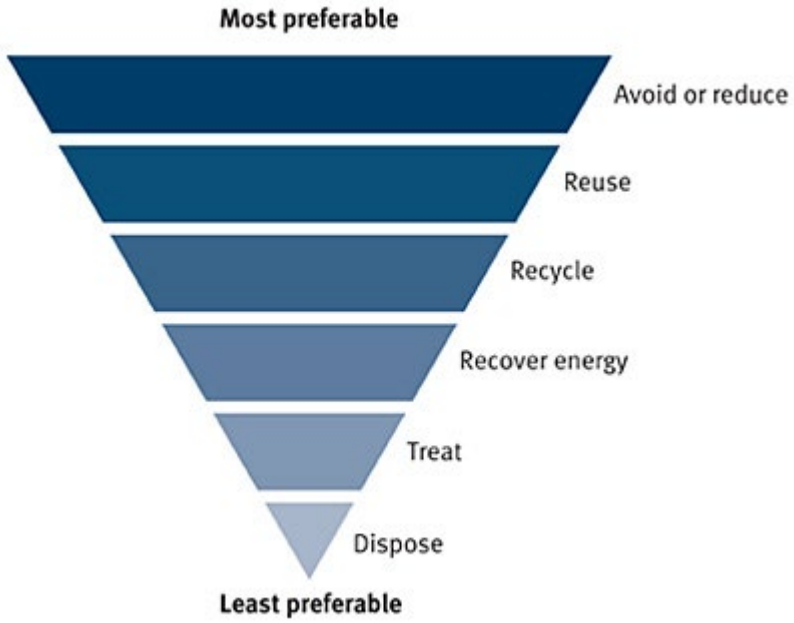


Figure 3 Waste and resource management hierarchy

It is likely that there will be a significant number of items across the mine that may have some residual scrap or salvage value at a sale or auction. Examples of these items include:

- aluminium cladding;
- copper from electrical services and some service pipe work;
- e-waste;
- steel from the CHPP and conveyors;
- mobile equipment; and
- pumps and pump parts.

7.3 Environmental management

7.3.1 Soil stockpiling and application

Appropriate soil management during site activities and rehabilitation is important to the successful rehabilitation of the mine. Soil management during the operation of the mine has included vegetation clearing, soil stripping, stockpiling, grading, ripping and de-compacting and soil conditioning / amelioration.

7.3.1.1 Stockpile measures

Where soil has been stockpiled it has been stored in a manner that ensures stability. Measures have included:

- vegetating stockpiles;
- minimising the height of stockpiles; and
- using stockpiles as soon as possible.

The following stockpile management measures have been adhered to where possible:

- all stockpiles are situated within the mine surface water catchment to prevent any off-lease dispersal of soil due to rainfall;
- weed control has been undertaken as required;

- following stockpile construction, the operation of machinery on stockpiles has been avoided to prevent compaction and maintain soil structure; and
- a stockpile register has been maintained.

7.3.2 Erosion and sediment control

During mine operation, erosion and sediment control plans have been developed using TerraCom's *Erosion and Sediment Control Plan*. General principles for erosion and sediment control have drawn *from Managing Urban Stormwater: Soils and Construction: Volume 1 March 2004* (Landcom 2004) and *Managing Urban Stormwater Volume 2E Mines and Quarries* (Landcom 2008).

The erosion and sediment control plans will continue to be reviewed and updated so that they remain applicable to the rehabilitated landform.

7.3.3 Surface water management

Surface water will be managed in accordance with the site *Water Management Plan.*

7.3.4 Groundwater management

Groundwater is largely confined to the coal seams acting as aquifers. Groundwater is generally saline and makes groundwater usage in the district limited.

The potential impacts on groundwater quality from mining activities include leachate to the groundwater containing dissolved salts and high or low pH from areas such as:

- voids containing pit water;
- landforms; and
- sumps and dams.

There is also potential for affecting the groundwater level at the mine because of pit dewatering operations.

A groundwater monitoring program for the operational phase of the mine has been developed.

Groundwater monitoring will continue during and post rehabilitation of the mine until bores are closed and rehabilitated or until relinquishment of the ML.

7.3.5 Contamination management

Contaminated soils or other potential sources of contamination will be preferentially treated on mine. If contamination cannot be treated, then it may be disposed of at an authorised facility. Treatment versus off-mine disposal will depend on whether domains are listed on the *Contaminated Land Register* (CLR) and *Environmental Management Register* (EMR) (administered by the Queensland Government) and whether it is deemed appropriate to have them removed from the registers as part of the rehabilitation process.

The process for assessing and adding / removing land from the CLR will need to be confirmed with DES at the time of rehabilitation.

7.3.6 Revegetation

The *Revegetation Plan* (SGME 2024) describes revegetation methods, management, objectives, monitoring and maintenance for the mine. Revegetation will entail seeding grasses and trees for a biodiversity land use. Ripping, seeding and fertilising (if required) will be undertaken following the placement of soil and construction of drainage structures on the reshaped landform. Ripping will be carried out to a depth of 0.3-0.5 m on the contour. The

maximum distance between any two rip lines and or rip sets will be 3 m. Seeding and fertilising (if required) will occur immediately after contour ripping, when appropriate.

Revegetated areas will be irrigated if required until vegetation is established or will be timed with the onset of the annual high rainfall periods to avoid the need for watering. Weed inspections and control will be undertaken regularly until vegetation criteria are met.

7.3.6.1 Fauna and vegetation

Most fauna habitat occurs within the undisturbed sections of the ML which were not impacted by mining operations.

7.3.7 Heritage

Cultural heritage will not be damaged in the rehabilitation process.

Plans for the management of cultural heritage will be addressed through stakeholder engagement.

7.4 Health and safety

The mine is operating under a safety and health management system as prescribed by legislation and in accordance with TerraCom internal standards. Any new activities will require appropriate risk management to ensure the mine meets its regulatory commitments.

Updates to the management system based on the assessment of risk will occur as necessary.

A mine based risk assessment will be completed to address mine security and prevention of unintentional access to the mine. Pending the outcome of the risk assessment, an action program will be developed.

The preparation of tender documents for significant works, eg demolition, will require a review of certain aspects of health, safety and the environment. Criteria for each element will be set to appropriately review tender applications. This approach will ensure tender documents provide contractors with appropriate information about potential site hazards and clarify TerraCom's expectations about the management of these hazards during execution of the contract. It also provides contractors with adequate time to plan how to meet TerraCom's expectations and this will reduce the potential for delays associated with non-compliant personnel, training and inductions, and equipment. For example, electrical testing and currency of maintenance schedule.

Post-relinquishment mine safety will be addressed through the achievement of the relevant criteria.

7.5 Landform establishment

The landform and drainage of the mine will direct surface flows preferentially to a void.

Rehabilitated slopes will be constructed no greater than 15% across the ML.

7.6 Geotechnical assessment

Geotechnical monitoring will be undertaken by a qualified geotechnical engineer who will assess the stability and quality of post-rehabilitation features in the mine.

The geotechnical monitoring and associated report must investigate void geotechnical stability and make recommendations to address any safety issues prior to ML surrender. For example, restriction of human access. Safety recommendations in the geotechnical monitoring report must be incorporated into the plan of operations for the mine.

An immediate priority is to complete a geotechnical assessment of rehabilitation landforms. The assessment is required so final rehabilitation criteria can be proposed.

7.7 Rehabilitation maintenance

Maintenance of rehabilitated areas must take place to demonstrate:

- stability of landforms;
- erosion control measures remain effective;
- stormwater runoff and seepage from rehabilitated areas does not negatively affect the environmental values of any waters;
- plants show healthy growth and recruitment is occurring; and
- rehabilitated areas are managed to reduce the presence of declared pest plants.

Maintenance activities on rehabilitation areas will be guided by general inspections and rehabilitation monitoring results. Maintenance activities may include:

- addition of fertiliser or other ameliorants;
- re-planting of significant areas of failed vegetation;
- upkeep of water management structures; and
- replacement and repairs to fencing and signage.

The maintenance requirements of rehabilitated land are not to be more than that required for the land as expected for the next land use.

References

Alluvium 2011, *Monitoring design report: Western Waterway Diversion — Blair Athol mine,* prepared for Rio Tinto Coal Australia by Alluvium Consulting.

Alluvium 2012, *Monitoring design report: Eastern Waterway Diversion — Blair Athol mine,* prepared for Rio Tinto Coal Australia by Alluvium Consulting.

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (2000). *Australian and New Zealand guidelines for fresh and marine water quality Volume 1*.

Australian Government (2006). *Community Engagement and Development – Leading practice sustainable development program for the mining industry*, developed by a Working Group of experts, industry, and government and nongovernment representative, October 2006.

Australian Government (2012). *Minimum Construction Requirements for Water Bores in Australia*, accessed at https://www.dnrm.qld.gov.au/__data/assets/pdf_file/0009/99765/minimum-construction-req-au.pdf

Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Bureau of Meteorology (2014). *State of the Climate 2014*, accessed at http://www.bom.gov.au/state-of-the-climate/2014/.

Department of Environment and Heritage Protection (EHP) (2013). *Water Quality Sampling Manual 2009*, accessed at https://www.ehp.qld.gov.au/water/pdf/monitoring-man-2009-v2.pdf.

Department of Environment and Heritage Protection (EHP) (2014). *Rehabilitation requirements for mining resource activities*, accessed at https://www.ehp.qld.gov.au/assets/documents/regulation/rs-gl-rehabilitation-requirements-mining.pdf.

Department of Environment and Heritage Protection (EHP) (2015). *Queensland's waste and recycling strategy*, accessed at https://www.ehp.qld.gov.au/waste/pdf/queensland-waste-strategy-quick-guide.pdf.

Department of Minerals and Energy (DME) (995). *Technical guidelines for the environmental management of exploration and mining in Queensland*, Queensland Government, Brisbane.

Division of Resources and Energy (DRE) (2013). *ESG3: Mining operations Plan (MOP) Guidelines*, September 2013.

Environmental Geochemistry International (Egi), (2007). *Geochemical Assessment of Rejects and Tailings from the Blair Athol Coal Washery Plant.* Report prepared for BAC JV.

Landcom 2004, *Managing Urban Stormwater: Soils and Construction, Volume 1*, 4th edition. Sydney.

Landcom 2008, *Managing Urban Stormwater Soils and Construction: Volume 2E Mine and Quarries*. Sydney.

Rosser J, Suatz GL, Dawson NM & Briggs HS (1974.) *A land capability classification for agricultural purposes. Qld*. Department of Primary Industry.

