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WATER MANAGEMENT PLAN

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Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

TABLE OF CONTENTS

ACRONYMS	9
1.0 INTRODUCTION	10
2.0 REGULATORY FRAMEWORK	12
2.1 OVERVIEW	12
2.2 WATER MANAGEMENT ACT 2000	12
2.2.1 Upper and Lower Namoi Regulated River Water Sources WSP.....	12
2.2.2 Namoi Unregulated and Alluvial Water Sources WSP 2012	13
2.2.3 Upper and Lower Namoi Groundwater Sources WSP	13
2.2.4 NSW Murray Darling Basin Porous Rock Groundwater Sources WSP	14
2.2.5 Water Licensing	14
2.4 WATER MANAGEMENT PLAN REQUIREMENTS.....	16
3.0 BTM COMPLEX WATER MANAGEMENT STRATEGY	22
4.0 SURFACE WATER MANAGEMENT PLAN	23
4.1 BASELINE DATA	23
4.1.1 Baseline Surface Water Data – Water Quantity	23
4.1.2 Baseline Surface Water Data – Water Quality	26
4.1.3 Baseline Geomorphology	43
4.2 WATER MANAGEMENT STRATEGY	50
4.3 SITE WATER MANAGEMENT SYSTEM	51
4.3.1 Proposed Water Management Infrastructure and System Configuration.....	51
4.3.2 Erosion and Sediment Controls	58
4.3.3 Clean Water Management System.....	63
4.3.4 Mine Water Management System	63
4.3.5 Reject Material Emplacement.....	64
4.3.6 Rehabilitation and Final Landform	65
4.3.7 Construction Water Supply	65
4.4 PERFORMANCE CRITERIA	66
4.5 SURFACE WATER MONITORING.....	68
4.5.1 Surface Water Quality and Quantity Monitoring Plan	71
4.5.2 Impact Assessment Criteria	75
5.0 SITE WATER BALANCE	79



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

5.1	OVERVIEW	79
5.2	WATER SOURCES AND USES	80
5.2.1	Rainfall Runoff	80
5.2.2	Groundwater Inflow.....	80
5.2.3	CHPP Process Water	81
5.2.4	Water Licences	81
5.2.5	Treated Water.....	82
5.2.6	Waste Water	82
5.2.7	Potable Water	83
5.3	FORECAST SIMULATION RESULTS INTERPRETATION	83
5.3.1	Overall Water Balance.....	83
5.3.2	Mine Site Storage Inventory	87
5.3.3	Off-site Water Requirements	91
5.3.4	Uncontrolled Spills	92
5.3.5	Adaptive Management of Mine Water Balance	94
5.4	WATER BALANCE MODEL VALIDATION	94
6.0	GROUNDWATER MANAGEMENT PLAN	95
6.1	BASELINE GROUNDWATER DATA.....	95
6.1.1	Aquifer Systems.....	95
6.1.2	Existing Monitoring Network	96
6.1.3	Groundwater Levels.....	99
6.1.4	Groundwater Quality.....	100
6.2	GROUNDWATER MONITORING.....	106
6.2.1	Maules Creek Complex	106
6.2.2	Replacement Bores	108
6.2.3	Cumulative Impacts and Monitoring Locations.....	111
6.2.4	Groundwater Level Monitoring Plan	115
6.2.5	Groundwater Quality Monitoring Plan.....	115
6.3	GROUNDWATER IMPACTS & MITIGATION MEASURES	115
6.3.1	Neighbouring Privately Owned Bores.....	116
6.3.2	Groundwater Inflows to Pit.....	118
6.3.3	Groundwater Dependent Ecosystems	120
6.3.4	Impact Assessment Criteria.....	120



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

6.3.5	Data Management and Reporting	122
6.3.6	PAC Recommendations	122
6.4	VALIDATION OF GROUNDWATER MODEL	123
6.5	FINAL VOID MANAGEMENT & DESIGN PARAMETERS	123
7.0	SURFACE AND GROUNDWATER RESPONSE PLAN	123
7.1	CRITERIA EXCEEDANCE PROTOCOL	123
7.2	UNFORESEEN IMPACTS	124
8.0	REPORTING AND REVIEW	129
8.1	WATER MANAGEMENT PLAN REVIEW	129
8.2	REPORTING AN INCIDENT	129
8.3	PUBLIC ACCESS TO INFORMATION	130
8.4	RESPONSIBILITIES	130
9.0	REFERENCES	132

LIST OF TABLES

Table 2.1	Lower Namoi Water Source Share Components for Different Licence Categories (Source: DIPNR, 2003)	13
Table 2.2	Existing Water Access Licences	15
Table 2.3	Water Management Plan Requirements	16
Table 4.1	Water Quality Data, Namoi River at Turrawan	26
Table 4.2	Water Quality Data, Local Monitoring Program	29
Table 4.3	Description of Existing Geomorphological Condition	45
Table 4.4	Maules Creek Water Management Structures	53
Table 4.5	Sediment Dam Preliminary Sizing	60
Table 4.6	Performance Criteria	66
Table 4.7	Monitoring Actions	68
Table 4.8	Surface Water Quality and Quantity Monitoring Plan	73
Table 4.9	Sediment Dam Discharge Triggers	75
Table 4.10	Preliminary Trigger Values for Water Quality Assessment	76
Table 4.11	Physical and Chemical Variables Commonly Measured in AUSRIVAS	78
Table 5.1	Simulated Inflows and Outflows to Mine Water Management System	79
Table 5.2	Predicted Groundwater Takes Versus Water Access Licences	81
Table 5.3	Annual Water Balance for Realisation with Median Runoff Inflows	85



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Table 5.4	Year 1 Water Balance – Wet, Average and Dry Conditions	87
Table 5.5	Predicted Spills from Mine site Storages	93
Table 6.1	Baseline Monitoring Network Details	96
Table 6.2	Water Quality Results - Summarised.....	105
Table 6.3	Replacement Monitoring Network Details.....	109
Table 6.4	Cumulative Impacts Groundwater Monitoring Locations	112
Table 6.5	Registered Bores within Zone of Influence	116
Table 7.1	Exceedance Response Protocol.....	124
Table 7.2	Unforeseen Impacts Protocol.....	125
Table 7.3	Contingency Actions	125
Table 8.1	Water Management Plan Responsibilities	130
Table B 1	Simulated Inflows and Outflows to Mine Water Management System	146
Table B2	Mean Monthly Evaporation Depths from Storages	148
Table B3	Adopted Pumping Rules for Water Balance Model	149
Table B4	Summary of AWBM Model Parameters	153
Table B5	Recorded and Simulated Runoff Events from On-site Catchments	154
Table B6	Adopted AWBM Parameters.....	155
Table B7	Catchment Areas and Land Types	156

No table of figures entries found.

Table E 1	Groundwater Quality Results	160
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LIST OF FIGURES

Figure 1-1	Project Layout	11
Figure 4-1	Locality Plan, Maules Creek Coal Mine	24
Figure 4-2	Flow-Duration Curves for (1) Namoi River at Boggabri, (2) Maules Creek at Dam Site, and (3) Maules Creek at Avoca East	25
Figure 4-3	Daily Flow and Electrical Conductivity Comparison, Namoi River at Gunnedah	27
Figure 4-4	Surface Water Sampling Locations.....	28
Figure 4-5	Geomorphological Condition Monitoring Locations	44
Figure 4-6	Photograph of Back Creek Channel at BCP1, Looking Upstream	46
Figure 4-7	Photograph of Back Creek Channel at BCP1, Looking Downstream.....	46



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Figure 4-8	Photograph of Back Creek Channel at BCP2, Looking Upstream	46
Figure 4-9	Photograph of Back Creek Channel at BCP2, Looking Downstream	47
Figure 4-10	Photograph of Back Creek Channel at BCP3, Looking Upstream	47
Figure 4-11	Photograph of Back Creek Channel at BCP3, Looking Downstream	47
Figure 4-12	Photograph of Back Creek Channel at BCP6, Looking Upstream	48
Figure 4-13	Photograph of Back Creek Channel at BCP6, Looking Downstream	48
Figure 4-14	Photograph of Back Creek Channel at BCP8, Looking Upstream	48
Figure 4-15	Photograph of Back Creek Channel at BCP8, Looking Downstream	49
Figure 4-16	Photograph of Maules Creek Channel at BCP7, Looking Upstream	49
Figure 4-17	Photograph of Maules Creek Channel at BCP7, Looking Downstream	49
Figure 4-18	Photograph of Maules Creek Channel at BCP9, Looking Upstream	50
Figure 4-19	Photograph of Maules Creek Channel at BCP9, Looking Downstream	50
Figure 4-20	Conceptual Water Management System Configuration.....	52
Figure 4-21	Staged Mine Plan – Year 1 Operations	54
Figure 4-22	Staged Mine Plan – Year 2 Operations	55
Figure 4-23	Staged Mine Plan – Year 3 Operations	56
Figure 4-24	Staged Mine Plan – Year 5 Operations	57
Figure 4-25	Sensitive Locations for Proposed Construction Works	62
Figure 4-27	Proposed Stream Water Quality Monitoring Locations	74
Figure 5-1	Forecast Mine Water Dam Inventory, 99 th (very dry), 90 th (dry), 50 th (median), 10 th (wet) and 1 st (very wet) Percentile conditions.	88
Figure 5-2	Forecast In-Pit Storage Inventory, 99 th (very dry), 90 th (dry), 50 th (median), 10 th (wet) and 1 st (very wet) Percentile conditions.	89
Figure 5-3	Distribution of Mine Water Dam Stored Volume Over First 5 years of Mine Life.....	90
Figure 5-4	Forecast Cumulative Pipeline Inflows, 99 th (very dry), 90 th (dry), 50 th (median), 10 th (wet) and 1 st (very wet) Percentile conditions.	92
Figure 6-1	Monitoring Bore Locations	98
Figure 6-2	Maules Creek Coal Project - Groundwater Levels.....	99
Figure 6-3	pH versus time	101
Figure 6-4	Electrical conductivity (µS/cm) versus time	102
Figure 6-5	Sulphate (mg/L) versus time	103
Figure 6-6	Piper Plot Showing Major Ions.....	104
Figure 6-7	Regional Monitoring Bore Network	107
Figure 6-8	Replacement Monitoring Bore Network	110



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Figure 6-9	Cumulative Impacts Bore Network.....	114
Figure 6-10	Simulated Seepage into the Maules Creek Coal Project and Neighbouring Mines	119
Figure B 1	Comparison of Mean Monthly Rainfalls from SILO Data Drill and Boggabri Kanownda (55076), 1900 to 2010.....	147
Figure B2	Adopted Time Series of CHPP Water Demand	151
Figure B3	Adopted Time Series of Groundwater Inflow to Open Cut Pit	152
Figure B4	Comparison of Recorded and Simulated Surface Runoff for Back Creek and Site Tributary Catchment, 1983/84	155
Figure E1	EC Trigger Level – Control Charts	164
Figure E2	SWL Trigger Level – Control Charts	165



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

LIST OF APPENDICES

APPENDIX A REGULATORY CORRESPONDENCE	134
APPENDIX B WATER BALANCE MODEL DEVELOPMENT AND CALIBRATION	145
APPENDIX C BOREHOLE CONSTRUCTION LOGS	158
APPENDIX D GROUNDWATER QUALITY RESULTS.....	159
APPENDIX E GROUNDWATER TRIGGER LEVELS	163
APPENDIX F LETTER OF ADVICE TO SEWPAC	166
APPENDIX G RESPONSE TO MATTERS RAISED BY SEWPac 17 May, 2013.....	175

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

ACRONYMS

AGE	Australasian Groundwater and Environmental Consultants Pty Ltd
ANZECC	Australian and New Zealand Environment Conservation Council
ARI	Average Recurrence Interval
ARMCANZ	Agricultural and Resource Management Council of Australia and New Zealand
AWBM	Australian Water Balance Model
CHPP	Coal Handling and Preparation Plant
CMA	Catchment Management Authority
EA	Environmental Assessment
EC	Electrical Conductivity
EIS	Environmental Impact Statement
EPL	Environment Protection Licence
KPI	Key Performance Indicator
MOV	Maximum Operating Volume
MWD	Mine Water Dam
NAF	Non Acid Forming
NTU	Nephelometric Turbidity Units
NOW	New South Wales Office of Water
OEA	Overburden Emplacement Area
OEH	Office of Environment and Heritage
PA	Project Approval
PAC	Planning Assessment Commission
PAF	Potentially Acid Forming
ROM	Run-of-Mine
RWD	Raw Water Dam
SD	Sediment Dam
SWMP	Surface Water Monitoring Plan
TDS	Total Dissolved Solts
TP	Total Phosphorous
TSS	Total Suspended Solids
WAL	Water Access Licence
WMP	Water Management Plan



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

1.0 INTRODUCTION

The Maules Creek Coal Mine (the Project) is located in the Gunnedah Coal Basin, approximately 18 km north-east of Boggabri in New South Wales. The existing surface water environment for the Project was described in detail in the Maules Creek Coal Project Environmental Assessment (EA) (Hansen Bailey, 2011).

The Maules Creek Coal Mine is currently owned by Maules Creek Coal Pty Limited (MCC), a joint venture between Aston Coal 2 Pty Limited (75%) (a wholly owned subsidiary of Whitehaven Coal), ITOCHU Coal Resources Australia Maules Creek (ICRA MC) (15%) and J-Power (10%).

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

MCC has gained approval for Modification of PA 10_0138 under Section 75W of the *Environmental Planning and Assessment Act 1979*. The Modification includes the following development:

- Construction and operation of TransGrid's high voltage (132 kV) transmission line;
- Construction of TransGrid's Boggabri North 132 kV Switching Station;
- Minor extension of an existing low voltage (11 kV) transmission line to the Project Boundary to supplement power supplies; and
- Minor realignment of the Coal Handling and Preparation Plant (CHPP) and associated facilities including the product stockpiles.

No construction will be undertaken on these components until the Modification is determined.

The construction of the shared rail spur line which commences at the junction with the Boggabri Coal rail spur line and continues down to the Werris Creek to Mungindi Railway Line is being constructed by Boggabri Coal under its planning approval (see Figure 1-1).

This Water Management Plan (WMP) provides information on proposed water management infrastructure and the site water management strategy for the Project. In keeping with sound environmental practice Maules Creek Coal intends to adopt an implementation strategy that represents a structured and iterative process of decision making with the objective of reducing areas of uncertainty over time through a comprehensive monitoring program.