TerraCom Limited (TerraCom) (2017). *Blair Athol Coal Mine Growth Media — Mitigation & Management Strategy*. Report prepared for TerraCom Limited.

SGME Pty Limited (2024). *Revegetation Plan: Blair Athol Coal Mine*. Report prepared for TerraCom Limited.

URS Australia Pty Limited (2006). *Site history review and limited Phase 2 environmental site assessment, Blair Athol Coal mine*, Clermont, QLD, Sept 2006. Report prepared for Rio Tinto Coal Australia.

URS Australia Pty Limited (2008). *Post Phase 2 environmental site assessment, Sept 2008*. Report prepared for Rio Tinto Coal Australia.

SGM Environmental Pty Limited (SGME) is a boutique consulting firm of experienced industry experts working with our clients and their stakeholders to develop and deliver innovative solutions to complicated challenges that create enduring value.

SGME was established to provide services in soil science, geochemistry, mine closure and Environmental management, planning & approvals cost efficiently. When you engage SGME you engage a partner to your business, priding themselves on:

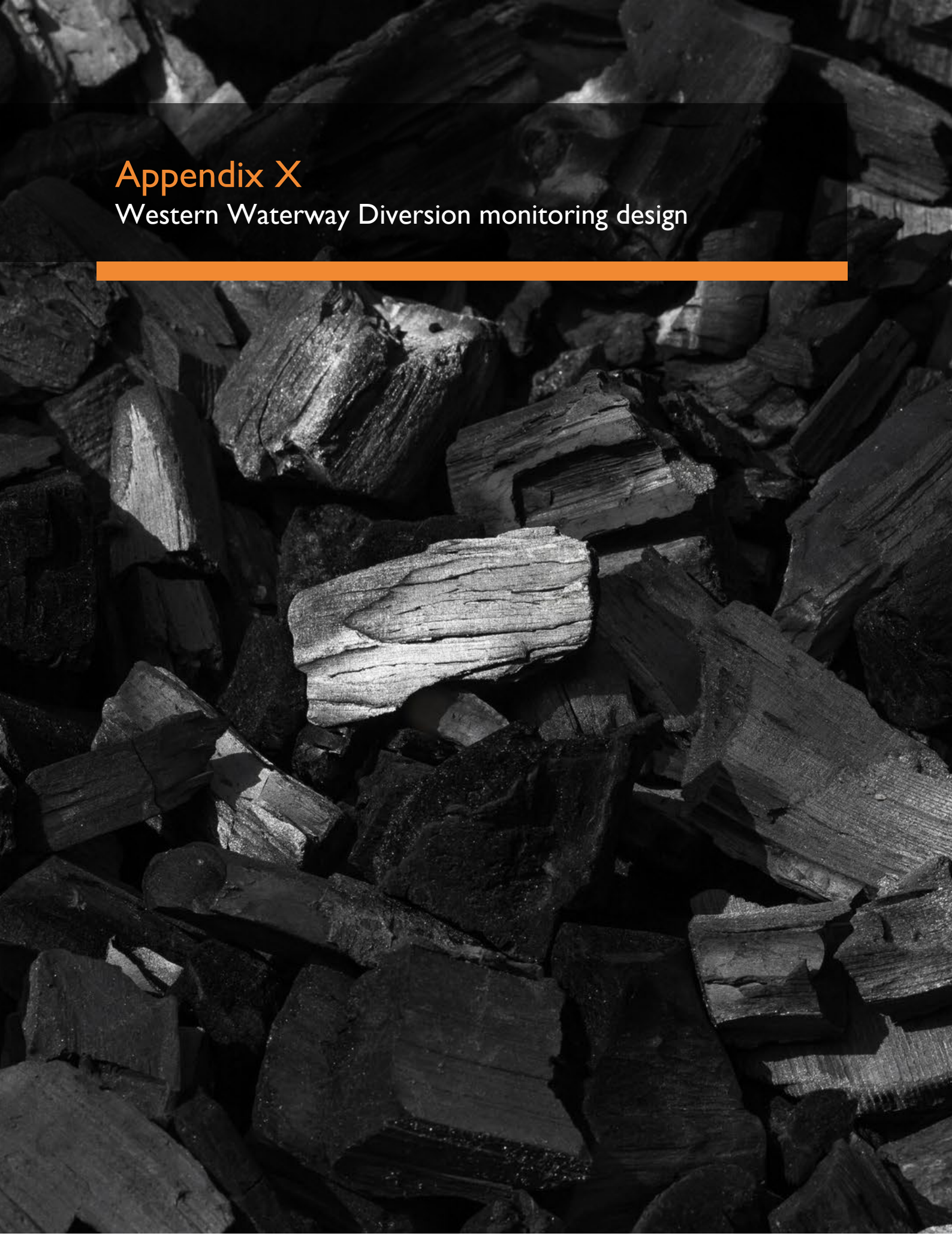
Honest – Straight-up and no nonsense.

Trust – We say what we mean and we will deliver on our promises. We will advocate strongly for you.

Innovation – We will always look for new ways to help and create enduring value because that is what friends do when they work together.

Safety – We do it right so we all go home safely.

Australian Location
PO Box 5622, Stafford Heights, Qld 4053
Tel +61 7 3148 6288
Email admin@sgmenvironmental.com
Web sgmenvironmental.com



Appendix X

Western Waterway Diversion monitoring design

This page is intentionally blank.

alluvium

MONITORING DESIGN REPORT:

Western Waterway Diversion – Blair Athol mine

May 2011

RioTinto

Document history

L:\Projects\2011\P211004_BA_design&monitoring\1_Deliverables\P211004_R01V1.0_BCW_monitoring_design.doc

REVISION

ISSUE DATE	VERSION NO.	AUTHOR(S)	CHECKED	APPROVED
13 May 2011	1	R Lucas (RPEQ)	L Sunner	R Lucas (RPEQ)

DISTRIBUTION

VERSION NO.	ISSUED TO	DESCRIPTION
V1.0	Darren Springer	For comment

Contents

Document history i

Contents ii

List of tables ii

List of figures iii

1 Introduction 1

1.1 Location 1

2 Baseline Monitoring 3

2.1 Overview 3

2.2 Index of Diversion Condition 4

2.3 Terrestrial and Riparian Vegetation monitoring 6

2.4 Flow events 6

3 Future Monitoring 7

3.1 Construction Monitoring 7

3.2 Operations Monitoring 7

3.3 Relinquishment Monitoring 8

4 References 11

List of tables

Table 1. Western waterway diversion monitoring package components 1

Table 2. Baseline Monitoring Components 3

Table 3. Construction monitoring components 7

Table 4. Operations monitoring components 7

Table 5: Relinquishment monitoring components 8

Table 6. Indicative timetable for future monitoring 10

List of figures

Figure 1. Location of Blair Athol mine 2

Figure 2. Proposed monitoring point locations 5

1 Introduction

A reconfiguration of the Breaker Creek diversion (known as the western waterway diversion) is proposed at Blair Athol mine. This diversion has the potential to increase flow rates, duration and frequency in Bath Creek West downstream of the diversion. As part of the assessment of any potential impacts the diversion may have and as a means of tracking the performance of the diversion a monitoring program is proposed.

The detailed design of the diversion which is a result of extensive impact assessment is in *Seam 4 Diversions – Western Waterway Diversion, Detail Design Summary Report* (Alluvium Consulting, November 2010).

The diversion monitoring program proposed is based upon the "Monitoring and Evaluation Program for Bowen Basin River Diversions" (ID&A 2001) undertaken for the Australian Coal Association Research Program. This monitoring program is considered best practice for Bowen Basin diversion at present and is the method accepted by the Department of Environment and Resource Management (DERM).

The proposed monitoring program is summarised in Table 1 and detailed in following sections of this report.

Table 1. Western waterway diversion monitoring package components

MONITORING PACKAGE COMPONENTS	OBJECTIVE
1: Baseline monitoring	To establish a baseline data set that can be used for comparison when applying for licence renewal and relinquishment.
2: Construction monitoring	To demonstrate works have been undertaken to specification.
3: Operations monitoring	To maintain channel condition, reduce risk to mining infrastructure and the environment and facilitate licence renewal.
4: Relinquishment monitoring	To demonstrate the diversion is operating as a waterway in equilibrium and not adversely impacting on adjoining reaches.

1.1 Location

Blair Athol Mine (BA) is located in the Bowen Basin in Central Queensland, 25 km north-west of the township of Clermont, as shown below in **Error! Reference source not found.**.

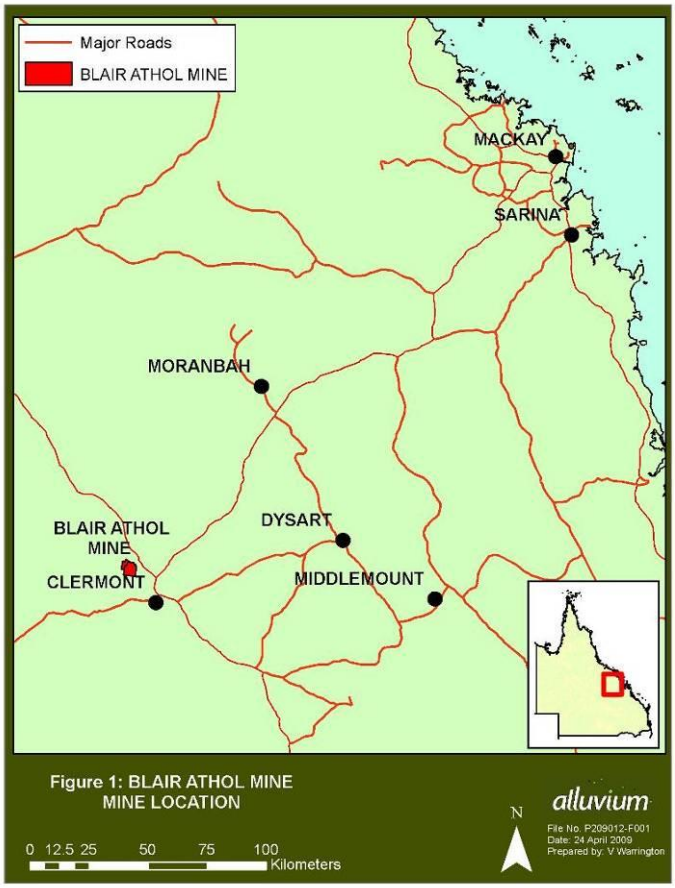


Figure 1. Location of Blair Athol mine

2 Baseline Monitoring

2.1 Overview

Baseline monitoring is undertaken to:

- establish a baseline data set that can be used for comparison when applying for licence renewal and relinquishment, and
- compare the performance of the diversion during its operation over time to itself and adjacent reaches.

The Baseline Monitoring Program has been based upon the "Monitoring and Evaluation Program for Bowen Basin River Diversions" (ID&A 2001) undertaken for the Australian Coal Association Research Program and consists of:

- Index of Diversion Condition (including the establishment of photopoints)
- aerial photograph prior to construction
- survey (cross sections and long section)
- vegetation information recorded as part of Index of Diversion Condition (IDC) assessment (see section 2.2, page 4) and
- flow event information.

Further details are provided in Table 2, page 3.

Table 2. Baseline Monitoring Components

BASELINE MONITORING UNDERTAKEN	
Index of Diversion Condition	IDC will be undertaken for each of the reaches, upstream control reach, reach to be diverted; and downstream reach. As part of the IDC assessment, photographs will be taken to record the condition of Breaker Creek and Bath Creek West before diversion construction. Photographs will be taken of the upstream control reach, the downstream reach and the reach to be diverted. The photographs will be taken from fixed points along the upstream and downstream reaches to allow future comparisons.
Aerial Photographs	An aerial photograph displaying the existing condition of the creek and also the location of the new diversion has to be taken prior to works beginning. This is added to the baseline monitoring database.
Survey	Detailed topographic survey of the monitoring reaches must be undertaken by Blair Athol Mine prior to construction. This information is included as part of the monitoring database report. This information will be used to monitor the performance of the diversion during its operation and contribute to relinquishment monitoring to demonstrate the diversion has had no adverse impacts on upstream and downstream reaches. The cross-sections generated from the survey need to include changes in bank shape. Cross-sections are located on meanders and straight sections to monitor horizontal and vertical displacement of the channel
Vegetation	The associations and condition of vegetation in each of the reaches is assessed as a record of its pre diversion state. .
Flow events	Information regarding the size and frequency of flow events will be assessed by debris marks and hydrologic data compiled as part of the engineering design process.

2.2 Index of Diversion Condition

Index of Diversion Condition (IDC) is a method of recording and monitoring the condition of diversions and adjacent upstream and downstream reaches and was developed for diversions in the Bowen Basin as part of the ACARP program "*Monitoring and Evaluation Program for Bowen Basin River Diversions"* (ID&A 2001). IDC provides a rapid assessment of the condition of diversions and adjoining stream reaches.

The purpose of the IDC is to flag potential management issues rather than provide a scientific assessment of a diversion or stream. It is an integrated suite of indicators that measures the geomorphic and riparian condition of a diversion and its upstream control and downstream reaches. The geomorphic and riparian condition (index) of a reach is each given a score out of 10 and the sum of these provides the IDC score.

For this monitoring program, four reaches are proposed for IDC. These reaches are:

- Upstream reach – upstream of diversion
- Diversion reach – includes the two existing diversions which will be subject to minor modification to facilitate this new diversion arrangement
- Proximal downstream reach – beginning immediately downstream of the diversion
- Downstream reach – further downstream on Bath Creek West through to Bath Creek

Within each reach four transects of approximately 50 m long are equally spaced apart. The following indicators for the geomorphic index and riparian index are then assessed within each transect.

Indicators for Geomorphic Index

- Width of high flow channel, active channel and low flow channel
- Bank condition
- Piping of banks
- Bed condition
- Spoil piles
- Recovery
- Instream structures

Indicators for Riparian Index

- Width of riparian zone
- Structural intactness
- Regeneration
- Longitudinal continuity

Each indicator is assigned a score at each transect. The average scores for each indicator from the four transects are then used to calculate the overall score for the geomorphic index and riparian index in each reach. The sum of the geomorphic and riparian index is then calculated to determine the score for the IDC.

The location of proposed monitoring transects and reaches are shown on Figure 2.

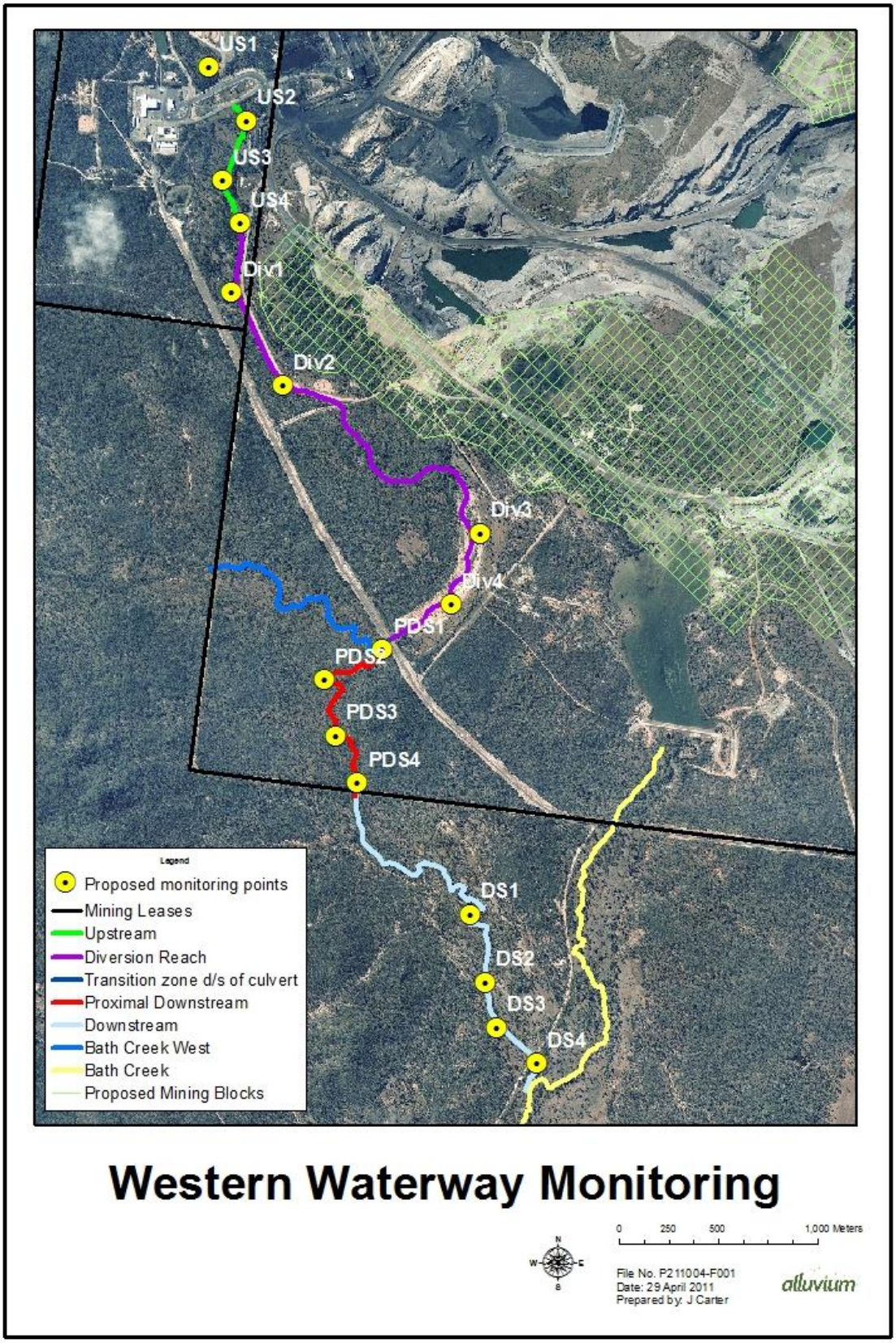


Figure 2. Proposed monitoring point locations

2.3 Riparian vegetation monitoring

In addition to the Riparian Index assessment, riparian and terrestrial vegetation will be assessed in all reaches using detailed site assessment and Regional Ecosystem mapping. This will allow for future comparison of upstream and downstream reaches with the diverted reach to identify key species absent from the diversion reach but present in control reach and to determine the success of the vegetation management plan, which aims to re-create a “natural” reach of channel that will be sustainable over the long term.

2.4 Flow events

Breaker Creek and Bath Creek West are currently un-gauged and as such no baseline flow data is available. Peak flow rates for various Average Recurrence Interval events were estimated from hydrologic modeling for the design. If no flow gauging is installed, when flows occur during operation of the diversion, the flow height can be recorded and compared to those in the hydraulic model to determine the approximate ARI of the flow event.

Flow information will be an essential element of monitoring data when assessing monitoring results as part of license relinquishment for diversions. Installing a station that monitors for both water quantity and quality should be considered.

Monitoring can be as simple as water soluble paint on surveyed marker staffs at varying bank heights and/or check and survey of flood debris post flow event. This will need to be monitored by a person on site who is able to check, when safely able to do so, following flow events. Dates of flow events should be recorded together with site rainfall data.

3 Future Monitoring

3.1 Construction Monitoring

Construction monitoring should be undertaken during and immediately after construction. The purpose of this stage is to demonstrate that works have been undertaken to specification, which is expected to be a requirement in the licence conditions.

Table 3. Construction monitoring components

CONSTRUCTION MONITORING REQUIREMENTS	
Execution outputs	An execution output database should be established to record descriptions of the construction activities completed. The date of activity completion should be noted along with details of any accompanying photographs. Construction activities not completed to specification should be recorded in the database along with an explanation and details of the modified design.
Photographs	Photographs should be taken during construction and immediately after the work is finished. Certain features of the diversion such as instream structures should have several photographs depicting different stages of their construction. Photographs should be taken from fixed photopoints where possible and details such as date, time and weather conditions should accompany the photographs.
Aerial photographs	If practical, an aerial photo should be taken immediately after diversion construction or rehabilitation has been completed. These photographs would accurately display the extent of change and provide a baseline reference for changes that may occur in the future.

Execution database

Works	Specification	Completed to Specification?	Completed

3.2 Operations Monitoring

The purpose of this monitoring is to maintain channel condition and reduce risk to mining infrastructure and the environment while also facilitating licence renewal.

Table 4. Operations monitoring components

OPERATIONS MONITORING REQUIREMENTS	
Survival of works	The survival of instream structures and works such as riprap and vegetation should be assessed during this phase of monitoring. Early detection of damage is likely to increase the options for remedial action.
Photographs	Photographs should continue to be taken from fixed photopoints in the

	control reach and downstream reach set up during the baseline monitoring. The diversion reach fixed photopoints established as part of the construction monitoring should also be repeated during IDC assessment.	
Aerial photographs	Aerial photographs of the control reach, diversion reach and downstream reach should be taken on an annual basis.	
Visual assessment	The control reach, diversion reach and downstream reach should be visually assessed using the IDC, which should be repeated in each of the years identified in Table 6., page 10. This inspection would include assessment of:	
(Index of Diversion Condition)	• bank condition • piping • bed condition • recovery • proximity of spoil piles from bank	• stability of instream structures • structural intactness of vegetation • regeneration of vegetation • longitudinal continuity of vegetation

The field data should be transferred into the IDC spreadsheet and added to the database established during baseline monitoring. The data can then be used to assist with comparing any changes.