Incorporated into the regular reviews of the Plan and the reporting processes to both state and federal agencies will be a systematic process of modifying the Plan as the mining footprint develops. That process encompasses the following steps:-

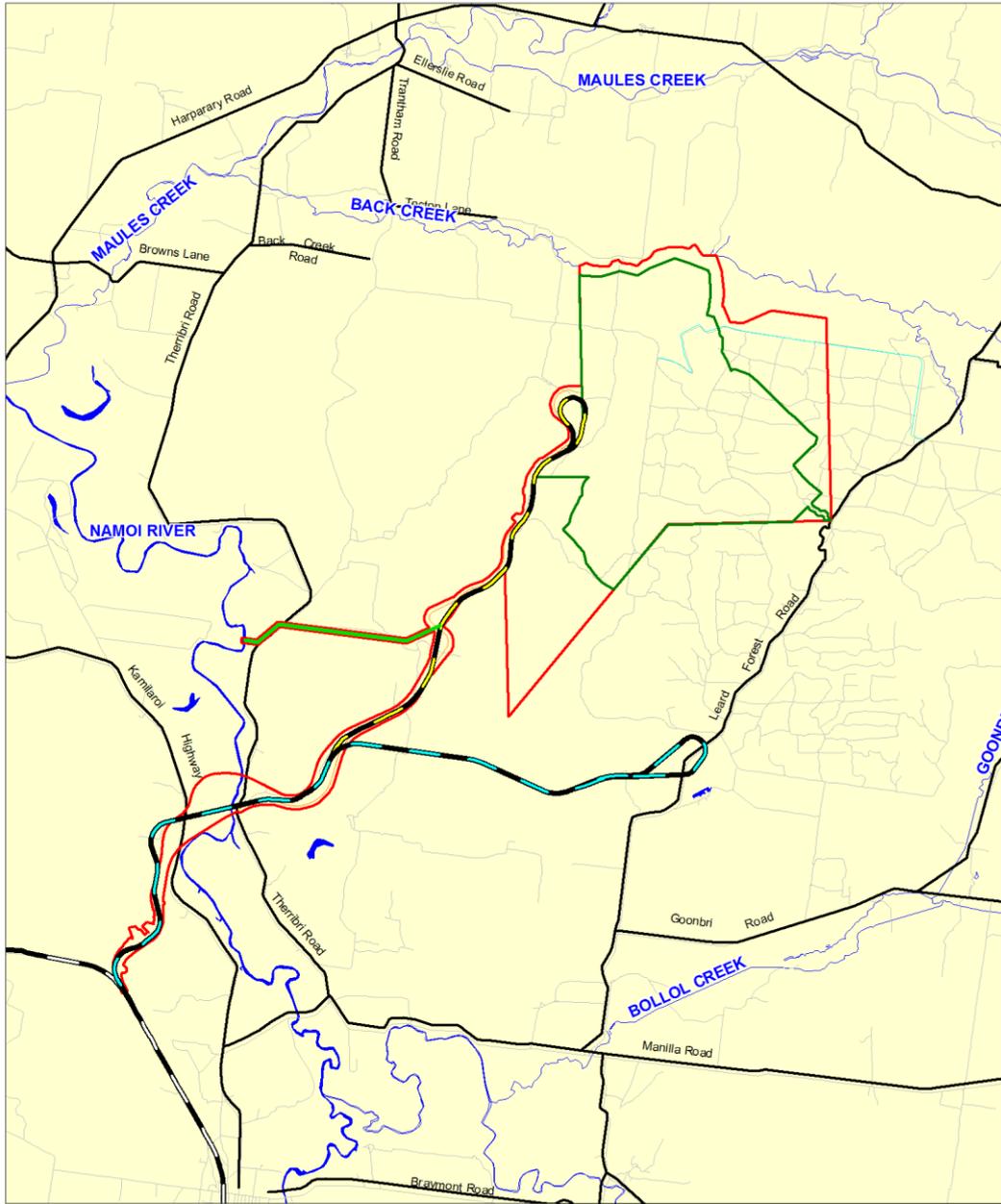
- conceptualising and assessing any issues arising from the monitoring;
- developing mitigation plans to address any impacts;
- implementing the plans and monitoring the outcomes;
- adapting the plans where necessary to achieve the requisite objectives.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN



LEGEND

- | | |
|----------------------------------|---------------------|
| Project Boundary | Roads |
| Disturbance Boundary | Minor roads/Streets |
| Rail Spur and Loop | Creeks/Rivers |
| Boggabri Coal Rail Spur and Loop | Northern Loop Road |
| Werris Creek to Mungindi Railway | Mine Access Road |
| Namoi River Pipeline | |

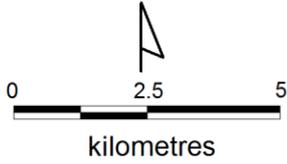


Figure 1-1 Project Layout

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

2.0 REGULATORY FRAMEWORK

2.1 Overview

The following legislation, plans, policies and regulations are relevant to the Project for water management:

- *Water Management Act 2000* (WM Act) and associated water sharing plans;
- National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality (NWQMS) (ANZECC/ARMCANZ, 2000);
- ANZECC Guidelines and Water Quality Objectives in NSW (DEC, 2006);
- Dams Safety Act 1978;
- Managing Urban Stormwater Soils and Construction – Volume 2E Mines and Quarries (DECC, 2008); and
- Managing Urban Stormwater, Soils and Construction (Landcom, 2004).

2.2 Water Management Act 2000

The objective of the WM Act is the sustainable and integrated management of the State's water for the benefit of both present and future generations. The WM Act provides clear arrangements for controlling land based activities that affect the quality and quantity of the State's water resources. It provides for four types of approval:

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

In accordance with Section 75U (former) of the EP&A Act, the above approvals under the WM Act do not apply to the Maules Creek Coal Mine as an *approved project* under Part 3A of the EP&A Act. However, water access licences are required to be held under the relevant water sharing plan (WSP) for any water take that occurs as a result of the Project on the various water sources neighbouring the mine. The WSPs relevant to the Maules Creek Coal Mine include:

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

2.2.1 Upper and Lower Namoi Regulated River Water Sources WSP

The Maules Creek Coal Mine is located within the catchment of the Lower Namoi Regulated River Water Source, which extends from Keepit Dam to the Barwon River. Flows in this reach of the Namoi River are regulated through the Namoi Regulated WSP (DIPNR, 2003), which was gazetted on 21 February 2004 and amended by order on 1 July 2004.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

The Namoi Regulated WSP allows for the extraction of water from the Namoi River without an access licence to provide basic landholder rights, which include domestic and stock rights as well as Native Title rights.

All water extraction that is not for basic landholder rights must be authorised by an access licence. Each access licence specifies a share component. Table 2.1 shows the categories of access licences in the Namoi Regulated WSP and their total share components at the commencement of the WSP. High security licences have a higher priority allocation of water than general security licences.

The Maules Creek Coal Mine will extract water from the Namoi River to supplement fresh water supplies throughout the construction and operation of the Project.

Table 2.1 Lower Namoi Water Source Share Components for Different Licence Categories (Source: DIPNR, 2003)

Access Licence Category	Total Share Component in the Lower Namoi
General Security	246,692 unit shares
High Security	3,418 unit shares
Supplementary Water	115,460 unit shares
Stock & Domestic	1,967 ML per year
Local Water Utility	2,271 ML per year

2.2.2 Namoi Unregulated and Alluvial Water Sources WSP 2012

The Namoi Unregulated WSP underwent public exhibition in 2011 and commenced on 4 October 2012. The area for the Namoi Unregulated WSP comprises 23 unregulated surface water sources in the Namoi River catchment and four alluvial water sources (Manilla, Currabubula, Quipolly, Quirindi) that are relatively distant from the Maules Creek Coal Mine.

The total licensed water entitlement has a share component of 32,259 MLpa in nine surface water licences. Almost all of this entitlement (99.7%) is currently categorised for irrigation purposes with the remainder being for stock and domestic purposes.

The open cut mining areas are located within the catchment of Back Creek, which is covered under the Namoi Unregulated WSP and will require the relevant water access licence for any water taken from the catchment according to the provisions of the WM Act.

2.2.3 Upper and Lower Namoi Groundwater Sources WSP

The Namoi Groundwater WSP commenced in November 2006. The Namoi Groundwater WSP sets the framework for managing groundwater in the Upper and Lower Namoi alluvial aquifers until the end of the 2015/16 water year (at which time there is anticipated to be a new water sharing plan created over this area). The Namoi Groundwater WSP applies to the "Upper and Lower Namoi Groundwater Sources" which include all water contained in the unconsolidated alluvial aquifers associated with the Namoi River and its tributaries and is subdivided into 13 zones.

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

The Project is located in an area of outcropping bedrock surrounded by Zone 4, Zone 5, and Zone 11. Any water take from the alluvial aquifers surrounding the Maules Creek Coal Mine as a result of the depressurisation of the Porous Rock aquifer requires licencing.

2.2.4 NSW Murray Darling Basin Porous Rock Groundwater Sources WSP

The MDB Porous Rock WSP commenced on 16 January 2012. The area covered by the MDB Porous Rock WSP is subdivided in zones and covers an extensive area across NSW. The Project is located in the Gunnedah-Oxley Basin Murray Darling Basin Zone (Other).

At the time of commencement of the MDB Porous Rock WSP, the share components of aquifer access licences authorised to take water from the Gunnedah–Oxley Basin MDB Groundwater Source was 16,197 unit shares. The plan reports the long-term average annual extraction limit of 199,893 ML/year for access licences, not including supplementary water and water taken pursuant to basic landholder rights.

The seepage of groundwater from the Porous Rock aquifer to the mining areas will require the relevant water share under the MDB Porous Rock WSP.

2.2.5 Water Licensing

Under the provisions of the WM Act, all water take that is not subject to an exemption must be authorised by the relevant water access licence (WAL). Table 2.2 lists MCC's predicted water takes from the various WSPs and the existing water access licences held for the Maules Creek Coal Mine.

As detailed in Section 5.3.3, the current forecast water balance modelling indicates that the high security water access licence under the Namoi Regulated WSP will be sufficient to supply the predicted external raw water requirements from the Namoi River during the life of the Project.

In addition to the Namoi River allocation, MCC has access to harvestable rights from the Velyama (906.4 ha) and Teston (1,295.04 ha) properties. Based on the harvestable rights multiplier of 0.07 ML/ha, the total harvestable right for these properties is 154 ML/annum.

MCC also holds two water licences (WAL 29467 (6 ML/annum) and 90SL101060 (30 ML/annum)) that will be utilised during the construction period in conjunction with water from the Namoi River and harvestable rights water sources to supplement dust suppression water supplies.

MCC has predicted that the take of groundwater will occur from the Porous Rock aquifer (initially as the open cut mine is developed) and will extend into the neighbouring alluvial aquifers (Zone 11, Zone 4, and Zone 5) once the depressurisation within the Porous Rock aquifer extends beneath the alluvial areas.

As explained in Section 5.2.4, MCC has sufficient water licence allocations under the MDB Porous Rock WSP and Namoi Groundwater WSP to offset the anticipated water takes from the two water sources.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Table 2.2 Existing Water Access Licences

WAL Number	Number of Units	Water Source	Existing Water Supply Work	Additional Intended Water Supply Work
29467	6	Porous Rock	One bore in Leard State Forest	Short term water supply during initial construction phase Dewatering of pit (pump in bottom of pit)
29588	300	Porous Rock	Two bores located on Lot 142 DP 580040	Dewatering of pit (pump in bottom of pit)
27385	38	Namoi Groundwater Zone 4	None	Dewatering of pit (no pumps or equipment)
12811	135	Namoi Groundwater Zone 5	Two bores located on Lot 822 DP 1074515	Dewatering of pit (no pumps or equipment)
12479	78	Namoi Groundwater Zone 11	One bore located on Lot 97 DP 754925 and one bore located on Lot 98 DP 754925	Dewatering of pit (no pumps or equipment)
27383	0	Namoi Groundwater Zone 11	None	None (spare WAL applied for prior to purchase of above WAL for Zone 11)
13050	3,000	Namoi River	610mm Axial Flow pump located on Lot 7002 DP 1051146	Raw water supply for onsite use
90SL101060	30	Surface Water	Water supply for mining and irrigation. Overshot Dam and a 150 mm Centrifugal Pump	Short term water supply during initial construction phase



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

2.4 Water Management Plan Requirements

This WMP has been developed in accordance with the requirements of Schedule 3, Condition 40 of PA10_0138 which are listed in Table 2.3. A reference to where each of the approval conditions is addressed in this WMP is also provided in Table 2.3.

Table 2.3 Water Management Plan Requirements

Condition	Requirement	WMP Section
Schedule 3, Condition 40	<p>The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Director-General. This plan must be prepared in consultation with OEH, NOW and Namoi CMA, by suitably qualified and experienced person/s whose appointment has been approved by the Director-General, and be submitted to the Director-General for approval prior to the commencement of construction.</p> <p>In addition to the standard requirements for management plans (see condition 3 of schedule 5), this plan must include:</p> <p>(a) a Site Water Balance, that:</p> <ul style="list-style-type: none"> • includes details of: <ul style="list-style-type: none"> i. sources and security of water supply, including contingency for future reporting periods; ii. water use on site; iii. water management on site; 	<p>Section 5.2</p> <p>Appendix B5</p> <p>Section 4.3</p> <p>Section 5.3.3</p>
	<p>iv. any off-site water discharges;</p> <p>v. reporting procedures, including the preparation of a site water balance for each calendar year;</p>	<p>Section 5.3.1</p>
	<p>vi. a program to validate the surface water model, including monitoring discharge volumes from the site and comparison of monitoring results with modelled predictions; and</p> <ul style="list-style-type: none"> • describes the measures that would be implemented to minimise clean water use on site. 	<p>Section 4.5, 5.4, 8.0</p> <p>Section 4.2, 4.3</p>
Schedule 3, Condition 40 (b)	<p>(b) a Surface Water Management Plan, which includes:</p> <ul style="list-style-type: none"> • detailed baseline data of surface water flows and quality in the water-bodies that could potentially be affected by the project; 	<p>Section 4.1</p>



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Condition	Requirement	WMP Section
	<ul style="list-style-type: none"> detailed baseline data on hydrology across the downstream drainage system of the Namoi River floodplain from the mine site to the Namoi River; 	Section 4.1.3
	<ul style="list-style-type: none"> a detailed description of the water management system on site, including the: <ul style="list-style-type: none"> i. clean water diversion systems; ii. erosion and sediment controls (dirty water system); iii. mine water management systems; iv. discharge limits in accordance with EPL requirements; v. water storages; vi. mine access road and Maules Creek rail spur line; 	Section 4.3.3 Section 4.3.2 Section 4.3.4 Sections 2.2, 2.5.3.3, 3.2 Section 4.3.1 Section 4.3.1
	<ul style="list-style-type: none"> detailed plans, including design objectives and performance criteria for: <ul style="list-style-type: none"> i. design and management of final voids; ii. design and management for the emplacement of reject materials, sodic and dispersible soils and acid or sulphate generating materials; 	Section 4.3.6 Section 4.3.5
	<ul style="list-style-type: none"> iii. design and management for construction and operation of the rail spur line and mine access road; 	Section 4.3.1
	<ul style="list-style-type: none"> iv. reinstatement of drainage lines on the rehabilitated areas of the site; 	Section 4.3.6
	<ul style="list-style-type: none"> v. control of any potential water pollution from the rehabilitated areas of the site; 	Section 4.4
	<ul style="list-style-type: none"> performance criteria for the following, including trigger levels for investigating any potentially adverse impacts associated with the project: <ul style="list-style-type: none"> i. the water management system; ii. downstream surface water quality; iii. downstream flooding impacts, including flood impacts due to the construction and operation of the rail spur line and mine access road, and flooding along Back Creek; 	Table 4.6



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Condition	Requirement	WMP Section
	<p>iv. stream and riparian vegetation health, including the Namoi River;</p> <ul style="list-style-type: none"> • a program to monitor: <ul style="list-style-type: none"> i. the effectiveness of the water management system; ii. surface water flows and quality in the watercourses that could be affected by the project; iii. downstream flooding impacts; • reporting procedures for the results of the monitoring program; and • a plan to respond to any exceedances of the performance criteria, and mitigate and/or offset any adverse surface water impacts of the project. 	<p>Section 4.5</p> <p>Section 8.0</p> <p>Section 7.0</p>



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Condition	Requirement	WMP Section
Schedule 3, Condition 40 (c)	<p>(c) A Groundwater Management Plan, which includes:</p> <ul style="list-style-type: none"> • detailed baseline data of groundwater levels, yield and quality in the region, and privately-owned groundwater bores including a detailed survey/schedule of groundwater dependent ecosystems (including stygofauna and Melaleuca riparian forest communities), that could be affected by the Project; • the monitoring and testing requirements specified in the PAC recommendations for groundwater management as set out in Appendix 6; • detailed plans, including design objectives and performance criteria, for the design and management of: <ul style="list-style-type: none"> ○ the proposed final void; and ○ coal reject and potential acid forming material emplacement; • a program to monitor and assess: <ul style="list-style-type: none"> ○ groundwater inflows to the open cut mining operations; ○ the seepage/leachate from water storages, backfilled voids and the final void; ○ interconnectivity between the alluvial and bedrock aquifers; ○ background changes in groundwater yield/quality against mine-induced changes; ○ the impacts of the project on: <ul style="list-style-type: none"> ▪ regional and local (including alluvial) aquifers; ▪ groundwater supply of potentially affected landowners; ▪ groundwater dependent ecosystems (including potential impacts on stygo-fauna and Melaleuca riparian forest communities) and riparian vegetation. ▪ a program to validate the groundwater model for the project, including an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions; and ▪ a plan to respond to any exceedances of the performance criteria; and 	<p>Section 6.1</p> <p>Section 6.3.6</p> <p>Section 6.5</p> <p>Section 6.2</p>

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Condition	Requirement	WMP Section
Schedule 3, Condition 40 (d)	<p>(d) a <u>Leard Forest Mining Precinct Water Management Strategy</u> that has been prepared in consultation with other mines within the Precinct to:</p> <ul style="list-style-type: none"> minimise the cumulative water quality impacts of the mines; review opportunities for water sharing/water transfers between mines; co-ordinate water quality monitoring programs as far as practicable; undertake joint investigations/studies in relation to complaints/exceedances of trigger levels where cumulative impacts are considered likely; and co-ordinate modelling programs for validation, re-calibration and re-running of the groundwater and surface water models using approved mine operation plans. <p><i>Note: The Leard Forest Mining Precinct Water Management Strategy can be developed in stages and will need to be subject to ongoing review dependent upon the determination of and commencement of other mining projects in the area.</i></p>	Section 6.2.3

Further to the requirements under PA 10_0138, MCC has requirements under its Controlled Action Approval which was granted by the Minister for the Environment for the Project on 11 February 2013. Specifically, conditions 20-23 of the Controlled Action Approval are appropriate to water management and include:

Condition	Requirement	WMP Section
Condition 20	<p><i>The person taking the action must provide to the Minister for approval, the surface and groundwater management plans as identified in condition 36 of the NSW state government Project Approval dated 23 October 2012 (application number 10_0138). The surface and groundwater management plans must be approved by the Minister prior to commencement of construction</i></p>	Appendix A
Condition 21	<p><i>The surface and ground water management plans must be consistent with the National Water Quality Management Strategy</i></p>	Section 3.5.1



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Condition	Requirement	WMP Section
Condition 22	<p>The person taking the action must, prior to commencement of construction, in collaboration with the proponent to develop and operate the Boggabri Extension (EPBC2009/5256) and any other approved mines within 20kilometres (km) of the project area, provide written advice to the Minister demonstrating how the NSW government approved surface and ground water management plans (condition20), addresses the cumulative impact of groundwater drawdown as a result of mining and how this may impact on the consequent health of the remnant native vegetation in the Leard State Forest, the Leard State Conservation Area and surrounding areas. In particular the advice must address the following matters</p> <ul style="list-style-type: none"> a) maximum amount of allowable drawdown in the alluvial aquifer; b) drawdown in hard rock; c) trigger levels pertaining to drawdown in the alluvial aquifer when corrective actions will be required to be undertaken; d) identify the depth of root zone of the native vegetation; and <p>monitoring to assess the ongoing quality and quantity of both surface and groundwater to identify impacts on the native vegetation.</p>	Appendix G
Condition 23	<p>The person taking the action must within 6 months of the date of this approval, or such other timeframe specified by the Minister, provide to the Minister a report on:</p> <ul style="list-style-type: none"> a) any updated modelling of surface and groundwater impacts that has been undertaken in preparing the surface and groundwater management plans b) how the surface and groundwater management plans addressed groundwater and surface water impacts on matters of national environmental significance 	Addressed in separate document to SEWPaC

This WMP has been prepared jointly by WRM Water and the Environment and AGE Consultants, who were endorsed as suitably qualified experts by the Director-General of DP&I on 9 November 2012 (see Appendix A). Consultation has occurred with Office of Environment and Heritage, NSW Office of Water and the Namoi Catchment Management Authority as required by the conditions of PA 10_0138. Relevant correspondence with these regulatory stakeholders is provided in Appendix A.

This WMP has been developed consistent with National Water Quality Management Strategy relating to the management of Project related groundwater and surface water impacts to achieve a sustainable use of water resources through water quality management, recycling and reuse of onsite water for the Project's requirements.

Appendix A also provides correspondence to and from the DP&I and the Department of Sustainability, Environment, Water Population and the Community (SEWPaC) in relation to the approval of this WMP.

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

3.0 BTM COMPLEX WATER MANAGEMENT STRATEGY

The BTM Complex Water Management Strategy (WMS) has been developed to manage cumulative impacts from the Boggabri-Tarrawonga-Maules Creek Complex (BTM Complex) on water in the surrounding region. Consistent with the required project approval conditions the objectives of the Leard Forest Mining Precinct Water Management Strategy include:

- minimise potential cumulative water quality impacts associated with the BTM Complex
- review opportunities for water sharing/water transfers within the BTM Complex
- co-ordinate water quality monitoring strategies between BTM Complex operations as far as practicable
- undertake joint investigations/studies between BTM Complex operations in response to complaints/exceedances of trigger levels where cumulative impacts are considered likely
- co-ordinate modelling programs between BTM Complex operations for validation, re-calibration and re-running of the groundwater and surface water models using approved mine operation plans

The Leard Forest Mining Precinct Water Management Strategy identifies:

- Potential cumulative impacts and issues; and
- Specific cumulative monitoring objectives to be incorporated into the monitoring programs for the BTM Complex.

Monitoring requirements and impact assessment criteria for the Maules Creek Water Management Plan (Section 4.5) have been developed to be consistent with those developed to achieve the objectives of the BTM Complex Water Management Strategy.

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

4.0 SURFACE WATER MANAGEMENT PLAN

4.1 Baseline Data

4.1.1 Baseline Surface Water Data – Water Quantity

Figure 4-2 shows recorded stream flow data at three NSW Office of Water (NOW) recording stations (shown in Figure 4-1) for:

- Namoi River at Boggabri (Station No. 419012);
- Maules Creek at Dam Site (Station No. 419044); and
- Maules Creek at Avoca East (Station No. 419051).

Streamflow data is shown as a flow-duration curve where daily flows over the period of record are ranked from highest to lowest.

The Namoi River to Boggabri has a catchment area of 22,600 km². Flow in the river has been regulated by releases from Keepit Dam, located about 56 km west of Tamworth, since the dam's completion in 1960. Keepit Dam has a storage capacity of 425,510 ML. The median flow in the Namoi River at Boggabri since completion of the dam is about 400 ML/d.

Maules Creek is ephemeral in the upper catchment. At the Dam Site gauge (Catchment area = 171 km²), the median flow is less than 0.2 ML/d and the creek flows for only about 60% of the time. Further downstream along Maules Creek at the Avoca East gauge (Catchment area = 663 km²), the creek flows about 94% of the time, with a median flow rate of about 8 ML/d. Analysis of recorded streamflow data for the two gauging stations indicates volumetric runoff coefficients (proportion of rainfall that becomes surface runoff) of approximately:

- 4.5% at Avoca East (data from 1975 to 2010); and
- 5.0% at Dam Site (data from 1968 to 1992).

No continuous streamflow data is available for Back Creek. However, a temporary runoff monitoring station was established on Back Creek near the downstream boundary of the Project Boundary in the early 1980s. The stream gauge at this location recorded discharges during a number of runoff events, but continuous flow data for the gauge was not available.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

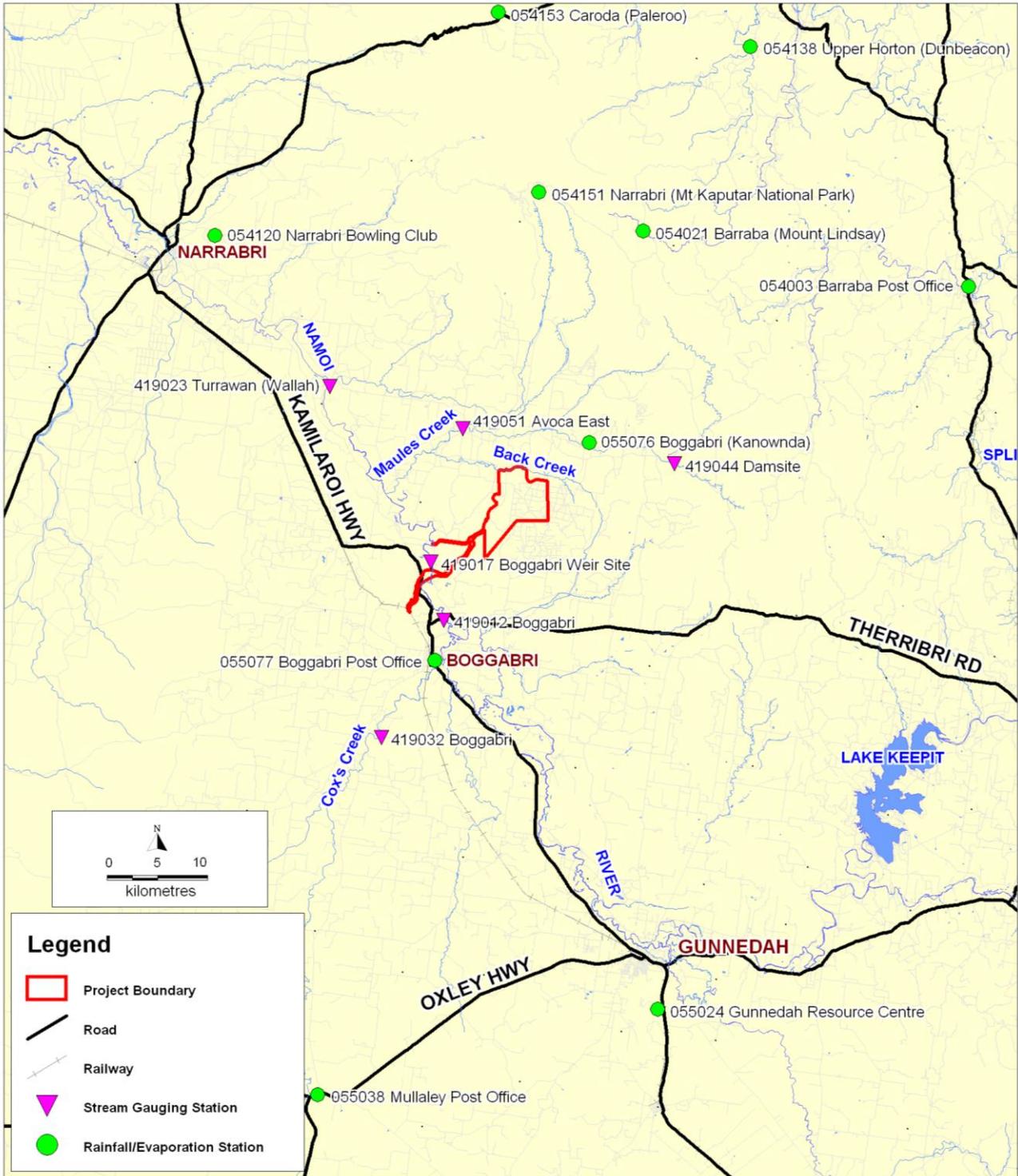


Figure 4-1 Locality Plan, Maules Creek Coal Mine



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

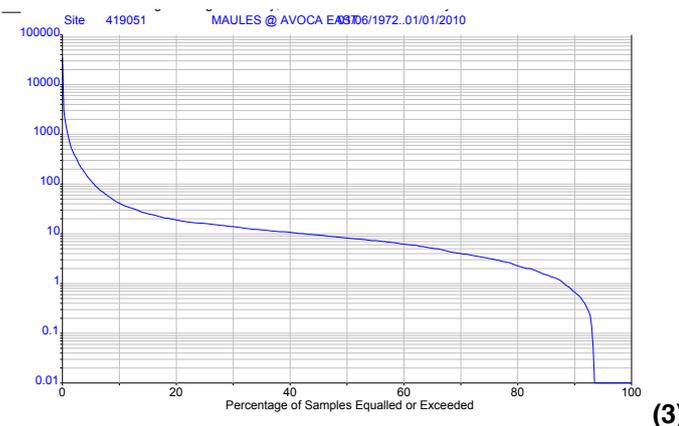
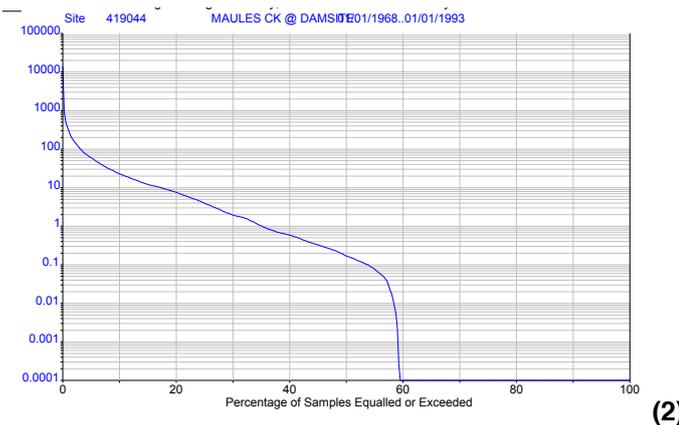
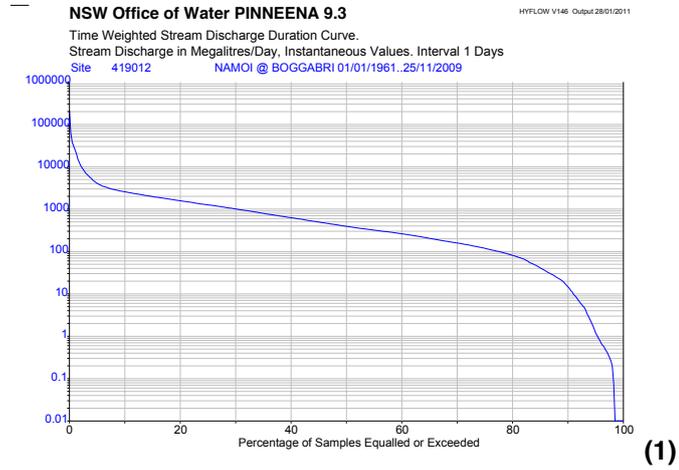


Figure 4-2 Flow-Duration Curves for (1) Namoi River at Boggabri, (2) Maules Creek at Dam Site, and (3) Maules Creek at Avoca East

	<h1>MAULES CREEK</h1>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

4.1.2 Baseline Surface Water Data – Water Quality

Regional Water Quality

Water quality data is available for the Namoi River at the Turrawan gauging station (Station No. 419023) for the period 15 October 1976 to 28 October 1986. The Turrawan gauging station is located about 15 km downstream of the Maules Creek confluence. The location of the Turrawan gauging station is shown in Figure 4-1. Table 4.1 shows a summary of available water quality data for the Namoi River at Turrawan gauging station. Over this 10 year period, the ANZECC & ARMCANZ (2000) default trigger values were exceeded 87% of the time for electrical conductivity (EC), 50% of the time for pH and 17% of the time for turbidity.