3.3 Relinquishment Monitoring

The objective of this phase is to demonstrate that the diversion is operating as a waterway in equilibrium and not having an adverse impact on adjoining reaches.

Table 5: Relinquishment monitoring components

RELINQUISHMENT MONITORING REQUIREMENTS	
Survey 1	Long-section and cross-section survey should be conducted during the first year of relinquishment monitoring. The survey should include the control reach, diversion reach and downstream reach. This survey will then be able to be compared to the 'as built' long-section to assess the change in bed elevation.
Stage 1 evaluation	Survey data from baseline and operations monitoring should be compared with data from relinquishment monitoring. Rates of change for channel top width, cross-section area, horizontal and vertical displacement can then be calculated.
Vegetation assessment	Detailed vegetation assessment should be conducted during the first year of relinquishment monitoring to determine key species absent from the diversion reach but present in control reach where this is appropriate. However, this must also take into account the fact that the diversion may be constructed in ground higher than the lower lying floodplain, containing larger flows in channel rather than engaging with an adjacent floodplain. The diversion reach may therefore have different geomorphic and ecological characteristics than the reach it will be replacing.
Photographs	Photographs should be taken from the fixed photo points in the control, diversion and downstream reaches.
Aerial	Aerial photos of diversion and control, diversion and downstream

RELINQUISHMENT MONITORING REQUIREMENTS	
photographs	reaches should continue to be taken on an annual basis.
Survey 2	A final long-section and cross-section survey should be conducted prior to application for licence relinquishment.
Stage 2 evaluation	All data should be evaluated and photographs collated for presentation in a report to regulators.
Survey	Long-section and cross-section surveys should be conducted in the control reach, diversion reach and downstream reach. These surveys should be repeated every biannually or after a major flood event (e.g. 20 year ARI event).
Flow events	Flow events should be monitored to determine the size of events the diversion has been subjected to.

Monitoring Package	Monitoring Activity	Year of diversion operation																					
		Prior to Construction of Diversion	During Construction	First year of Diversion operation	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Baseline monitoring	Photographs																						
	Aerial photographs																						
	Survey																						
	Vegetation																						
	Flow events																						
Construction monitoring	Execution outputs																						
	Photographs																						
	Aerial Photographs																						
Operations monitoring	Survival of works																						
	Photographs																						
	Aerial Photographs																						
	Index of Diversion Condition																						
	Survey																						
	Flow events																						
Relinquishment Monitoring	Survey 1																						
	Stage 1 evaluation																						
	Vegetation assessment																						
	Photographs																						
	Aerial photographs																						
	Survey 2																						
	Stage 2 evaluation																						

Table 6. Indicative timetable for future monitoring

4 References

ID&A, 2001. *Monitoring and Evaluation Program for Bowen Basin River Diversions*, Australian Coal Association Research Program.



Appendix Y

Eastern Waterway Diversion monitoring design

This page is intentionally blank.

alluvium

MONITORING DESIGN REPORT:

Eastern Waterway Diversion – Blair Athol Mine

January 2012

RioTinto

Document history

Version and Revision:

Version no.	1.0
Author/s	Joanne Crerar Luke Sunner
Checked	Rohan Lucas
Approved	Rohan Lucas

Distribution:

Version no.	1.0
Issue date	January 2012
Issued to	Sandra Verano – Environmental Project Officer (Projects and Closure – Clermont Region)
Description:	DRAFT for comment

Citation:

Please cite this document as: Alluvium. (2012). Eastern Waterway Diversion Monitoring Design Report for Rio Tinto Coal Australia – Blair Athol Mine, PO Box 177, Clermont QLD 4721, Australia.

Acknowledgements:

Ref: \\server1\departments$\Projects\2011\P211004_BA_design&monitoring\1_Deliverables\P211004_R09V1.0_EWD_monitoring_design.docx

Contents

1 Introduction 1

1.1 Eastern Waterway diversion[s] and mining influences 1

1.2 Overview of diversion details 5

1.3 Previous surveillance inspection reports 7

1.4 Previous reports prepared by Alluvium for the Eastern Diversion Waterway 7

1.5 The monitoring program 8

2 Baseline monitoring 9

2.1 Index of Diversion Condition (IDC) 10

2.2 Vegetation 15

2.3 Flow event monitoring 15

2.4 Cross and long section comparisons 15

3 Future monitoring 16

4 References 18

Figures

Figure 1-1. *Overview of BA waterways* 2

Figure 2-1. *Rail Loop Diversion monitoring overview* 12

Figure 2-2. *Eastern Waterway Diversion monitoring overview* 13

Tables

Table 1-1. Eastern Waterway Diversion licences (most up to date provided to Alluvium) 3

Table 1-2. Rail Loop Diversion details overview 5

Table 1-3. Eastern Diversion Waterway details overview 6

Table 1-4. Eastern Waterway Diversion monitoring package components 8

Table 2-1. Baseline Monitoring Summary 9

Table 2-2. Location of monitoring photo points 14

Table 3-1. Construction/Establishment monitoring requirements 16

Table 3-2. Operations monitoring requirements 16

Table 3-3. Relinquishment monitoring requirements 17

Abbreviations

Alluvium	Alluvium Consulting
BA	Blair Athol Mine
DERM	Department of Environment and Resource Management
DTM	Digital terrain model
EWD	Eastern waterway diversion

EDW	Eastern diversion waterway
IDC	Index of Diversion Condition
ML	Mining Lease
RPEQ	Registered Professional Engineer of Queensland
RTCA	Rio Tinto Coal Australia Pty Ltd
WSPL	Water Solutions Pty Ltd

Glossary

Eastern Waterway Diversion – synonymous with Eastern Diversion Waterway

1 Introduction

The development of Blair Athol Mine (BA) has intercepted a number or waterways which flow towards the mine from the west, north and east including Breaker, Washpool and Bath Creeks and Ti-Tree gully, all part of the Bath Creek system which is a tributary in the Theresa Creek subcatchment of the Fitzroy River. This resulted in a number of watercourse diversions to divert flows around the eastern and western extents of mining operations. Alluvium refers to the diversions and their contributing catchments as the Eastern and Western Waterways shown in Figure 1-1.

The monitoring program for the Western Waterways is reported in "*Monitoring Design Report: Western Waterway Diversion – Blair Athol Mine*" prepared by Alluvium in May 2011.

This report outlines the monitoring program to be undertaken for the Eastern Waterway diversions (some of which has already been undertaken). A discussion on the diversions constituting the eastern waterway, mining influences and licencing follows.

1.1 Eastern Waterway diversion[s] and mining influences

Since the development of mining operations at BA a number of connected diversions have been developed at different stages to divert creek flows and non-mine affected water around the eastern extent of operations into the environmental dam and ultimately off site. Collectively, this series of connected diversions is known as the Eastern Waterway Diversion or Eastern Diversion Waterway (the terms are used synonymously throughout Alluvium reporting). Development of this diversion in a number of stages has resulted in BA holding a number of separate water licenses for the following diversions that form the Eastern Diversion Waterway:

- Northern Boundary Drain
- Eastern Diversion Realignment
- Eastern Diversion
- South Eastern Diversion

Table 1-1 presents the water licences provided to Alluvium by BA.

The Rail Loop Diversion is west of the West Dam and diverts flows from Breaker Creek North into the West Dam via Washpool Creek. Therefore this diversion has been included into the monitoring program for the Eastern Waterway.

The Eastern Waterway Diversion takes flows from West Dam and Washpool Creek East in the north, and Bath Creek and Ti-Tree Gully from the east and currently discharges into the Environmental Dam. Overflows from the Environmental Dam flow down Bath Creek. Bath Creek is a tributary in the Theresa Creek subcatchment of the Fitzroy River.

BA plan to divert the Eastern Diversion Waterway to allow development and extraction of Seam 4 coal, allowing the mine to continue operating. The preferred diversion option is to permanently divert the Eastern Diversion Waterway upstream of the Environmental Dam, within the ML, into Bath Creek East. This diversion has the potential to increase flow rates, duration and frequency in Bath Creek East downstream of the diversion to the confluence with Bath Creek several kilometres downstream. A number of reports have been prepared by Alluvium for design and impact assessment of this proposed diversion and are listed in section 1.4 of this report.

The Eastern Waterway Diversion Monitoring Program is set up to monitor the impacts and performance of the diversion waterway[s], including Bath Creek East downstream to the confluence with Bath Creek. This will enable detection of maintenance issues and ultimately provide a performance record over time, which will

assist with licence renewal and ultimately relinquishment sometime at or beyond the cessation of BA mining activities.