Additional water quality monitoring was undertaken at 22 sites throughout the Namoi River catchment during 2000 and 2001 (DLWC, 2002). Three of these sites, including at the Namoi River at Gunnedah, Cox's Creek at Boggabri (see Figure 4-1) and Narrabri Creek (Namoi River) at Narrabri are of relevance to regional water quality in the vicinity of the Project Boundary. Of the samples tested over this period, the ANZECC & ARMCANZ default trigger values for EC were exceeded 100% of the time at the two Namoi River stations and 97% of the time at the Cox's Creek station. The default trigger value for turbidity was exceeded between 69% and 88% of the time at the three locations and total phosphorus (TP) was exceeded between 97% and 100% of the time.

Table 4.1 Water Quality Data, Namoi River at Turrawan

Parameter	Years Data	Mean	Median	Min	Max	10th Percentile	90th Percentile
Electrical Conductivity (µS/cm)	10	545	538	275	1,720	330	716
pH	10	8.0	8.0	7.4	8.8	7.6	8.4
Temperature (°C)	10	19.6	20.5	10.0	30	11.0	26.5
Turbidity (NTU)	9	15.6	5.4	2.0	130	2.0	40.4

Insufficient water quality data is available at the Turrawan station to derive a relationship between water quality and flow rates in the Namoi River. However, continuous water quality data, measuring EC, is available between 1995 and 2005 at the Gunnedah Station (GS419001), located about 50 km upstream of Boggabri. A plot of daily flows against EC at this station is shown in Figure 4-3.

The available water quality data for the Namoi River at Gunnedah indicates that:

- EC varies between 200µS/cm and 1,200µS/cm at Gunnedah with the majority of elevated EC values occurring when flows are lower than 1,000 ML/d;
- There is a strong relationship between flow rate and EC with high flows, associated with floods, measuring lower EC values;



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

- Higher EC values tend to occur when there are limited releases from Keepit Dam to supply the downstream irrigation demand and the majority of the flow is being generated from the Peel and Mooki Rivers which join the Namoi between Keepit Dam and Gunnedah. This generally occurs during the winter months; and
- Elevated EC values can occur for many months during low flow periods.

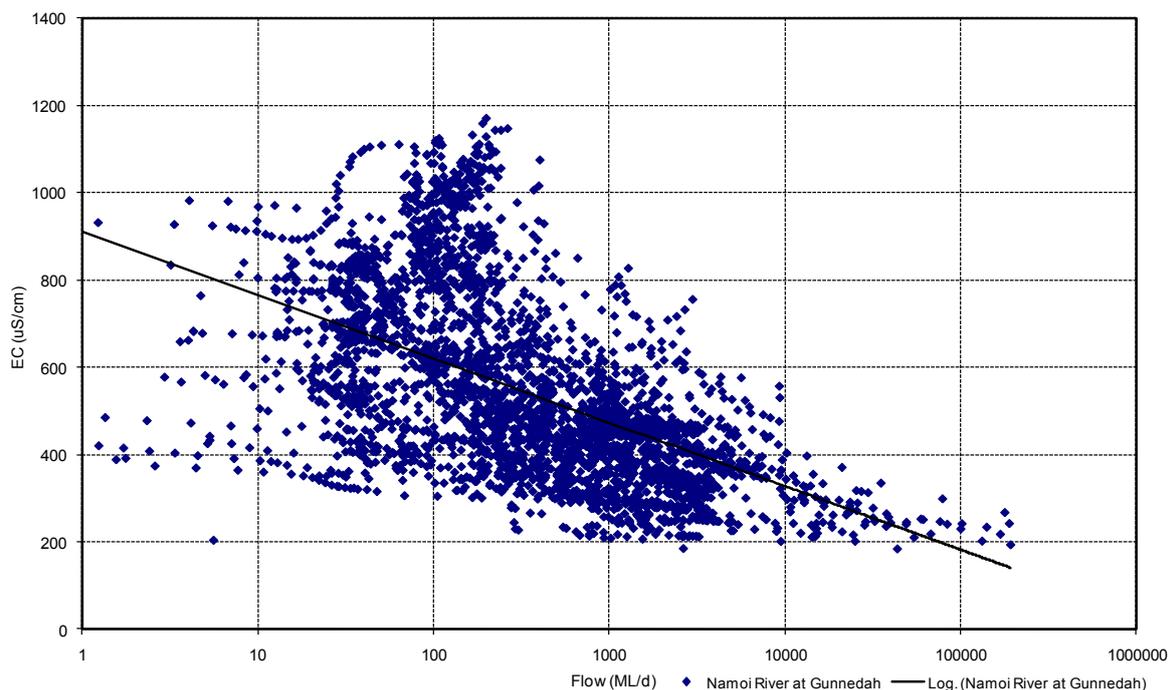


Figure 4-3 Daily Flow and Electrical Conductivity Comparison, Namoi River at Gunnedah

Local Catchments

Surface runoff water quality data is available from a water quality monitoring program undertaken in 1983 and 1984 by Lyall Macoun and Joy Consulting Engineers (LMJ) for Kembla Coal and Coke Pty Ltd (LMJ, 1986). Additional water quality sampling has also been undertaken by MCC from 2010 to present. The locations of the water sampling locations for both the LMJ studies and the recent sampling by MCC are shown in Figure 4-4. Figure 4-4 also provides further detail on the drainage network within and surrounding the Project Boundary. Table 4.2 shows summary water quality results for the LMJ and MCC's sampling programs. Key results of the water quality sampling show the following:

- In some instances, results from the LMJ sampling program appear to be quite different from MCC's sampling program. For example, TSS values are orders of magnitude higher.
- pH values are generally slightly alkaline. The median pH values for the Namoi River range from 8.0 to 8.1, slightly higher than those for Maules Creek (7.8 to 7.9) and Back Creek (7.3 to 8.1).
- From ten attempted sampling occasions, sampling locations SW3 and SW4 were dry on 9 and 8 occasions respectively, hence the limited data available.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

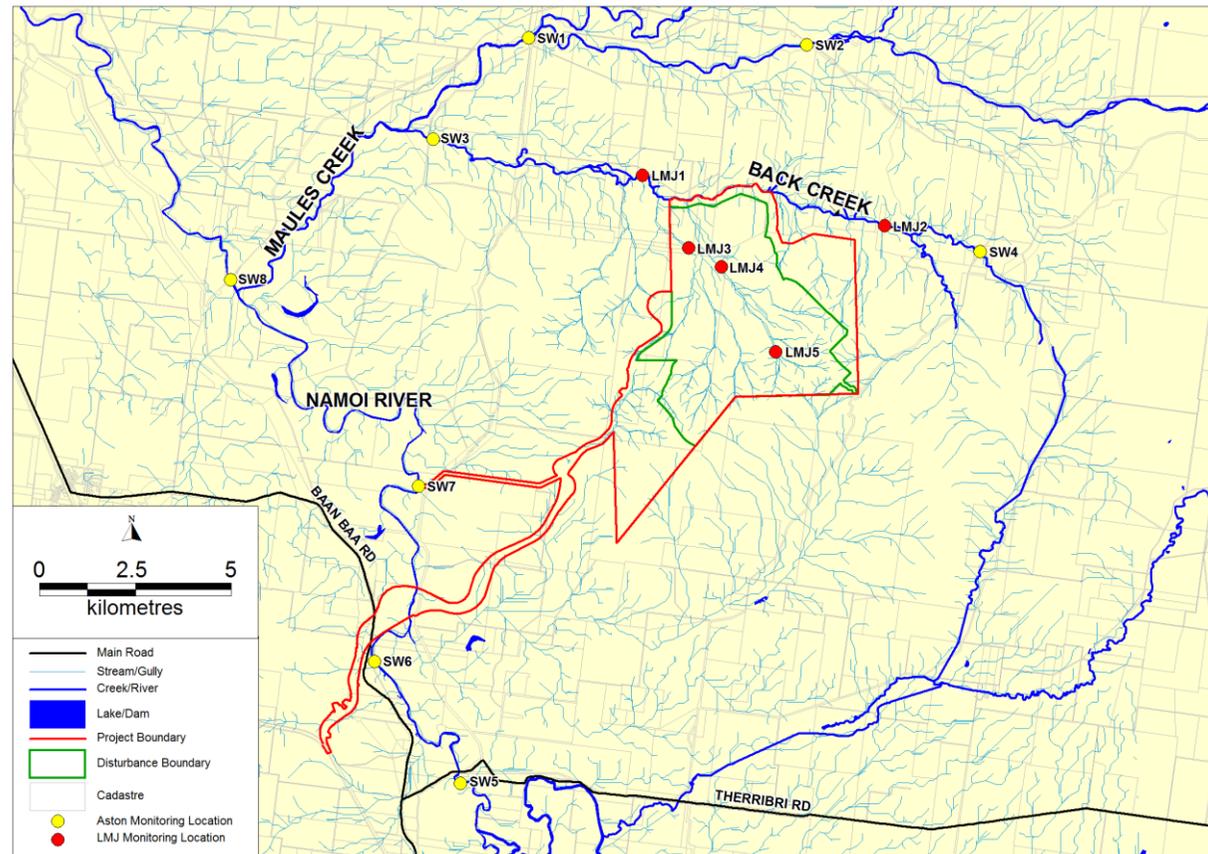


Figure 4-4 Surface Water Sampling Locations



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Table 4.2 Water Quality Data, Local Monitoring Program

Parameter		Maules Creek		Back Creek				Site Catchments			Namoi River			
		SW 1	SW 2	SW 3	SW 4	LMJ1	LMJ2	LMJ3	LMJ4	LMJ5	SW 5	SW 6	SW 7	SW 8
pH (Field)	20%ile	7.5	7.6	7.7	7.9	6.8	7.0	6.9	6.7	6.6	8.0	7.9	7.9	7.7
	Median	7.8	7.9	7.7	8.1	7.3	7.3	7.2	6.9	6.8	8.2	8.3	8.3	8.2
	80%ile	8.1	8.4	7.7	8.3	7.7	7.6	7.5	7.1	7.1	8.7	8.7	8.7	8.6
	Count	34	9	1	2	38	14	8	8	16	34	32	31	33
pH (Lab)	20%ile	7.5	7.5	-	7.09						7.9	7.9	7.9	7.8
	Median	7.8	7.7	-	7.09						8.0	8.0	8.1	8.0
	80%ile	8.1	7.7	-	7.09						8.2	8.2	8.2	8.2
	Count	34	7	0	1						14	12	12	14
Turbidity (NTU)	20%ile					1,200								
	Median					3,600	1,300	2,500	5,700	10				
	80%ile					16,000								
	Count					9	2	5	5	2				



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Parameter		Maules Creek		Back Creek				Site Catchments			Namoi River			
		SW 1	SW 2	SW 3	SW 4	LMJ1	LMJ2	LMJ3	LMJ4	LMJ5	SW 5	SW 6	SW 7	SW 8
EC (Lab) (μ S/cm)	20%ile	311	469	-	223	70	80	60	50	90	286	264	264	267
	Median	381	481	-	223	110	110	100	80	90	346	364	365	330
	80%ile	429	501	-	223	170	140	160	110	110	523	524	509	492
	Count	14	7	0	1	38	14	8	8	16	14	12	12	14
EC (Field) (μ S/cm)	20%ile	233	428	268	162						263	237	254	254
	Median	290	462	268	168						338	335	351	327
	80%ile	394	481	268	173						501	534	501	495
	Count	36	10	1	2						36	33	32	35
TDS/FR (mg/L)	20%ile	175	247	246	151	37	66	34	52	87	189	199	186	182
	Median	192	296	246	151	64	120	58	96	130	230	220	244	222
	80%ile	239	322	246	151	180	173	98	178	194	315	310	362	327
	Count	29	3	1	1	37	12	8	8	16	29	28	27	28



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Parameter		Maules Creek		Back Creek				Site Catchments			Namoi River			
		SW 1	SW 2	SW 3	SW 4	LMJ1	LMJ2	LMJ3	LMJ4	LMJ5	SW 5	SW 6	SW 7	SW 8
TSS/NFR (mg/L)	20%ile	175	247	246	151	37	66	34	52	87	189	199	186	182
	Median	192	296	246	151	64	120	58	96	130	230	220	244	222
	80%ile	239	322	246	151	180	173	98	178	194	315	310	362	327
	Count	29	3	1	1	37	12	8	8	16	29	28	27	28
Fe Diss. (mg/L)	20%ile					0.7								
	Median					2.6	1.7	0.24	3.4	3.5				
	80%ile					9.2								
	Count					9	4	5	5	2				
Fe Absorb. (mg/L)	20%ile					13	4.4	9.7	5.5	8.5				
	Median					49.2	13	33.4	26.2	12.8				
	80%ile					186	38.4	114.7	124.1	19.2				
	Count					28	12	8	8	13				



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Parameter		Maules Creek		Back Creek				Site Catchments			Namoi River			
		SW 1	SW 2	SW 3	SW 4	LMJ1	LMJ2	LMJ3	LMJ4	LMJ5	SW 5	SW 6	SW 7	SW 8
Sulphate as SO ₄ - Turbidimetric (mg/L)	20%ile	4	24	<1	<1	1.4	2.1	1.4	2.2	1.7	15	15	14.8	14.4
	Median	7	25	<1	<1	2.9	4	3.2	4	3.8	22	21.5	20	22
	80%ile	22.4	25.2	<1	<1	6.1	5.9	5	5.8	5.9	34.8	34	35.6	32
	Count	39	10	1	2	29	12	8	8	13	39	36	35	38
Bicarbonate Alkalinity as CaCO ₃ (mg/L)	20%ile	98	1	<1	<1						84	85	85	86
	Median	112	1	<1	<1						110	111	111	110
	80%ile	124	170	<1	<1						154	148	155	151
	Count	39	10	1	1						39	36	35	38
Carbonate Alkalinity as CaCO ₃ (mg/L)	20%ile	<1	1	<1	<1						1	1	1	1
	Median	<1	1	<1	<1						1	1	1	1
	80%ile	<1	1	<1	<1						1	1	1	1
	Count	43	10	1	1						39	36	35	38



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Parameter		Maules Creek		Back Creek				Site Catchments			Namoi River			
		SW 1	SW 2	SW 3	SW 4	LMJ1	LMJ2	LMJ3	LMJ4	LMJ5	SW 5	SW 6	SW 7	SW 8
Hydroxide Alkalinity as CaCO ₃ (mg/L)	20%ile	1	1	105	78						1	1	1	1
	Median	1	152	105	79						1	1	1	1
	80%ile	1	165	105	80						1	1	1	1
	Count	39	10	1	2						39	36	35	38
Total Alkalinity as CaCO ₃ (mg/L)	20%ile	109	158	105	78						98	97	95	97
	Median	116	166	105	79						120	126	124	122
	80%ile	132	180	105	80						172	159	166	158
	Count	39	10	1	2						39	36	35	38
Chloride (mg/L)	20%ile	14	29	27	10						17	14	16	16
	Median	16	32	27	11						22	24	23	22
	80%ile	32	36	27	11						46	44	47	43
	Count	39	10	1	2						39	36	35	38



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Parameter		Maules Creek		Back Creek				Site Catchments			Namoi River			
		SW 1	SW 2	SW 3	SW 4	LMJ1	LMJ2	LMJ3	LMJ4	LMJ5	SW 5	SW 6	SW 7	SW 8
Calcium (mg/L)	20%ile	21	42	26	14						20	20	20	20
	Median	23	42	26	15						24	25	25	26
	80%ile	30	45	26	16						35	33	36	32
	Count	39	10	1	2						39	36	35	38
Magnesium (mg/L)	20%ile	8	15	6	4						12	11	11	11
	Median	9	16	6	4						15	15	15	15
	80%ile	12	16	6	4						24	21	24	21
	Count	39	10	1	2						39	36	35	38
Sodium (mg/L)	20%ile	23	31	20	14						18	17	17	17
	Median	26	32	20	15						25	25	25	25
	80%ile	32	34	20	16						37	36	38	36
	Count	39	10	1	2						39	36	35	38



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Parameter		Maules Creek		Back Creek				Site Catchments			Namoi River			
		SW 1	SW 2	SW 3	SW 4	LMJ1	LMJ2	LMJ3	LMJ4	LMJ5	SW 5	SW 6	SW 7	SW 8
Potassium (mg/L)	20%ile	1	1	13	10						3	3	3	3
	Median	2	1	13	11						3	3	3	3
	80%ile	2	1	13	11						4	4	4	4
	Count	39	10	1	2						39	36	35	38
Aluminium (mg/L)	20%ile	0.020	0.028	0.290	1.126						0.080	0.084	0.100	0.080
	Median	0.060	0.050	0.290	2.215						0.175	0.140	0.155	0.160
	80%ile	0.120	0.138	0.290	3.304						0.680	0.594	0.712	0.824
	Count	36	10	1	2						36	33	32	35
Arsenic - filtered (mg/L)	20%ile	0.001	0.001	0.001	0.002						0.001	0.001	0.001	0.001
	Median	0.001	0.001	0.001	0.002						0.001	0.001	0.001	0.001
	80%ile	0.001	0.001	0.001	0.002						0.002	0.002	0.002	0.002
	Count	36	10	1	2						33	33	32	35



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Parameter		Maules Creek		Back Creek				Site Catchments			Namoi River			
		SW 1	SW 2	SW 3	SW 4	LMJ1	LMJ2	LMJ3	LMJ4	LMJ5	SW 5	SW 6	SW 7	SW 8
Barium - filtered (mg/L)	20%ile	0.025	0.014	0.142	0.118						0.031	0.034	0.032	0.033
	Median	0.055	0.016	0.142	0.130						0.046	0.051	0.046	0.047
	80%ile	0.086	0.021	0.142	0.141						0.072	0.072	0.062	0.066
	Count	36	10	1	2						36	33	32	35
Boron - filtered (mg/L)	20%ile	0.05	0.05	0.1	<0.05						0.05	0.05	0.05	0.05
	Median	0.05	0.05	0.1	<0.05						0.05	0.05	0.05	0.05
	80%ile	0.05	0.05	0.1	<0.05						0.05	0.05	0.05	0.05
	Count	36	10	1	2						36	33	32	35
Bromine - filtered (mg/L)	20%ile	0.1	0.1	0.2	0.2						0.1	0.1	0.1	0.1
	Median	0.1	0.2	0.2	0.2						0.1	0.1	0.1	0.1
	80%ile	0.2	0.2	0.2	0.2						0.2	0.2	0.2	0.2
	Count	29	9	1	1						30	28	22	29



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Parameter		Maules Creek		Back Creek				Site Catchments			Namoi River			
		SW 1	SW 2	SW 3	SW 4	LMJ1	LMJ2	LMJ3	LMJ4	LMJ5	SW 5	SW 6	SW 7	SW 8
Cadmium (mg/L)	20%ile	0.0001	0.0001	<0.0001	<0.0001						0.0001	0.0001	0.0001	0.0001
	Median	0.0001	0.0001	<0.0001	<0.0001						0.0001	0.0001	0.0001	0.0001
	80%ile	0.0001	0.0001	<0.0001	<0.0001						0.0001	0.0001	0.0001	0.0001
	Count	36	10	1	2						36	33	32	35
Chromium (mg/L)	20%ile	0.001	0.001	<0.001	0.0012						0.001	0.001	0.001	0.001
	Median	0.001	0.001	<0.001	0.0015						0.001	0.001	0.001	0.001
	80%ile	0.001	0.001	<0.001	0.0018						0.001	0.001	0.001	0.001
	Count	36	10	1	2						36	33	32	35
Copper (mg/L)	20%ile	0.001	0.001	0.01	0.003						0.002	0.002	0.002	0.002
	Median	0.001	0.001	0.01	0.003						0.003	0.003	0.003	0.004
	80%ile	0.002	0.0012	0.01	0.003						0.005	0.0062	0.0068	0.005
	Count	36	10	1	2						36	33	32	35



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Parameter		Maules Creek		Back Creek				Site Catchments			Namoi River			
		SW 1	SW 2	SW 3	SW 4	LMJ1	LMJ2	LMJ3	LMJ4	LMJ5	SW 5	SW 6	SW 7	SW 8
Iron (mg/L)	20%ile	0.070	0.050	0.210	1.170						0.080	0.084	0.090	0.066
	Median	0.140	0.050	0.210	2.205						0.240	0.150	0.225	0.130
	80%ile	0.300	0.110	0.210	3.240						0.770	0.820	0.818	1.004
	Count	36	10	1	2						36	33	32	35
Lead - filtered (mg/L)	20%ile	0.001	0.001	<0.001	0.0012						0.001	0.001	0.001	0.001
	Median	0.001	0.001	<0.001	0.0015						0.001	0.001	0.001	0.001
	80%ile	0.001	0.001	<0.001	0.0018						0.001	0.001	0.001	0.001
	Count	36	10	1	2						36	33	32	35
Lithium - filtered (mg/L)	20%ile	0.001	0.002	0.001	0.0016						0.001	0.001	0.001	0.001
	Median	0.002	0.002	0.001	0.0025						0.001	0.001	0.001	0.001
	80%ile	0.003	0.0022	0.001	0.0034						0.002	0.002	0.002	0.002
	Count	36	10	1	2						36	33	32	35



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Parameter		Maules Creek		Back Creek				Site Catchments			Namoi River			
		SW 1	SW 2	SW 3	SW 4	LMJ1	LMJ2	LMJ3	LMJ4	LMJ5	SW 5	SW 6	SW 7	SW 8
Manganese - filtered (mg/L)	20%ile	0.029	0.004	0.027	0.066						0.004	0.003	0.003	0.003
	Median	0.037	0.006	0.027	0.085						0.011	0.006	0.008	0.005
	80%ile	0.058	0.016	0.027	0.104						0.093	0.072	0.071	0.063
	Count	36	10	1	2						36	33	32	35
Nickel - filtered (mg/L)	20%ile	0.001	0.001	0.004	0.004						0.001	0.0014	0.0012	0.002
	Median	0.001	0.001	0.004	0.004						0.002	0.002	0.002	0.002
	80%ile	0.001	0.001	0.004	0.004						0.004	0.004	0.003	0.004
	Count	36	10	1	2						36	33	32	35
Rubidium - filtered (mg/L)	20%ile	0.001	0.001	0.005	0.0044						0.001	0.001	0.001	0.001
	Median	0.001	0.001	0.005	0.0065						0.001	0.001	0.001	0.001
	80%ile	0.001	0.001	0.005	0.0086						0.002	0.002	0.002	0.003
	Count	36	10	1	2						36	33	32	35



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Parameter		Maules Creek		Back Creek				Site Catchments			Namoi River			
		SW 1	SW 2	SW 3	SW 4	LMJ1	LMJ2	LMJ3	LMJ4	LMJ5	SW 5	SW 6	SW 7	SW 8
Selenium - filtered (mg/L)	20%ile	0.01	0.01	0.01	0.010						0.01	0.010	0.01	0.010
	Median	0.01	0.01	0.01	0.010						0.01	0.010	0.01	0.010
	80%ile	0.01	0.01	0.01	0.010						0.010	0.010	0.01	0.010
	Count	26	3	1	1						26	25	24	25
Silver - filtered (mg/L)	20%ile	0.001	0.001	0.001	0.001						0.001	0.001	0.001	0.001
	Median	0.001	0.001	0.001	0.001						0.001	0.001	0.001	0.001
	80%ile	0.001	0.001	0.001	0.001						0.001	0.001	0.001	0.001
	Count	26	3	1	1						26	25	24	25
Strontium - filtered (mg/L)	20%ile	0.210	0.294	0.323	0.245						0.215	0.197	0.186	0.218
	Median	0.238	0.317	0.323	0.246						0.266	0.263	0.275	0.261
	80%ile	0.306	0.329	0.323	0.246						0.382	0.412	0.422	0.355
	Count	36	10	1	2						36	33	32	35



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Parameter		Maules Creek		Back Creek				Site Catchments			Namoi River			
		SW 1	SW 2	SW 3	SW 4	LMJ1	LMJ2	LMJ3	LMJ4	LMJ5	SW 5	SW 6	SW 7	SW 8
Zinc - filtered (mg/L)	20%ile	0.0050	0.0050	0.0300	0.0216						0.0050	0.0050	0.0050	0.0050
	Median	0.0200	0.0050	0.0300	0.0270						0.0075	0.0130	0.0090	0.0100
	80%ile	0.0300	0.0092	0.0300	0.0324						0.0130	0.0288	0.0218	0.0208
	Count	36	10	1	2						36	33	32	35
Ammonia as N (mg/L)	20%ile	0.01	0.018	0.04	0.02						0.01	0.01	0.01	0.01
	Median	0.02	0.02	0.04	0.02						0.02	0.02	0.02	0.02
	80%ile	0.04	0.04	0.04	0.02						0.04	0.04	0.04	0.05
	Count	36	10	1	1						36	33	32	35
Nitrite as N (mg/L)	20%ile	0.01	0.01	<0.01	<0.01						0.01	0.01	0.01	0.01
	Median	0.01	0.01	<0.01	<0.01						0.01	0.01	0.01	0.01
	80%ile	0.01	0.02	<0.01	<0.01						0.01	0.01	0.01	0.01
	Count	36	10	1	2						36	33	32	35



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Parameter		Maules Creek		Back Creek				Site Catchments			Namoi River			
		SW 1	SW 2	SW 3	SW 4	LMJ1	LMJ2	LMJ3	LMJ4	LMJ5	SW 5	SW 6	SW 7	SW 8
Nitrate as N (mg/L)	20%ile	0.01	0.47	0.16	<0.01						0.01	0.01	0.01	0.01
	Median	0.07	1.47	0.16	<0.01						0.09	0.07	0.07	0.05
	80%ile	0.28	1.91	0.16	<0.01						0.32	0.35	0.27	0.33
	Count	36	10	1	2						36	33	32	35
Nitrite + Nitrate as N (mg/L)	20%ile	0.010	0.472	0.160	<0.01						0.010	0.014	0.010	0.010
	Median	0.065	1.510	0.160	<0.01						0.090	0.070	0.070	0.050
	80%ile	0.280	1.932	0.160	<0.01						0.320	0.350	0.268	0.334
	Count	36	10	1	2						36	33	32	35
Total Phosphorus as P	20%ile	0.100	0.040	0.290	0.162						0.040	0.050	0.042	0.058
	Median	0.145	0.070	0.290	0.255						0.100	0.100	0.090	0.100
	80%ile	0.200	0.094	0.290	0.348						0.140	0.176	0.150	0.190
	Count	36	10	1	2						36	33	32	35

Note: SW = MCC's Sampling Program. LMJ = Lyall Macoun and Joy Sampling Program (1983/84)

For statistical analyses, values lower than the sampling limits were assumed to be at the sampling limit.

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

- Water quality is fresh across all sampling locations. Median EC values at Maules Creek range from 290 to 460 $\mu\text{S}/\text{cm}$. Back Creek median EC values range from 170 to 270 $\mu\text{S}/\text{cm}$. Namoi River median EC values range from 330 to 350 $\mu\text{S}/\text{cm}$.
- TSS values recorded for Back Creek as part of the LMJ sampling program in 1983/84 are high with median values of 2,060 mg/L and upper values above 11,000 mg/L. Note however that the more recent sampling taken at SW3 and SW4 recorded a TSS of approximately 20 mg/L. Site catchment TSS values are high (also recorded as part of the LMJ sampling program), but not as high as Back Creek. The reasons for the high TSS levels from on-site catchments and Back Creek are uncertain. Monitoring of Back Creek water quality will continue to be undertaken throughout construction and into operations for the Project.

4.1.3 Baseline Geomorphology

Nine sites have been selected for photographic survey of the existing geomorphological condition of the downstream drainage system, from the minesite to the Namoi River, as shown in Figure 4-5.

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

A description of the existing geomorphological condition of the downstream drainage system is provided in Table 4.3, and shown in Figure 4-6 to Figure 4-19. Note that BCP4 and BCP5 are yet to be photographically surveyed as access has not yet been granted by the Landowners. It is envisaged that access agreements will be finalised later this year.

The nine baseline sites will be included in the stream and riparian vegetation health assessment using the AusRivAS protocols.