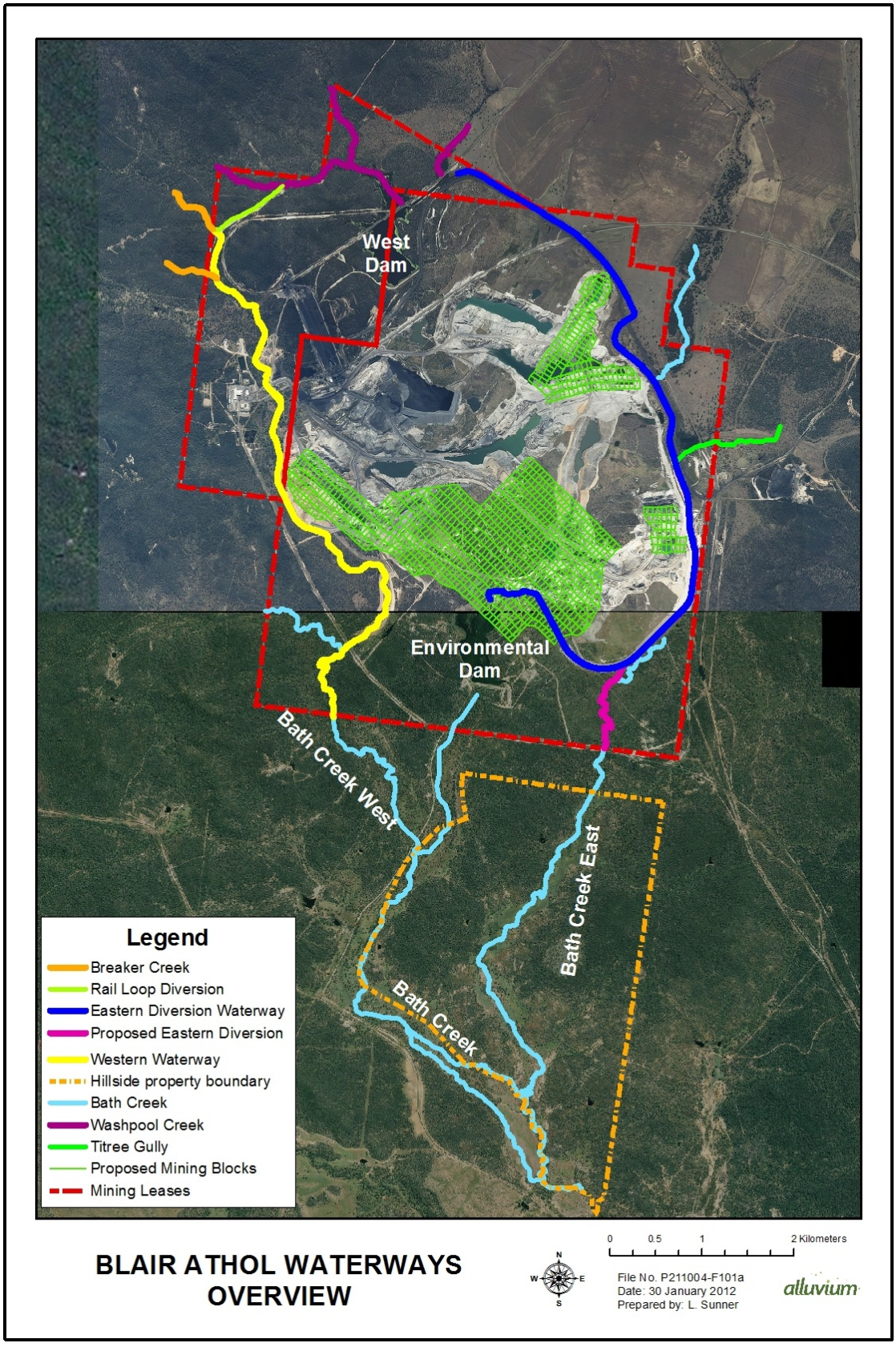


Figure 1-1. ***Overview of BA waterways***

Table 1-1. Eastern Waterway Diversion licences (most up to date provided to Alluvium)

Activity	Licence	Relevant licence conditions	Additional notes:
Interfere with the flow of water in WASHPOOL CREEK by changing the course of flow on or adjoining land described as Mining Lease 1804.	Development Permit 145470. Water Licence 48361F. Licence expiry 30/11/2010.	A monitoring report must be prepared by an RPEQ at each renewal of the water licence or at any time if alarming, unusual or otherwise unsatisfactory conditions are observed. The report must detail the following: • Performance of the diversion by way of comparison with the design report, plans and specifications. • Surveys to identify and quantify any changes to the channel bed and profiles. • Detail any remedial works to be undertaken including a timetable for completion of proposed works. • Any recommendations on measures to be taken to ensure the physical integrity of the works.	Interference with the flow for a length of 2980m. Northern Boundary Diversion. **Associated licences:** Water Licence 38931F (West Dam). Water Licence 100915 (Eastern Diversion). Water Licence 101815 (South Eastern Diversion). Water Licence 38929F (Environmental Dam).
Interfere with the flow of water in BATH CREEK by changing the course of flow on or adjoining land described as Mining Lease 1804.	Development Permit 116037. Water Licence 100915. Licence expiry 17/11/2011.	A monitoring report must be prepared by an RPEQ at each renewal of the water licence or at any time if alarming, unusual or otherwise unsatisfactory conditions are observed. The report must detail the following: • Performance of the diversion by way of comparison with the design report, plans and specifications. • Surveys to identify and quantify any changes to the channel bed and profiles. • Detail any remedial works to be undertaken including a timetable for completion of proposed works. • Any recommendations on measures to be taken to ensure the physical integrity of the works.	Additional location description: Construction of diversion works on BATH CREEK via a Channel with the following dimensions: Length 2138m. Bath Creek (Eastern) Diversion. **Associated licences:** Water Licence 48368F (Breaker Creek Diversion) Water Licence 38931F (West Dam). Water Licence 48361F (Northern Diversion). Water Licence 101815 (South Eastern Diversion).
Interfere with the flow of water in an UNNAMED TRIBUTARY OF BATH CREEK by changing the course of flow on or adjoining land	Water Licence 101815. Licence expiry 31/03/2012.	The interference with the flow of water authorised by this water licence is considered to be temporary and subject to future requirements of approved final mine site rehabilitation plans for the mining leases. The temporary interference with the flow has been approved on the understanding that the licensee will further investigate and complete detailed design of a permanent location of the diversion.	South Eastern Diversion.

Activity	Licence	Relevant licence conditions	Additional notes:
described as Mining Lease 1804.			
Interfere with the flow of water in an UNNAMED TRIBUTARY OF WASHPOOL CREEK by changing the course of flow on or adjoining land described as Mining Lease 1881.	Development Permit 145476. Water Licence 48368F. Licence expiry 30/11/2010.	The water licence is temporary until the licensee negotiates acceptance from the Department of Natural Resources and Water (now DERM) for the end of mine life rehabilitation of the Unnamed Tributary of Washpool Creek. A monitoring report must be prepared by an RPEQ at each renewal of the water licence or at any time if alarming, unusual or otherwise unsatisfactory conditions are observed. The report must detail the following: • Performance of the diversion by way of comparison with the design report, plans and specifications. • Surveys to identify and quantify any changes to the channel bed and profiles. • Detail any remedial works to be undertaken including a timetable for completion of proposed works. Any recommendations on measures to be taken to ensure the physical integrity of the works.	Interference with the flow for a length of 650m including the construction of the levee system. Breaker Creek (Rail Loop) Diversion. **Associated licences:** Water Licence 38931F (West Dam). Water Licence 48361F (Northern Diversion). Water Licence 100915 (Eastern Diversion). Water Licence 101815 (South Eastern Diversion).

1.2 Overview of diversion details

Rail Loop Diversion
The Rail Loop Diversion diverts flows from Breaker Creek North to West Dam via a diversion and a short section of Washpool Creek West. The diversion consists of two distinct sub reaches including a 210m (approx.) long section of flood-out area where water pools against a levee during flow events and a 650m long channel from the flood out area to discharge to West Dam via a short section of Washpool Creek. The levee effects the diversion of flows up to an elevation of approximately 328.0m AHD at which flows overtop the levee via a spillway (known as the Bywash channel) and continue down Breaker Creek, through the Western Waterway system. Some basic details of the diversion are presented in Table 1-2.

It is understood the Rail Loop Diversion is considered to be temporary as at some point in the future it is likely the Rail Loop Diversion may be decommissioned. The timing of this is presently not certain and is likely to occur once Clermont Mine discontinues using water from the West Dam.

Table 1-2. Rail Loop Diversion details overview

Item	Characteristic	Value	Source
Levee	Max. height	5.0m 4.5m (approx.)	Water Solutions Pty Ltd (WSPL), 2010 Aerial survey supplied by BA
	Max. elevation	330.0m AHD (approx.)	WSPL, 2010 and aerial survey supplied by BA
	Length	300m	WSPL, 2010
Levee bywash channel	Base width	18.0m 19.0m (approx.)	WSPL, 2010 Aerial survey supplied by BA
	Invert elevation	328.0m AHD 328.1m AHD (approx.)	WSPL, 2010 Aerial survey supplied by BA
	Length	100m (approx.)	Aerial survey supplied by BA
Diversion channel	Length	650m	WSPL, 2010 and Aerial survey supplied by BA
	Top width	26m Varies 15-35m	WSPL, 2010 Aerial survey supplied by BA and inspection
	Base width	5m Varies 4-10m	WSPL, 2010 Aerial survey supplied by BA and inspection
	Depth	7.0m Varies 4-5.5m	WSPL, 2010 Aerial survey supplied by BA and inspection
Culvert crossing	Culvert cells	3/1350mm dia	WSPL, 2010
	Culvert length	24m	Aerial survey supplied by BA
	Embankment elevation	331.0m AHD 331.6m	WSPL, 2010 Aerial survey supplied by BA

Eastern Diversion Waterway (Northern Boundary Drain, Eastern Diversion/Eastern Diversion Realignment and South-Eastern Diversion)
The Eastern Diversion Waterway was built to divert water from the eastern waterways (Washpool and Bath Creeks and Ti-tree Gully) around the eastern extent of mining operations. The diversion channel present today was built and realigned in a number of stages and consists of a number of parts over which BA hold water licences:

- Northern Boundary Drain
- Eastern Diversion Realignment
- Eastern Diversion

- South Eastern Diversion

Ideally, these water licences will be converted into one licence covering the entire Eastern Diversion Waterway.

The Eastern Diversion Waterway commences immediately downstream of the West Dam control weir and extends for approximately 9.0km to the Environmental Dam. There are two major culvert crossings of the diversion, the conveyor crossing (for Clermont Mine) and Harrisons Haul Road crossing and there are a number of bed level access track crossings. There are also inlet structures for Washpool Creek (drop structure) and Bath Creek (culverts). It is thought there are culverts at the Ti-tree gully confluence however, water levels prevented confirmation of this during previous site inspections. Some basic details of the diversion are presented in Table 1-3.