Further details on surface water monitoring are detailed in section 4.5.1

	<h1>MAULES CREEK</h1>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

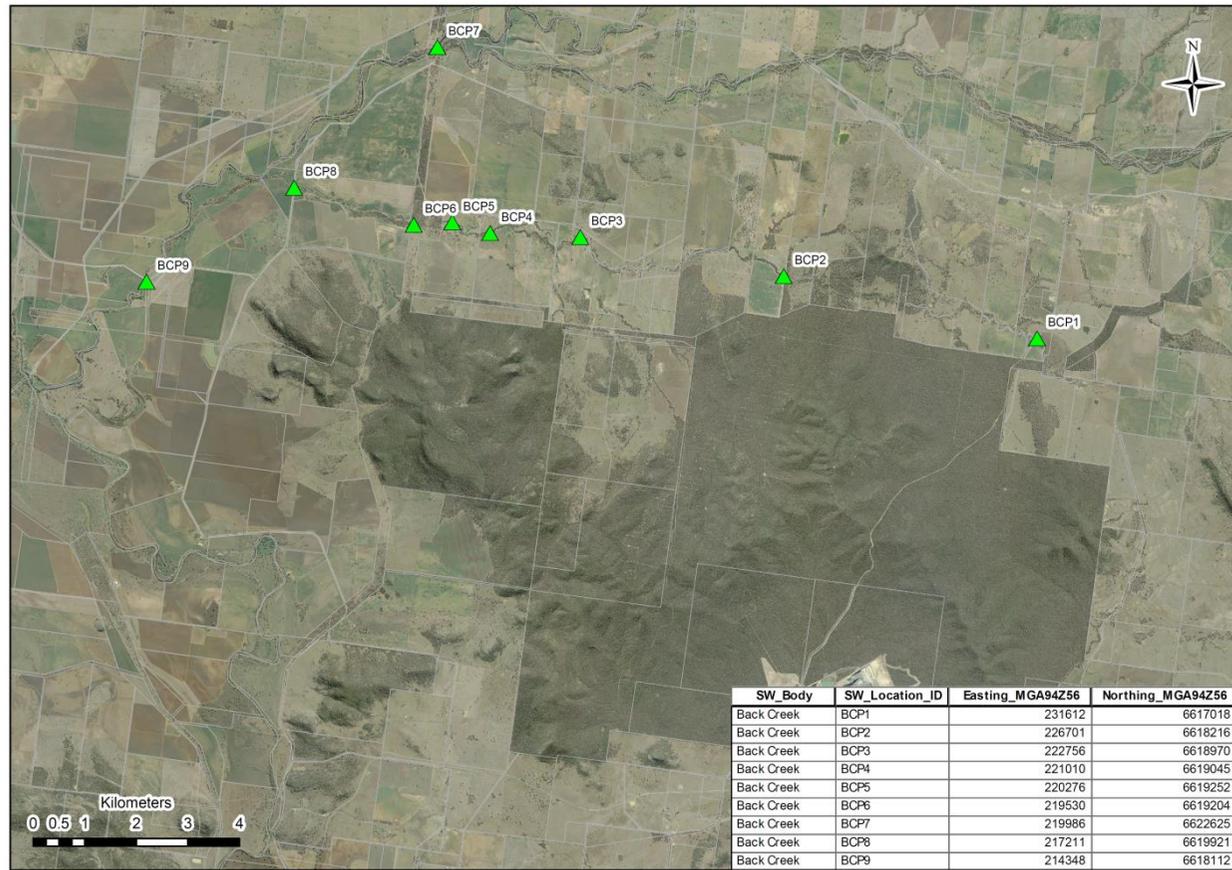


Figure 4-5 Geomorphological Condition Monitoring Locations

	<h1>MAULES CREEK</h1>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

Table 4.3 Description of Existing Geomorphological Condition

Stream	Monitoring Area	Monitoring Site	Description of Existing Geomorphological Condition	Photograph
Back Creek	Upstream of the Project	BCP1	Shallow incised channel	Figure 4-6 & Figure 4-7
			Lightly vegetated with grass and scattered trees	
		Bed and banks generally stable with some minor erosion evident		
		Dry		
	Downstream of the Project	BCP2	Shallow incised channel	Figure 4-8 & Figure 4-9
			Limited grass cover with scattered trees	
		Bed and banks generally stable with some minor erosion		
		Dry		
Maules Creek	Upstream of Back Creek Confluence	BCP3	Shallow incised channel	Figure 4-10 & Figure 4-11
			Some grass cover to banks with few trees	
			Dry	
	Downstream of Back Creek Confluence	BCP4	-	Figure 4-12 & Figure 4-13
		BCP5	-	
		BCP6	Wide shallow main channel with some isolated pools	
Downstream of Back Creek Confluence	BCP8	Wide shallow main channel with some isolated pools	Figure 4-14 & Figure 4-15	
		Significant bank erosion evident		
		Grassed banks with minimal trees		
Downstream of Back Creek Confluence	BCP7	Shallow channel	Figure 4-16 & Figure 4-17	
		Cleared, flat overbank area		
Downstream of Back Creek Confluence	BCP9	Minimal vegetation, grassed banks	Figure 4-18 & Figure 4-19	
		Dry		
Downstream of Back Creek Confluence	BCP9	Wide gravel bed	Figure 4-18 & Figure 4-19	
		Grassed banks with some scattered trees		
Downstream of Back Creek Confluence	BCP9	Bed and banks appear stable	Figure 4-18 & Figure 4-19	
		Dry		



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN



Figure 4-6 Photograph of Back Creek Channel at BCP1, Looking Upstream



Figure 4-7 Photograph of Back Creek Channel at BCP1, Looking Downstream



Figure 4-8 Photograph of Back Creek Channel at BCP2, Looking Upstream



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN



Figure 4-9 Photograph of Back Creek Channel at BCP2, Looking Downstream



Figure 4-10 Photograph of Back Creek Channel at BCP3, Looking Upstream



Figure 4-11 Photograph of Back Creek Channel at BCP3, Looking Downstream



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN



Figure 4-12 Photograph of Back Creek Channel at BCP6, Looking Upstream



Figure 4-13 Photograph of Back Creek Channel at BCP6, Looking Downstream



Figure 4-14 Photograph of Back Creek Channel at BCP8, Looking Upstream



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN



Figure 4-15 Photograph of Back Creek Channel at BCP8, Looking Downstream



Figure 4-16 Photograph of Maules Creek Channel at BCP7, Looking Upstream



Figure 4-17 Photograph of Maules Creek Channel at BCP7, Looking Downstream

	<h1>MAULES CREEK</h1>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			



Figure 4-18 Photograph of Maules Creek Channel at BCP9, Looking Upstream



Figure 4-19 Photograph of Maules Creek Channel at BCP9, Looking Downstream

4.2 Water Management Strategy

The Project's Water Management System aims to ensure leading-practice management of all water on site. The objectives of the water management system are to ensure:

- Clean water runoff from undisturbed catchment areas is diverted away from the mining area, where possible;
- Sediment laden runoff from disturbed areas is treated prior to re-use in the water management system or released into the receiving environment if water quality meets EPL requirements;
- Mine water (including water that accumulates within, or drains from, active mining areas, coal reject emplacement areas and CHPP infrastructure areas) and groundwater collected within open cut pits is contained and reused on-site;
- No discharge of mine water off-site; and

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

- On-site water demands are satisfied whilst minimising offsite water requirements.

4.3 Site Water Management System

4.3.1 Proposed Water Management Infrastructure and System Configuration

A conceptualisation of the water management system for the first five years of operation of the Maules Creek Coal Mine, including the water management structures and the pipelines linking these structures, is shown on Figure 4-20. A brief description of each of the water management structures is presented in Table 4.4. Note that sediment dam sizes have been based on the proposed design standards for sediment control dams (see Section 4.3.2).

The operational strategy developed to meet the objectives of the water management system has been tested using the site water balance model (see Section 4.5.2). The operational strategy includes the following rules:

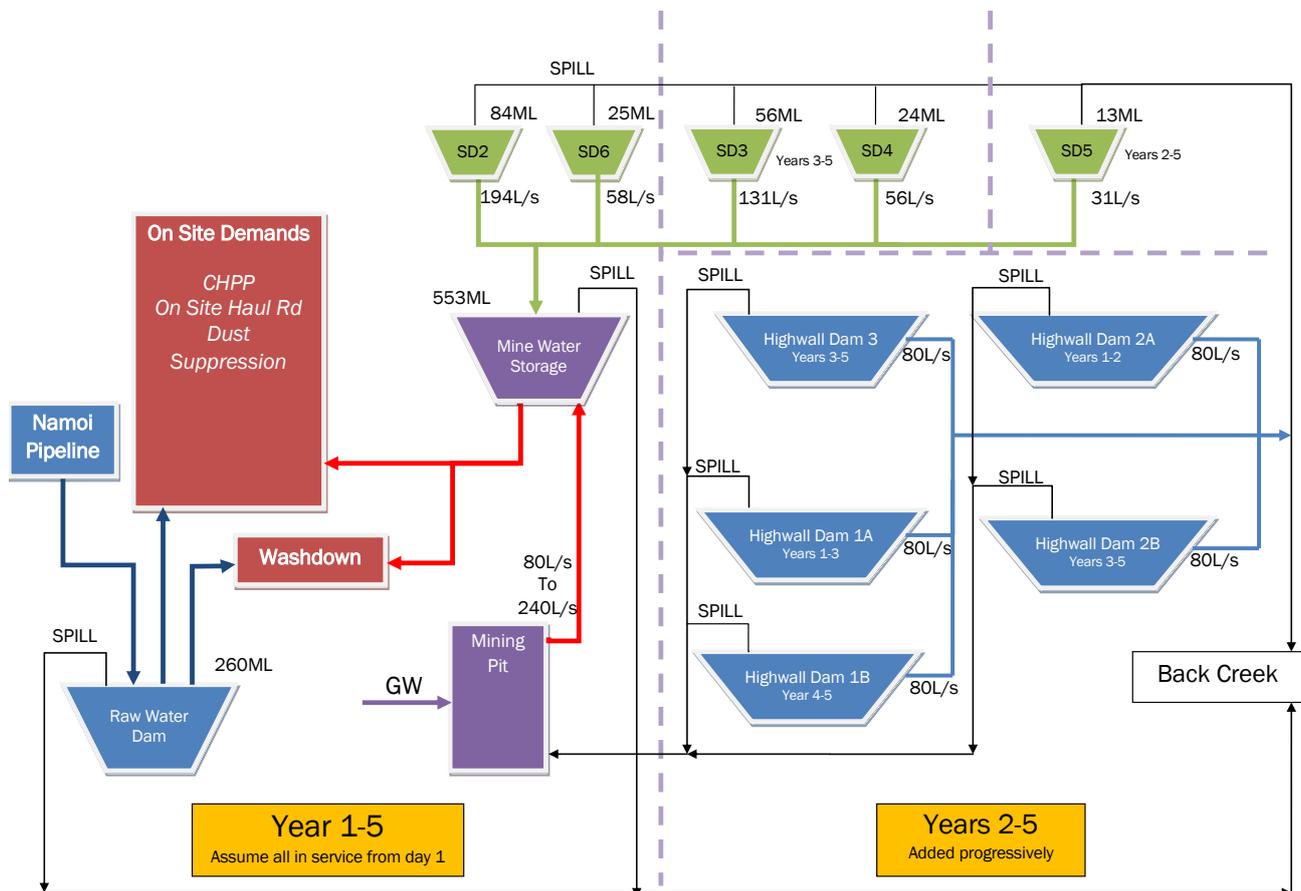
- Water accumulating in the open cut pit, from groundwater and surface water runoff, is pumped to the Mine Water Dam at the highest priority (i.e. prior to the dewatering of sediment dams). The dewatering rate increases with the volume of water within the Open Cut Pit;
- Runoff from the CHPP infrastructure area, including coal stockpiles, will drain to the Mine Water Dam
- Runoff from the Mine Infrastructure Area will be captured in SD6 during the construction phase, and the Mine Water Dam during the operations phase, following separation of grease and oils via a suitably engineered separator;
- Runoff accumulating in the sediment dams is pumped back into the mine water management system. If a rainfall event occurs that exceeds the design capacity of the sediment control system (see section 2.3.2), then water may be released offsite, in accordance with EPL conditions. Water captured in the sediment control system may also be released offsite at any time, provided water quality satisfies EPL conditions and it is not required to supply the mine water management system;
- Pumped inflows into the Mine Water Dam from all storages cease when the Mine Water Dam reaches its maximum operating volume (MOV) of 403 ML. The MOV has been selected based on the results of the mine water balance to ensure no spills of mine-affected water from the Mine Water Dam under historical climate conditions;
- The Mine Water Dam is used as the first priority storage for supply of all mine site demands, excluding the vehicle wash-down demand which is exclusively drawn from the Raw Water Dam;
- The Raw Water Dam will supply any shortfall in meeting the mine site water demands through pumped inflows from the Namoi River; and
- Runoff accumulating in the high wall structures is pumped or drains to clean water drains and diverted around disturbed areas and through the mine site to Back Creek.
- Runoff from the rail loop area will be captured and treated for sediment before discharging offsite. The rail loop area sediment dam will not be pump transferred to the mine water management system.

Additional information on the adopted pumping rates for the modelling of the water management system is provided in Appendix B.

Staged mine plans over the first 5 years of operation showing the locations of the water management structures are provided in Figure 4-21 to Figure 4-24. Note that two Mine Water Dams exist, however for the purpose of illustration of the Water Management System; these two dams have been considered as one.

MCC will seek the relevant approval for any *prescribed dams* from the Dam Safety Committee prior to the commencement of their construction.

Each Principal Contractor will be required to provide a Construction Environmental Management Plan (CEMP) for the area of construction under their respective contracts with MCC. The CEMP will incorporate various environmental management and mitigation measures including detailed erosion and sediment control plans to manage water on site and to ensure that the activities meet the stringent requirements of the Project Approval, Controlled Action Approval and EPL. Further the management and mitigation measures will be in accordance with the approved Environmental Management Plans, including this WMP. Construction activities are further discussed in Section 4.3.2.



^ Note that the Mine Water Storage is designed to not spill based on the current water balance modelling; however an emergency spillway is required for dam safety purposes.

Figure 4-20 Conceptual Water Management System Configuration

Table 4.4 Maules Creek Water Management Structures

Storage	Minimum Capacity (ML)	Spills To	Comments
Mine Water Dam ^a	553	Off site ^b	Accepts mine water from the pit and CHPP. Captures runoff from the CHPP infrastructure area. Supplies water management system demands at the highest priority.
Raw Water Dam	260	Off site	Storage dam for Namoi River water supplies. Supplies water management system demands at the lowest priority.
SD2	83.8	Off site	Captures runoff from the OEA.
SD3	56.4	Off site	Captures runoff from the OEA.
SD4	24.0	Off site	Captures runoff from the OEA.
SD5	13.2	Off site	Captures runoff from the OEA.
SD6	24.9	Off site	Capture runoff from haul road area during operations, and MIA and CHPP during construction phase
Highwall Dam 1A	100 ^c	Pit	Captures runoff from undisturbed catchments.
Highwall Dam 1B	100 ^c	Pit	Captures runoff from undisturbed catchments.
Highwall Dam 2	100 ^c	Pit	Captures runoff from undisturbed catchments.
Highwall Dam 3	100 ^c	Pit	Captures runoff from undisturbed catchments.