Table 1-3. Eastern Diversion Waterway details overview

Item	Characteristic	Value	Source
Northern Boundary Drain diversion channel	Length	2950m	WSPL, 2010
	Top width	Varies,15-40m approx.	Aerial survey supplied by BA
	Base width	6.0m	WSPL, 2010
	Depth	Varies, max.15m approx.	Aerial survey supplied by BA
Washpool Ck drop structure	Crest width	16.0m	WSPL, 2010
	Crest level	322.0m AHD	WSPL, 2010
	Drop	8.0m	WSPL, 2010
Conveyor crossing culverts	Culvert cells	2/4000mm dia	SKM Drawing # 3000-DG-CC-0132
	Culvert length	68.9m	SKM Drawing # 3000-DG-CC-0132
	Embankment elevation	323.5-323.8m 323.3m approx.	SKM Drawing # 3000-DG-CC-0132 Aerial survey supplied by BA
Harrison's Haul Road crossing culverts	Culvert cells	2/4500mm dia	SKM Drawing # 3000-DG-CC-0133
	Culvert length	67.83m	SKM Drawing # 3000-DG-CC-0133
	Embankment elevation	319.0m approx.	Aerial survey supplied by BA
Eastern Diversion/Re-alignment diversion channel	Length	2138m	WSPL, 2010
	Top width	Varies, 25-95m approx.	Aerial survey supplied by BA
	Base width -u/s of Bath Ck -bt. Bath Ck&Ti-Tree Gully -d/s of Ti-Tree Gully	 6.0m 20.0m 20.0m	 WSPL, 2010 WSPL, 2010 WSPL, 2010
	Depth		
Eastern Diversion/Re-alignment levee	Length	1380m	WSPL, 2010
	Crest width	4m	WSPL, 2010
	Elevation		
South-Eastern Diversion channel	Length	3184m	WSPL, 2010
	Top width	Varies, 10-50m approx.	Aerial survey supplied by BA
	Base width	10m	WSPL, 2010

1.3 Previous surveillance inspection reports

Monitoring of the Eastern Waterway Diversion[s] and the Rail Loop Diversion has previously been undertaken by WSPL for a number of years using a surveillance inspection style assessment. A list of these reports, provided by BA, is provided here:

- *Waterworks Licensing Surveillance Inspection Report May 2008* (Water Solutions Pty Ltd, 2008)
- *Waterworks Licensing Surveillance Inspection Report July 2009* (Water Solutions Pty Ltd, 2009)
- *Waterworks Licensing Surveillance Inspection Report October 2010* (Water Solutions Pty Ltd, 2010)

The previous surveillance inspection locations have been utilised where suitable.

1.4 Previous reports prepared by Alluvium for the Eastern Diversion Waterway

The following reports have been prepared by Alluvium in relation to the proposed diversion of the Eastern Diversion Waterway into Bath Creek East and provide much background information:

- *Seam 4 Diversions – Design Review* (Alluvium Consulting, 2009) – an options report to review existing site conditions, existing waterway diversion proposals and to provide and test alternative diversion options for the Eastern and Western Diversion waterways of Bath and Breaker Creeks respectively. The report was prepared for presentation to BA and DERM to seek agreement and approval to proceed with preferred diversion options.
- *Seam 4 Diversions – Design Review* (Alluvium Consulting, 2010a) – an addendum options report to provide additional assessment requested by DERM for their preferred long term solutions. Additional assessment included further assessment for proposed designs and potential impacts to Bath Creek East and West, resulting from proposed diversions, downstream to their confluence with Bath Creek.
- *Seam 4 Diversions – Preferred Diversion Options* (Alluvium Consulting, 2010b) – a report updating and amending *Seam 4 Diversions – Design Review* (Alluvium, 2009) to include only the options preferred by DERM and the additional assessment (including downstream impact assessment). This report was prepared to be submitted to DERM as part of the diversion license application documentation.
- *Seam 4 Diversions – Preferred Diversion Options Concept Design and Impact Assessment* (Alluvium Consulting, 2010c) – a report to summarise previous work undertaken and present the preferred options concept/functional design and impact assessment for the Eastern and Western Diversion waterways. The report forms the initial advice statement for a pre-design conferencing request to elucidate levee design, construction and licensing requirements.
- *Bath Creek East Culvert Upgrade – Options Investigation* (Alluvium Consulting, 2011a)
- *Bath Creek East Culvert Upgrade – Detailed Design Summary Report* (Alluvium Consulting, 2011b)
- *Eastern Waterway Diversions Baseline Monitoring Report 2011* (Alluvium Consulting, 2011c)

Alluvium has also prepared Concept Management Plan drawings for Bath Creek East through the downstream property known as 'Hillside'.

1.5 The monitoring program

As part of the diversion design, construction and operation process, this proposed monitoring program is an essential component of the assessment of any impacts associated with the diversion and mining infrastructure located within BA ML's and along Bath Creek East to the confluence with Bath Creek. Monitoring is required as part of the licence conditions for all such infrastructure impacting on Bath Creek.

Monitoring for the diversion and associated infrastructure should comprise components as shown in Table 1-4. This is based upon the "Monitoring and Evaluation Program for Bowen Basin River Diversions" (ID&A 2001) undertaken for the Australian Coal Association Research Program (ACARP). This monitoring program is considered best practice for Bowen Basin diversion at present and is the method accepted by DERM.

Table 1-4. Eastern Waterway Diversion monitoring package components

Monitoring package components	Objective
1: Baseline monitoring (Undertaken in 2011 except for the downstream reaches of Bath Creek East)	To establish a baseline data set that can be used for comparison when applying for licence renewal and relinquishment.
2: Construction monitoring	To demonstrate works have been undertaken to specification.
3: Operations monitoring	To maintain channel condition, reduce risk to mining infrastructure and the environment and facilitate licence renewal.
4: Relinquishment monitoring	To demonstrate the diversion is operating as a waterway in equilibrium and not adversely impacting on adjoining reaches.

2 Baseline monitoring

Baseline monitoring is required to:

- Establish a baseline data set of waterway condition that can be used for comparison when applying for licence renewal and relinquishment, and
- Compare the performance of the diversion with adjoining reaches and track that over time.
- The baseline data will also provide a reference to measure the condition of all reaches against themselves over time.

Baseline Monitoring is based upon *"Monitoring and Evaluation Program for Bowen Basin Diversions"* (ID&A 2001) undertaken for ACARP and consists of the following:

- Index of Diversion Condition (including repeat/new photos at photo points)
- aerial photography analysis
- cross-sections and long-section survey comparison
- riparian vegetation assessment
- flow event information (where available)

A brief description of each is provided in Table 2-1. In addition to the above quantitative components, assessment of survival of works and any necessary maintenance/management intervention is required. Monitoring should also be undertaken by experienced professionals in waterway health, particularly geomorphology and riparian vegetation and with appropriate Registered Professional Engineer Queensland (RPEQ) qualifications as required under the *Water Act 2000*.

Table 2-1. Baseline Monitoring Summary

Index of Diversion Condition	IDC will be undertaken at selected transects within each reach. Reaches to be monitored to include an upstream reach[es], diversion reaches and downstream reach[es]. As part of the IDC assessment, photographs will be taken to record the condition. The IDC is discussed further in Section 2.1.
Aerial Photographs	An aerial photograph displaying the existing condition of the creek and also the location of the new diversion has to be taken prior to works beginning. This is added to the baseline monitoring database.
Survey	Detailed topographic survey of the monitoring reaches must be undertaken by Blair Athol Mine prior to construction. This information is included as part of the monitoring database report. This information will be used to monitor the performance of the diversion during its operation and contribute to relinquishment monitoring to demonstrate the diversion has had no adverse impacts on upstream and downstream reaches. The cross-sections generated from the survey need to include changes in bank shape. Cross-sections are located on meanders and straight sections to monitor horizontal and vertical displacement of the channel
Vegetation	The associations and condition of vegetation in each of the reaches is assessed as a record of its pre diversion state (where possible).
Flow Events	Information regarding the size and frequency of flow events will be collected (by the most appropriate means) to inform assessment of the performance of the diversion. .

Baseline Monitoring of the Eastern Waterway Diversion and Rail Loop Diversion through the mine lease was undertaken in November 2011. The delineation of reaches and the selection of monitoring photopoints is outlined in Section 2.1 Index Diversion Condition.

2.1 Index of Diversion Condition (IDC)

Index of Diversion Condition (IDC) is the method accepted by DERM of recording and monitoring the condition of diversions and adjacent upstream and downstream reaches. IDC provides a rapid assessment of the condition of diversions and adjoining reaches of watercourse(s) and is designed to flag potential management issues rather than provide an in depth scientific assessment of the waterway. It is an integrated suite of indicators that measures the geomorphic and riparian condition of a diversion and its upstream and downstream reaches. The indicators for the geomorphic index and riparian index are listed below:

Indicators for Geomorphic Index

- Width of high flow channel, active channel and low flow channel
- Bank condition
- Piping of banks
- Bed condition
- Spoil piles
- Recovery
- In-stream structures

Indicators for Riparian Index

- Width of riparian zone
- Structural intactness
- Regeneration
- Longitudinal continuity

Each indicator is assigned a score at each transect. The average scores for each indicator from the four transects are then used to calculate the overall score for the geomorphic index and riparian index in each reach. The sum of the geomorphic and riparian index is then calculated to determine the score for the IDC.

Selection and establishment of reaches

Baseline Monitoring 2011 established and surveyed six reaches for IDC. The established reaches are:

- Eastern Waterway – Rail Loop Diversion Upstream reach (transect sites EW-RLD-US1-4)
- Eastern Waterway – Rail Loop Diversion reach (transect sites EW-RLD1-4)
- Eastern Waterway – Upstream reach (Bath Creek) (transect sites EW-US1-4)
- Eastern Waterway – Diversion reach (upstream) (transect sites EW-Div1-4)
- Eastern Waterway – Diversion reach (downstream) (transect sites EW-Div5-8) and
- Eastern Waterway – Downstream reach (Bath Creek East) (transect sites EW-DS1-4)

The use of the six reaches is a deviation from the standard (three reaches) monitoring program because:

- the system of waterways is large, complex and contains more than one diversion
- the main diversion is substantially long and has two distinct reaches with different geomorphic characteristics that requires the diversion to be divided into two reaches.

At DERM's request another two monitoring reaches are to be established for Bath Creek East downstream through the 'Hillside' property to the confluence with Bath Creek. The reaches are:

- Eastern Waterway – Downstream reach 2 (Bath Creek East) (transect sites EW-DS5-8)
- Eastern Waterway – Downstream reach 3 (Bath Creek East) (transect sites EW-DS9-12)

Eastern Waterway – Rail Loop diversion reaches

The Rail Loop Diversion diverts flows from Breaker Creek North to the West Dam via a diversion and a short section of Washpool Creek West. The Rail Loop diversion upstream reach is located mostly outside of the north-western extent of Blair Athol's mining lease[s] and is approximately 900m long. The diversion reach consists of two distinct zones including a 210m (approximately) long section of flood-out area against the levee

and a 650m long channel from the flood out area to discharge to West Dam via a short section of Washpool Creek West. The reaches for the Rail Loop Diversion section of the Eastern Waterway are shown on Figure 2-1.

Eastern Waterway – Diversion reaches

The Eastern Waterway Diversion diverts flows from Washpool and Bath Creeks and Ti-Tree Gully around the eastern extent of mining operations. As previously described this diversion is comprised of four separate parts; Northern Boundary Drain, Eastern Diversion and Realignment and South Eastern Diversion. This monitoring program considers those diversions as the single Eastern Waterway Diversion. Two reaches have been established for monitoring within the diversion based on geomorphic character and length (primarily based on geology, a deeply cut basalt reach and a channel deeply cut in highly weathered metasediment reach). These reaches are shown on Figure 2-2.