^a Combined capacity of MWD1 (18ML) and MWD2 (535ML)

^b Mine Water Storage is designed to not spill based on the current water balance modelling, however an emergency spillway is required for dam safety purposes. ^c Diversion structure may be used as alternative to storage where practical



MAULES CREEK

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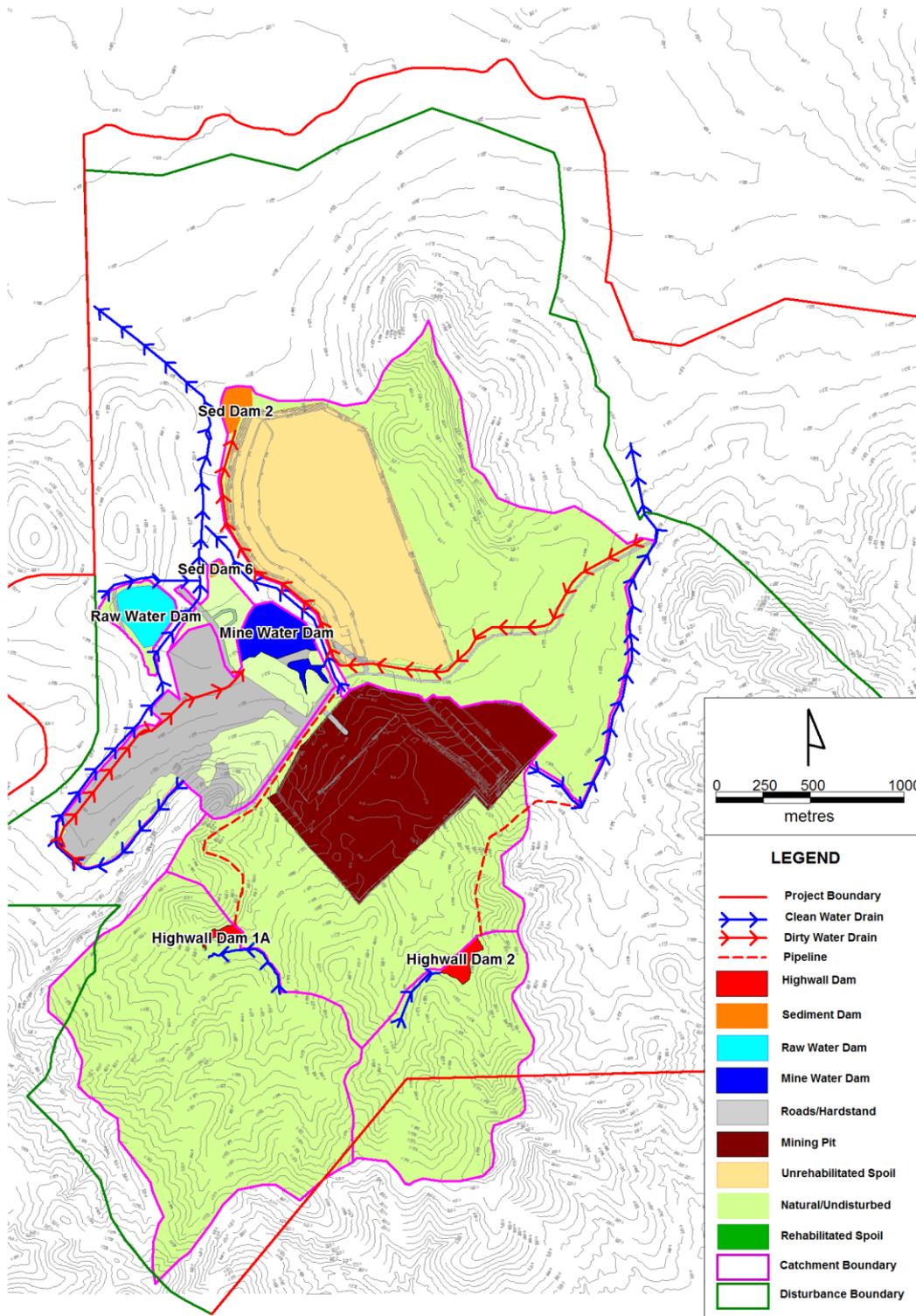


Figure 4-21 Staged Mine Plan – Year 1 Operations



MAULES CREEK

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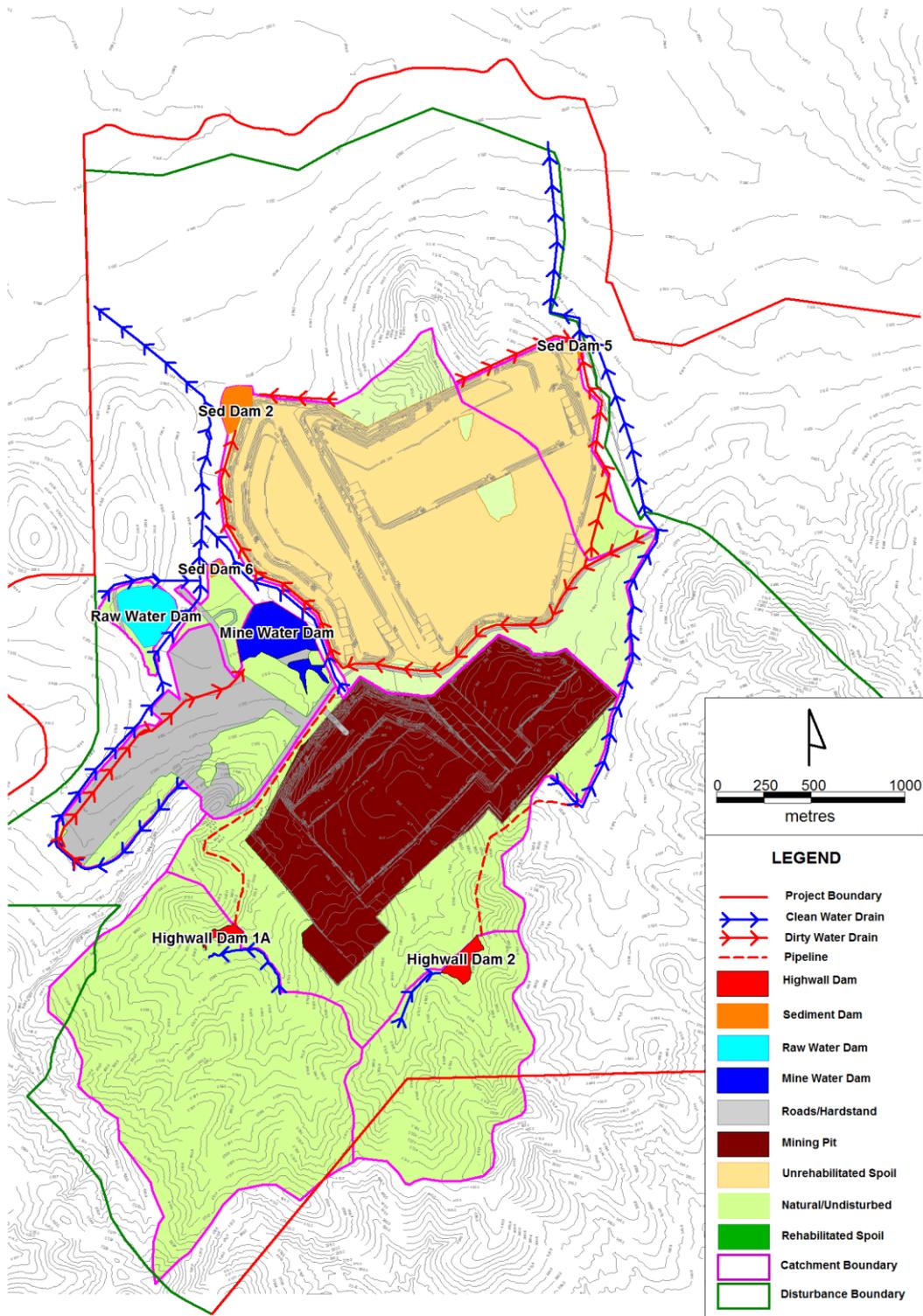


Figure 4-22 Staged Mine Plan – Year 2 Operations



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Date Printed:	

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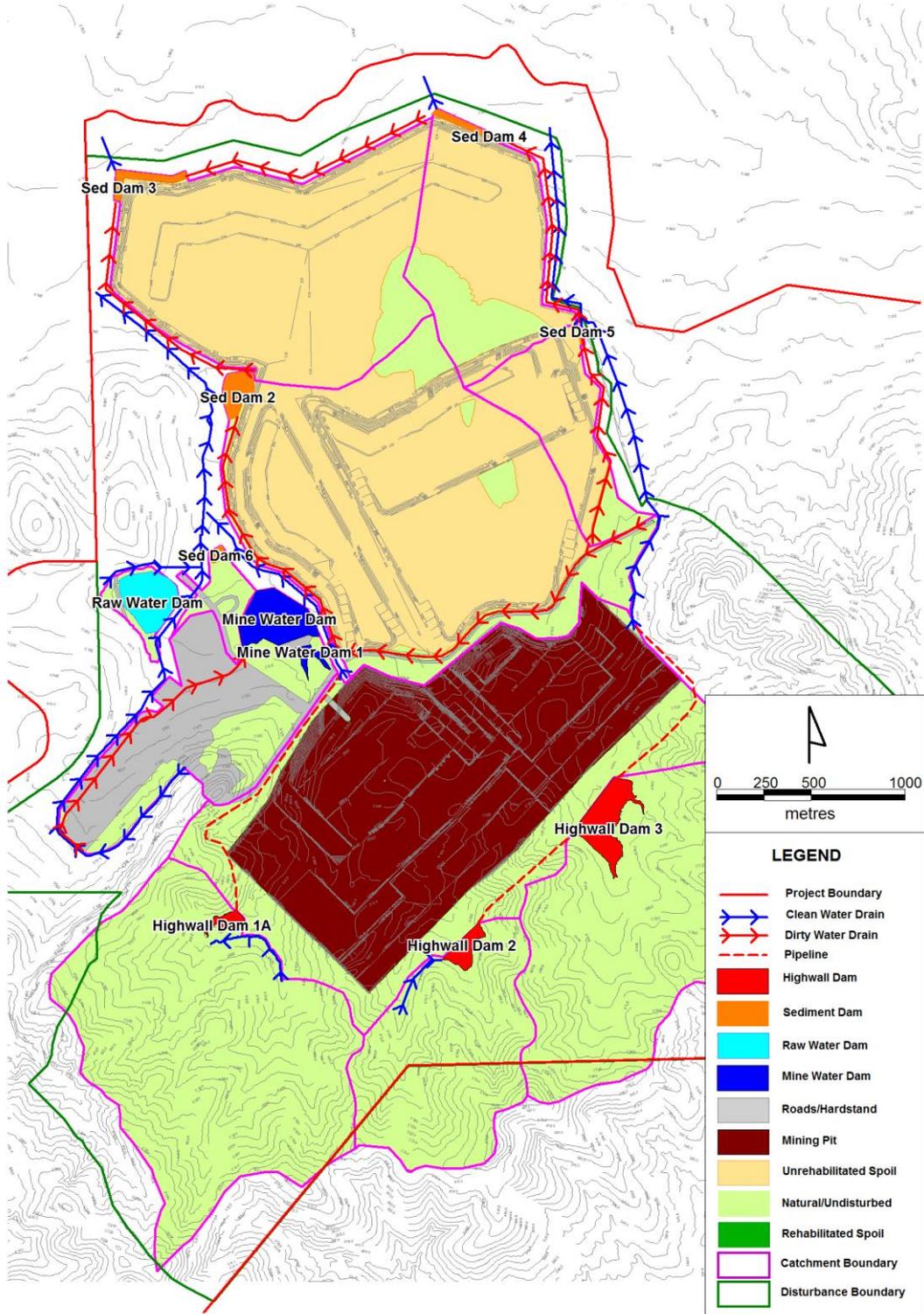


Figure 4-23 Staged Mine Plan – Year 3 Operations



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Revision Period:	2 years
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Last Revision Date:	March 2019
Date Printed:	

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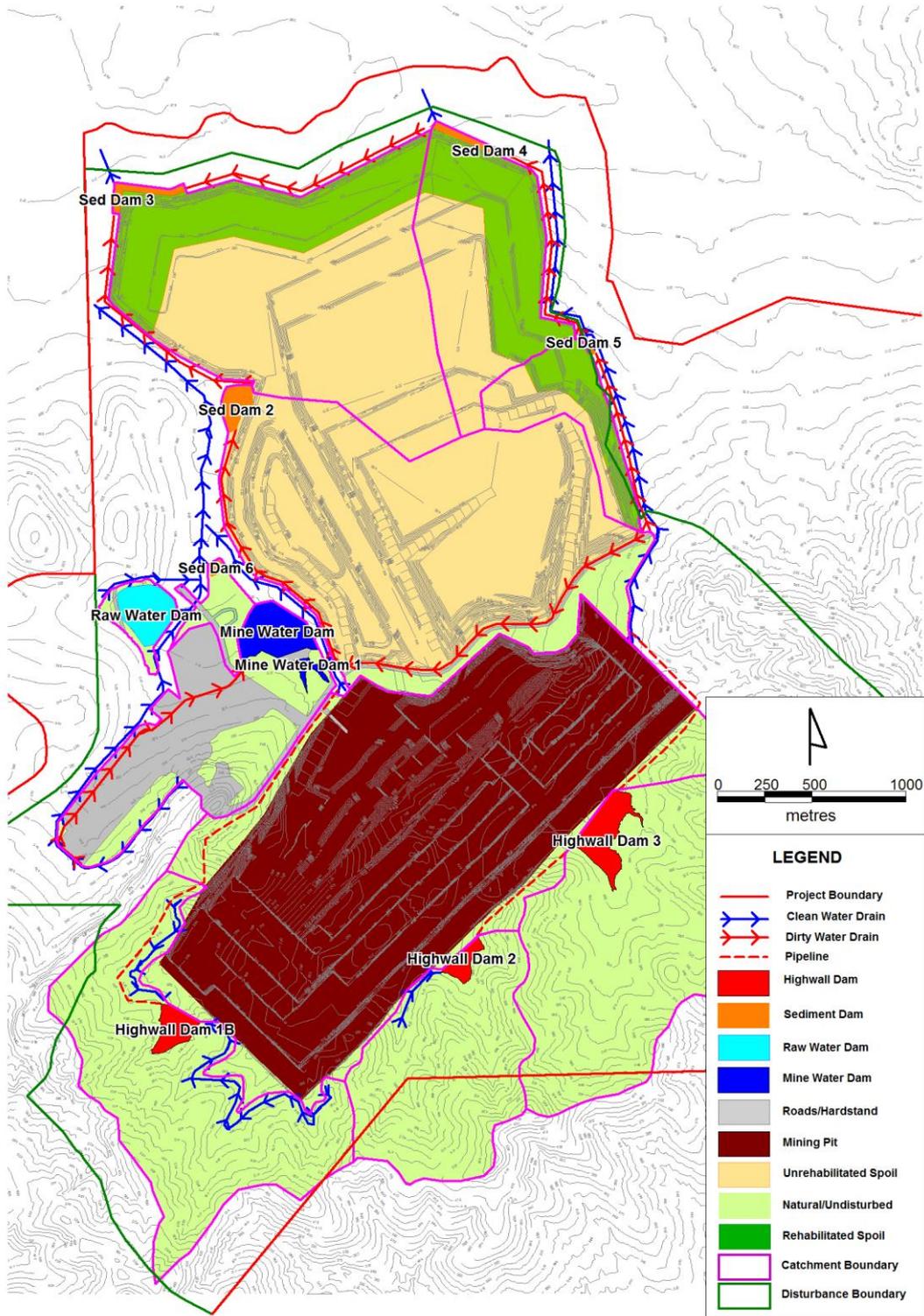


Figure 4-24 Staged Mine Plan – Year 5 Operations

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		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
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4.3.2 Erosion and Sediment Controls

Overview

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

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

- Vegetation clearing and topsoil stripping;
- Stockpiling of topsoil;
- Construction of roads and infrastructure; and
- Construction of overburden emplacement areas;
- Re-routing drainage lines via clean water diversions; and
- Construction activities as detailed below.