The upstream reach extends for approximately 4395m from the West Dam spillway to slightly downstream of Des' Dam adjacent to where Ti-Tree Gully enters the diversion. There are also three major structures at separate locations within this reach which are monitored. The downstream reach is approximately 2590m in length extending downstream to the proposed location for diversion of flows into Bath Creek East as part of the Seam 4 coal project. As the diversion into Bath Creek East is likely to be built within the next 6 months, subject to approval, the reach of the South Eastern Diversion downstream of this has not been included in diversion monitoring. Similarly, Bath Creek East from the proposed diversion to the ML boundary has been chosen as the first downstream reach. Another two downstream reaches in Bath Creek East are required downstream to the confluence with Bath Creek. Bath Creek (upstream of the diversion) has been chosen for the upstream monitoring reach as it is a major upstream tributary and is not impacted by the West Dam. If the West Dam is decommissioned at some point in the future, consideration may be given to adding another upstream reach to the monitoring program.

Location of transects and photo points

Within each of the reaches, four transects of approximately 50m wide running lengthwise perpendicular to stream flow were chosen, some of which co-locating with previous monitoring sites. Transects are usually approximately equally spaced throughout reaches. However, variation to this occurred through the upstream diversion reach due to the large length and location of structures to be monitored throughout and similarly for downstream reaches 2 and 3 (Bath Creek East).

Each of the transects were/will be formally established by the installation of a steel peg at the centreline of the transect. The coordinates of each steel peg was/will be recorded during installation and each steel peg is also regarded as a photo point. Monitoring sites were/will be established at locations to provide reasonable representation of the geomorphic and riparian vegetation characteristics and condition within each of the reaches. The location of each transect and photo point is detailed in Table 2-2, page 14 and shown on Figure 2-1 and Figure 2-2.

Photographs

Photographs were/will be taken at each monitoring point and at other features of interest within the study area to enable comparison and visual assessment of changes over time. In general, six photos were/will be taken at each monitoring point, and include views of:

- Upstream – looking upstream with the monitoring peg in the lower centre of the frame
- Cross-stream – looking across the stream with the monitoring peg in the lower centre of the frame
- Downstream – looking downstream with the monitoring peg in the lower centre of the frame
- Away from stream – looking away from the stream with the monitoring peg in the lower centre of the frame
- In bed upstream – looking upstream from the centre of the creek bed (or as near as possible) and
- In bed downstream – looking downstream from the centre of the creek bed (or as near as possible).

Details of all photographs have been/will be recorded in the monitoring program database. The database is to be added to in future monitoring rounds.

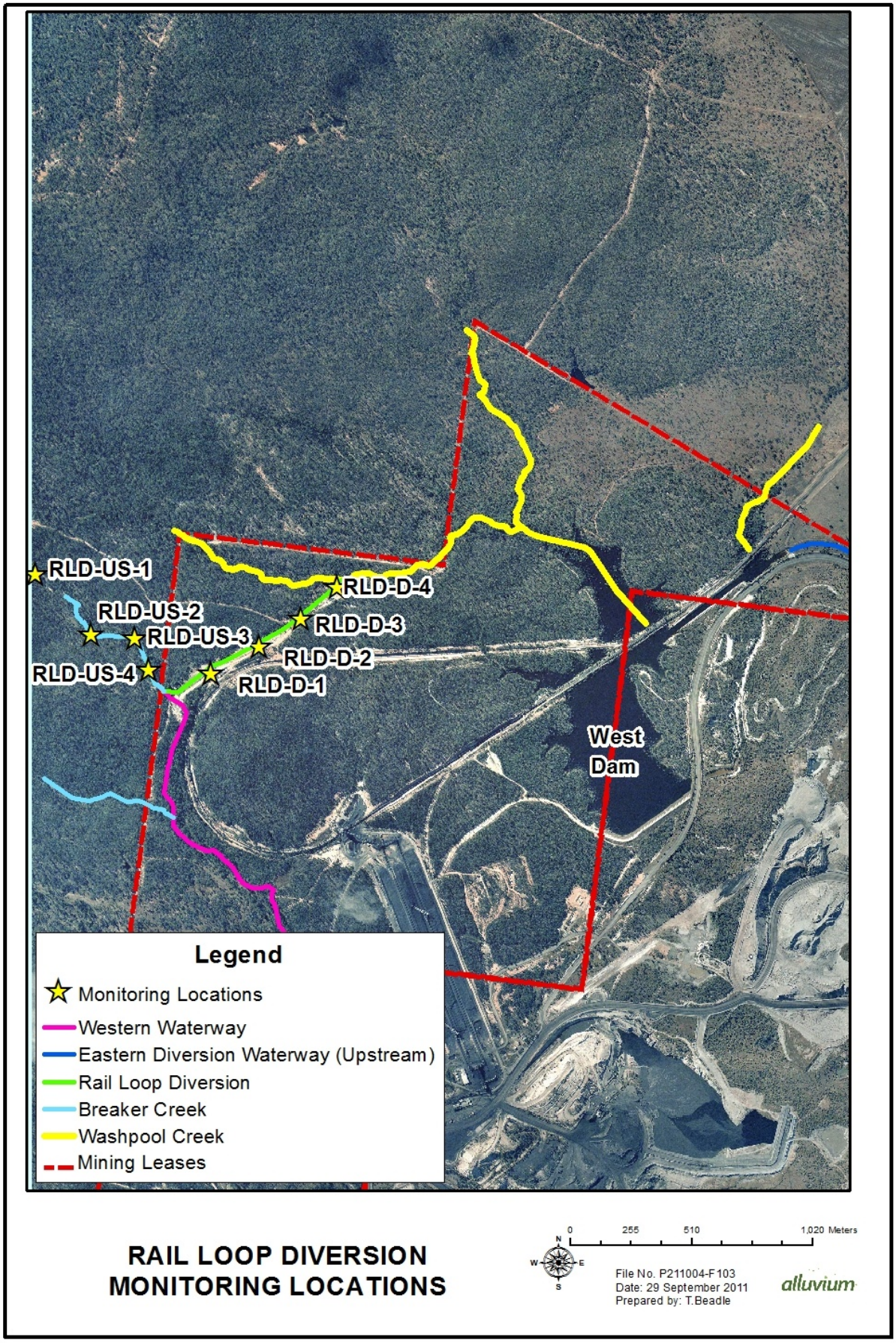


Figure 2-1. *Rail Loop Diversion monitoring overview*

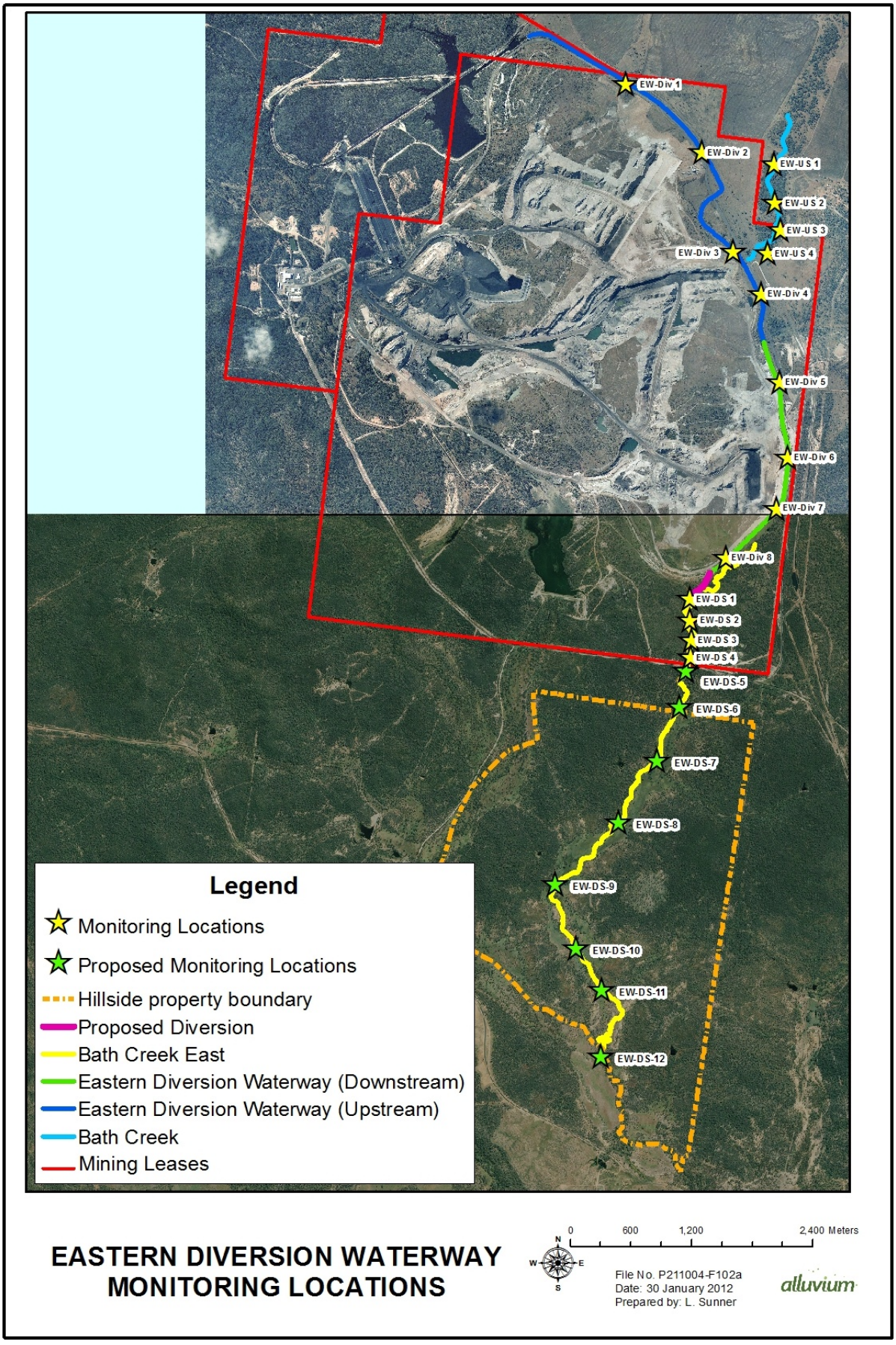


Figure 2-2. *Eastern Waterway Diversion monitoring overview*

Table 2-2. Location of monitoring photo points

Transect Site ID	Location Description	Photo point Easting	Northing
Established in Baseline Monitoring 2011			
Eastern Waterway – Rail Loop Diversion - Upstream Reach			
EW-RLD-US1	right bank	551517	7492908
EW-RLD-US2	left bank	551753	7492657
EW-RLD-US3	right bank	551937	7492639
EW-RLD-US4	left bank	551994	7492508
Eastern Waterway – Rail Loop Diversion Reach			
EW-RLD1	right bank	552257	7492490
EW-RLD2	right bank	552461	7492605
EW-RLD3	right bank	552637	7490723
EW-RLD4	right bank	552788	7492854
Eastern Waterway – Upstream Reach (Bath Creek)			
EW-US1	right bank	557127	7491748
EW-US2	right bank	557139	7491366
EW-US3	left bank	557189	7491095
EW-US4	left bank	557067	7490870
Eastern Waterway – Diversion Reach (upstream)			
EW-Div1	right bank	555662	7492540
EW-Div2	right bank	556414	7491865
EW-Div3	right bank	556721	7490881
EW-Div4	left bank	556997	7490462
Eastern Waterway – Diversion Reach (downstream)			
EW-Div5	left bank	557180	7489590
EW-Div6	right bank	557263	7488848
EW-Div7	right bank	557150	7488341
EW-Div8	right bank	556653	7487851
Eastern Waterway – Downstream Reach (Bath Creek East)			
EW-DS1	right bank	556296	7487448
EW-DS2	right bank	556298	7487238
EW-DS3	left bank	556309	7487037
EW-DS4	right bank	556301	7486869
To be established in Baseline Monitoring 2012			
Eastern Waterway – Downstream Reach 2 (Bath Creek East)*			
EW-DS5	To be established	556256	7486733
EW-DS6	To be established	556188	7486379
EW-DS7	To be established	555972	7485850

Transect Site ID	Location Description	Photo point	
		Easting	Northing
EW-DS8	To be established	555590	7485238
Eastern Waterway – Downstream Reach 3 (Bath Creek East)*			
EW-DS9	To be established	554966	7484628
EW-DS10	To be established	555170	7483994
EW-DS11	To be established	555424	7483578
EW-DS12	To be established	555415	7482919

* Coordinates listed are approximations only. The actual locations of monitoring photo points will be determined and recorded in the field at the time of site establishment.

2.2 Vegetation

A more detailed assessment of riparian vegetation than is included in the IDC is recommended for the baseline monitoring. Riparian and terrestrial vegetation should be assessed in all reaches by field identification and reference to Regional Ecosystem Mapping. This data will assist in the condition monitoring and future development of a revegetation program for diversions at the mine site.

A detailed vegetation assessment was undertaken during the 2011 baseline monitoring round for monitoring locations established within the ML and listed in Table 2-2. This should also be undertaken for Bath Creek East downstream reaches 2 and 3.

2.3 Flow event monitoring

The Eastern Diversion Waterway has a flow gauging station at the outlet of Des' Dam. To date, no flow event information has been made available. There is also a flow gauging station on the outlet of the Environmental Dam, however, this includes both Eastern and Western Diversion flows. Apart from this, the nearest flow monitoring station is on Sandy Creek at Clermont, many kilometres downstream of the mining lease.

BA are currently planning to install flow monitoring devices on all watercourse diversions across the mining lease for use in future years. Flow information will be an essential element of monitoring data when assessing monitoring results as part of license relinquishment for diversions. Installing stations that monitor both water quantity and quality should be considered. Flow events should be recorded together with site rainfall data.

2.4 Cross and long section comparisons

Cross section survey (extracted from aerial DTM) at each of the monitoring transects and a long section along all of the reaches should be undertaken. For the 2011 monitoring round, the DTM data provided was in LiDAR format providing a high level of accuracy and extends for the full length of the monitoring area. Ideally, all future surveys should be in LiDAR format also.

The 2011 surveys will be adopted as baseline for comparison into the future. However, past aerial DTMs can also be referenced in future monitoring activities if necessary.

There have been some flows through Bath Creek East during the 2011/12 wet season and conditions through the downstream reaches 2 and 3 along Bath Creek East may have changed since the 2011 LiDAR survey was undertaken. Therefore, to gain an accurate baseline data set prior to construction of works through these reaches (within the Hillside property) a new survey should ideally be undertaken following the wet season and prior to implementation of the works.

3 Future monitoring

It is recommended that monitoring continue in line with licencing requirements and the ACARP and DERM recommended monitoring program. With the construction of the proposed diversion works this will be comprised of Construction monitoring; Operations monitoring and Relinquishment monitoring.

Monitoring locations for construction and operations monitoring will be as close as reasonably possible to those established for baseline monitoring. Following construction, points EW-Div6-8 will be formally established at the top of bank of the constructed batters and EW-Div5 will be re-established if required.

Construction/Establishment monitoring
The purpose of this stage is to provide technical oversight to construction and demonstrate that works have been undertaken to the design specification or justify any modifications that may occur during construction. An As-Constructed report will be prepared to document construction.

Table 3-1. Construction/Establishment monitoring requirements

CONSTRUCTION/ESTABLISHMENT MONITORING REQUIREMENTS	
Execution outputs	Execution outputs of construction activities completed will be recorded and reported. The date of inspection will be noted along with details of any accompanying photographs. Construction/establishment activities not completed to specification will be recorded in the database along with an explanation and details of the modified design.
Photographs	Photographs will be taken during construction/establishment and immediately after the work is finished. Photographs should be taken from fixed photopoints where possible and details such as date, time and weather conditions will accompany the photographs.
Aerial photographs	An aerial photo should be taken immediately after diversion construction and rehabilitation has been completed. These photographs will accurately display the extent of change and provide a baseline reference for changes that may occur in the future.

Operations monitoring
The purpose of this monitoring is to maintain channel condition and reduce risk to adjoining reaches and mining infrastructure.

Table 3-2. Operations monitoring requirements

OPERATIONS MONITORING REQUIREMENTS	
Survival of works	The diverted channel and adjoining reaches, associated structures and levees are to be assessed during this phase of monitoring. Early detection of any damage is likely to increase the options for remedial action.
Photographs	Photographs will continue to be taken from fixed photopoints in the upstream and downstream reaches set up during the baseline monitoring. The diversion reaches fixed photopoints established as part of the construction/establishment monitoring will also be repeated during IDC assessment.
Aerial photographs	Aerial photographs of the upstream reaches, diversion reaches and downstream reaches will be taken periodically.
Visual assessment	Each of the reaches will be visually assessed using the IDC and repeated annually, as per licence conditions or in the following years after construction/establishment (as a minimum): 1st , 2nd, 5th , 8th , 10th years and after significant flow events. This inspection would include assessment of:

(Index of Diversion Condition)	bank condition piping bed condition recovery proximity of spoil piles from bank	stability of instream structures structural intactness of vegetation regeneration of vegetation longitudinal continuity of vegetation

The field data will be transferred into the IDC spreadsheet and added to the database established during baseline monitoring. The data can then be used to assist with comparing any changes.

Relinquishment monitoring

The objective of this phase is to demonstrate that the diversion is operating as a waterway in equilibrium and not having an adverse impact on adjoining reaches.

Table 3-3. Relinquishment monitoring requirements

RELINQUISHMENT MONITORING REQUIREMENTS	
Survey 1	Long-section and cross-section survey will be conducted during the first year of relinquishment monitoring. The survey will include all reaches. This survey will then be able to be compared to the 'as built' long-section to assess the change in bed elevation.
Stage 1 evaluation	Survey data from baseline and operations monitoring will be compared with data from relinquishment monitoring. Rates of change for channel top width, cross-section area, horizontal and vertical displacement can then be calculated.
Vegetation assessment	Detailed vegetation assessment will be conducted during the first year of relinquishment monitoring to determine key species absent from the diversion reaches but present in adjoining reaches where this is appropriate.
Photographs	Photographs will be taken from the fixed photo points in all reaches.
Aerial photographs	Aerial photos of all reaches will continue to be taken on an annual basis.
Surveys	Long-section and cross-section surveys will be conducted in all reaches. These surveys will be repeated every 5 years as a minimum or after a substantial flood event during monitoring for licence relinquishment.
Flow events	Flow events and debris heights will be monitored to enable an estimation of the size and frequency of events the diversion has been subjected to.
Survey 2	A final long-section and cross-section survey will be conducted prior to application for licence relinquishment.
Stage 2 evaluation	All data should be evaluated and photographs collated for presentation in a report to regulators.

4 References

Alluvium Consulting, 2009. *Options Report: Seam 4 Diversions – Design Review* for Blair Athol Mine

Alluvium Consulting, 2010a. *Addendum Options Report: Seam 4 Diversions – Design Review* for Blair Athol Mine.

Alluvium Consulting, 2010b. *Initial Advice Statement: Seam 4 Diversions – Preferred Diversion Options* for Blair Athol Mine.

Alluvium Consulting, 2010c. *Initial Advice Statement: Seam 4 Diversions – Preferred Diversion Options Concept Design and Impact Assessment* for Blair Athol Mine.

Alluvium Consulting, 2011a. *Options Investigation: Bath Creek East Culvert Upgrade* report for Blair Athol Mine.

Alluvium Consulting, 2011b. *Detailed Design Summary Report: Bath Creek East Culvert Upgrade* report for Blair Athol Mine.

Alluvium Consulting, 2011c. *Eastern Waterway Diversions Baseline Monitoring 2011* report for Blair Athol Mine.

ID&A, 2001, *Monitoring and Evaluation Program for Bowen Basin Diversions*, undertaken for the Australian Coal Association Research Program (ACARP), Program No. C9068.

Water Solutions Pty Ltd, 2008. *Waterworks Licensing Surveillance Inspection Report May 2008,* report for Blair Athol and Clermont Mines.

Water Solutions Pty Ltd, 2009. *Waterworks Licensing Surveillance Inspection Report July 2009,* report for Blair Athol and Clermont Mines.

Water Solutions Pty Ltd, 2010. *Waterworks Licensing Surveillance Inspection Report October 2010,* report for Blair Athol and Clermont Mines.



SGM Environmental Pty Limited (SGME) is a boutique consulting firm of experienced industry experts working with our clients and their stakeholders to develop and deliver innovative solutions to complicated challenges that create enduring value.

SGME was established to provide services in soil science, geochemistry, mine closure and Environmental management, planning & approvals cost efficiently. When you engage SGME you engage a partner to your business, priding themselves on:

Honest – Straight-up and no nonsense.

Trust – We say what we mean and we will deliver on our promises. We will advocate strongly for you.

Innovation – We will always look for new ways to help and create enduring value because that is what friends do when they work together.

Safety – We do it right so we all go home safely.

Australian Location
PO Box 5622, Stafford Heights, Qld 4053
Tel +61 7 3148 6288
Email admin@sgmenvironmental.com
Web sgmenvironmental.com