Potential impacts from these activities include:

- Increased surface erosion from disturbed and rehabilitated areas through the removal of vegetation and stripping of topsoil;
- Increased sediment and pollutant load entering the natural water system; and
- Siltation or erosion of watercourses and water bodies.

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

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

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

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

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

- Managing Urban Stormwater, Soils and Construction (Landcom, 2004); and
- Managing Urban Stormwater, Soils and Construction, Volume 2E Mines and Quarries (DECC, 2008).
- The design of linear construction (including pipelines, roads and rail spur line) will be in accordance with current recommended design standards in the following guidelines:
- Managing Urban Stormwater, Soils and Construction, Volume 2A Installation of Services;
- Volume 2C unsealed roads; and
- Volume 2D Main Road Construction.

Proposed Sediment Control Structures

Sedimentation dams, dirty water drains and contour banks will direct runoff from disturbed areas away from the undisturbed areas. Each of the dirty water drains directs water into sedimentation dams, which provides additional settlement of runoff prior to overflow into natural drainage lines.

The general arrangement of the proposed erosion and sediment control structures is shown in the staged mine plans (Figure 4-21 to Figure 4-24). The proposed sediment dams are positioned between the active mining area and Back Creek to capture runoff from the overburden emplacement areas and other disturbed land.

All rehabilitated land where required will be shaped to minimise down slope flows e.g. use of contour banks or other structures. These structures can carry water around the slopes to sediment dams where it is either pumped back into the mine water management system, or released offsite if a rainfall event occurs that exceeds the design capacity of the sediment control system (as described below). Water captured in the sediment control system may also be released offsite at any time, provided water quality meets EPL conditions and is not required to supply the mine water management system.

Sediment dam sizes and locations will be confirmed during the detailed design process. However, the dam sizes will be based on the following design standards and methodology:

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

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

- Flocculated to reduce TSS to less than the EPL limit;
- Pumped to another water storage with available capacity; or
- Pumped into the mine water management system.

Note also that other pollutants not specified in the EPL will need to meet the general provisions of section 120 of the *Protection of the Environment Operations Act 1997*.

Table 4.5 provides the adopted sediment dam volumes required during the first 5 years of operation and the associated pump requirements to restore the settling zone capacity within 5 days. Note that current design guidelines (DECC, 2008) allow for the adoption of larger dam sizes to allow for dewatering over a longer period to reduce the required pumping rate.

For rainfall events that exceed the design standard, it is possible that the sediment dams may overflow with pollutant concentrations that exceed the water quality discharge limits of the EPL. Note however that such overflows are likely to occur during large rainfall events when background suspended solids concentrations in receiving waters are likely to be well above the water quality objective (see Section 4.1.2).

Table 4.5 Sediment Dam Preliminary Sizing

Sediment Dam	Maximum Catchment Area (ha)	Minimum Total Volume Required (ML)	Minimum 5 day Pump Rate (L/s)
2	291	84	194
3	196	56	131
4	83	24	56
5	46	12	31
6	86 ^a	25	58

^a Maximum catchment area occurs during construction phase.

Construction Phase Control Measures

Principal Contractors will be appointed by MCC to undertake the construction activities for the Project. The Principal Contractors will be required to prepare CEMPs and submit them to MCC for approval prior to commencing any construction works on site. MCC will review the Principal Contractors CEMPs for compliance with the MCC approved management plans and EPL conditions. MCC will also conduct regular reviews and audits of the Principal Contractor’s activities to ensure the effective implementation of the plans.

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

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These CEMPs will include Erosion and Sediment Control Plans that will detail the measures for water management and erosion and sediment control for their respective work site in line with the principles outlined in this WMP.

Areas where potential impacts may occur include:

- Construction of a CHPP with a throughput of 13 Mtpa ROM coal;
- Construction of the Maules Creek rail spur, rail loop, associated load out facility; Note: The construction of the shared portion of the rail spur will be managed under the Boggabri Coal approvals and construction environmental management plan;
- Sealing of Therribri Road to the Mine Access Road;
- Sealing of Manilla Road between Leard State Forest Road and the Whitehaven - Tarrawonga Haul Road ;
- Construction of the Mine Access Road;
- Upgrade of the Northern Link Road and East Link Roads;
- Construction and operation of administration, workshop and related facilities;
- Construction and operation of a water pipeline, pumping station and associated infrastructure for access to water from the Namoi River;
- Installation of power transmission line and related infrastructure; and
- Installation of communications, water management and reticulation infrastructure.

Where practicable, runoff from undisturbed catchments will be diverted around the construction activities via diversion drains and banks to discharge into the natural watercourses. Runoff from disturbed areas will be retained on site in sediment dams and allowed to settle prior to discharge into the natural system.

Prior to disturbance of land, appropriate erosion and sediment controls will be established. During construction, a number of temporary sediment dams will be used to collect runoff from disturbed areas. Disturbed area runoff accumulating in these dams will be used for dust suppression. Excess water accumulating in the dams will be treated or allowed to settle and discharged to receiving waters (once water quality is acceptable), or pumped to an alternate storage; either another sediment dam which will be constructed early in the construction program.

A combination of temporary and permanent clean and dirty water drains will also be established during construction to divert runoff from undisturbed areas and collect runoff from disturbed areas. Additional erosion and sediment control measures will be used for other small disturbance areas including silt fences, hay bales and other measures consistent with current best practice standards.

Figure 4-5 shows locations within the Project Boundary including places along the construction areas for the Mine Access Road and Rail Spur that have been identified where potential offsite discharge may directly enter the drainage lines and streams. These locations will be a point of focus when the Principal Contractor is developing their Erosion and Sediment Control Plans for construction activities.



MAULES CREEK

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Revision Period:	2 years
Issue:	2
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Date Printed:	

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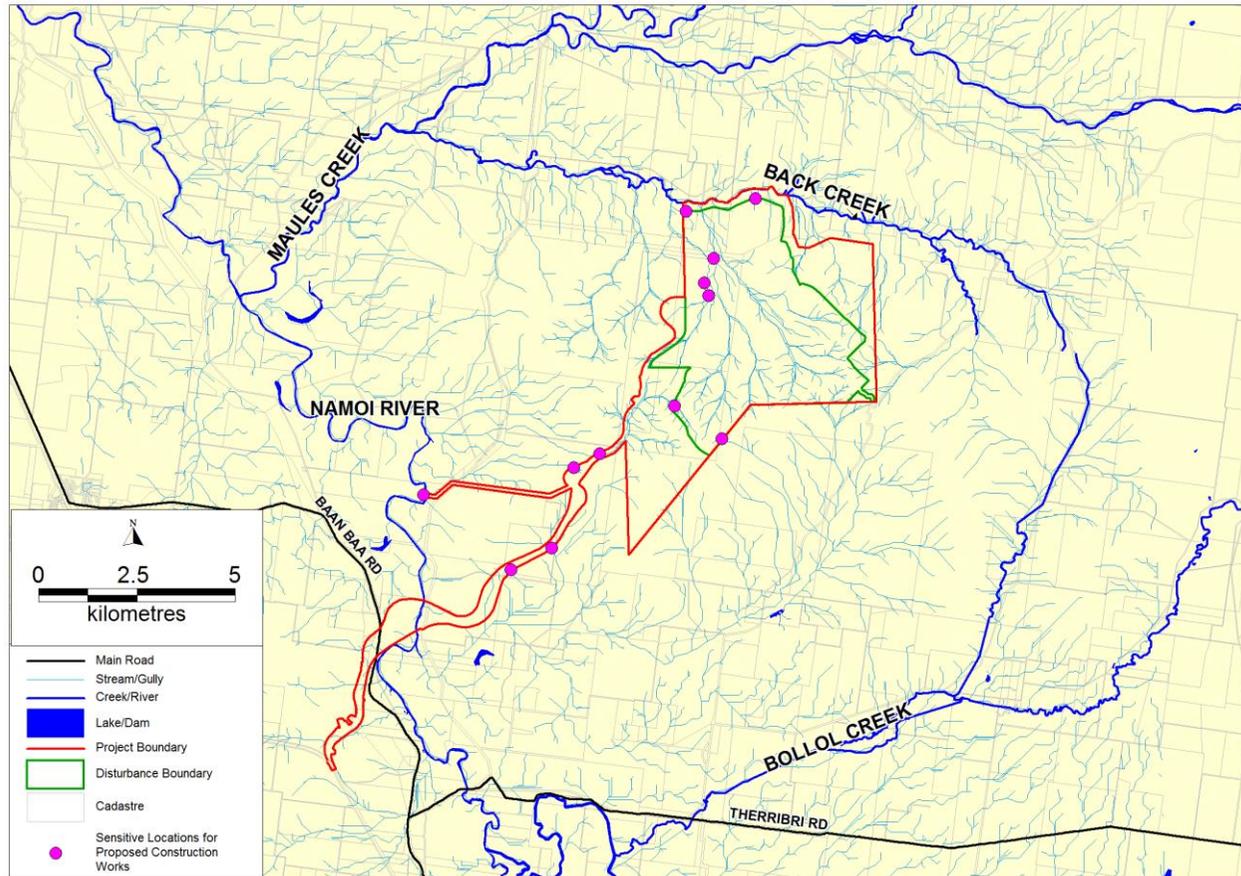


Figure 4-25 Sensitive Locations for Proposed Construction Works

	<h1>MAULES CREEK</h1>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

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Maintenance

Dams, contour banks and drainage lines across Maules Creek will be regularly inspected to assess their integrity and efficiency to control and capture water. Maintenance works will be undertaken on these structures as required, including repair of any erosion damage to channel banks and desilting of sediment control dams to ensure that sufficient capacity for sediment storage and runoff capture is available.

Monitoring and Reporting

Monitoring includes real time weather monitoring, quarterly assessment of all erosion control and sediment retention devices and monthly surface water quality monitoring. Additional post-event inspections of sediment control structures will be undertaken where more than 25 mm of rainfall is recorded in 24 hours or more than 38 mm of rainfall is recorded over 48 hours. The post-event inspection will include field-based assessment of water quality for any sedimentation dam overflows and also the capacity of the structures for any possible future rainfall events.

4.3.3 Clean Water Management System

Surface runoff water from areas where water quality is not affected by mining operations is considered 'clean' water.

A series of temporary highwall structures and drains will be constructed to divert clean water around the disturbance area to the downstream waterway as shown in Figure 4-21 to Figure 4-24.

During the first five years of operations, water collected in or diverted by the highwall structures will primarily be pumped along the south eastern boundary of the active mining area to clean water drains originating to the east of the disturbance area. These drains will direct the clean runoff around the overburden emplacement area and discharge to Maules Creek at the north west of the Project Boundary. In the first 2 years of operation, clean water from highwall structures will also be pumped around the active mining area on the north western side to the clean water drain passing through the middle of the site.

Runoff from the undisturbed catchments will also be diverted to the clean water drainage system and discharged to Back Creek. The Raw Water Dams will contain clean water only, and any overflows from these dams will be directed to the clean water drainage system and allowed to drain to Back Creek.

The main clean water drain through the mine site will be designed to convey clean water runoff at non-erosive velocities for flows up to the 20 year ARI peak stormwater discharge, with discharge capacity equal to the 100 year ARI discharge. To achieve these design objectives, the drain may require engineered drop structures and/or channel rock lining in steep sections. Site drainage will be designed to provide a stable long-term drainage network at the completion of mining.

4.3.4 Mine Water Management System

Water that has come in to contact with coal such as groundwater inflows and surface runoff to the open cut pit or stormwater runoff from the ROM and product coal stockpiles is considered 'mine' water.

A summary of the proposed mine water management system within the study area is given below:

- Water collected in the active mining areas will be pumped to the Mine Water Dam as the highest priority;
- Water stored in the Mine Water Dam will be used for all mine site demands, excluding the vehicle wash-down demand, which is exclusively drawn from the Raw Water Dam; and
- Should the Mine Water Dam reach its maximum operating level to prevent uncontrolled spills, pumped inflows of mine affected water will cease and will be retained in the open cut pit.

	<h1>MAULES CREEK</h1>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

A numerical water balance model was used to design the operating rules and assess the effectiveness of the mine water management system. The model identifies water supply and discharge requirements based on the expected catchment runoff and water demands at the Maules Creek Mine. The water balance model is discussed in detail in Section 4.5.2.

4.3.5 Reject Material Emplacement

A geochemical assessment undertaken by RGS Environmental Pty Ltd (RGS) indicates that:

- Overburden materials and most potential coal reject materials at the Maules Creek Mine are likely to have negligible (<0.1%) total sulphur content and are therefore classified as Non Acid Forming (NAF) barren;
- Overburden also appears to have excess acid buffering capacity typical of a moderate Acid Neutralising Capacity value;
- Most overburden materials and NAF potential coal rejects were predicted to generate slightly alkaline and relatively low salinity runoff and seepage following surface exposure;
- Overburden materials have been predicted to be non sodic (and as such non dispersive) and may be suitable for revegetation and rehabilitation activities (in final surfaces or as a growth medium);and
- A small proportion of the potential coal reject materials are classified as Potentially Acid Forming – High Capacity (PAF). These materials may generate acidic and more saline runoff and seepage if exposed to oxidising conditions.

The identification of any PAF material will initially occur via a combination of in pit sampling and the use of the elemental ash analyser installed on the in feed raw coal conveyor to the CHPP. In addition, coarse reject will be sampled at the rejects screen, and ultrafine reject will be sampled at the underflow sampling unit of the thickener to ensure all PAF material is identified prior to disposal from the CHPP. If PAF material is identified by the Mining Manager and CHPP Manager will be notified so that appropriate management measures can be implemented.

PAF material will be disposed of either within the Overburden Emplacement Area (OEA) or in pit. PAF material will be disposed of in a location to minimise further oxidation and ensure there is no leaching into the surrounding environment.

When determining the appropriate disposal location, the following objectives will be considered to manage quality of any runoff and seepage from overburden and coal reject materials including:

- Deep (in pit) burial of PAF coal reject materials;
- Out of pit co-disposal of PAF coal reject materials;
- Encapsulated cells using Non Acid Forming (NAF) for higher risk PAF materials. The walls to be of a thickness whereby mine haul trucks will provide compaction during waste emplacement;
- Provision of adequate drainage and containment structures;
- Pre stripping topsoil from areas to be mined for use in final rehabilitation activities;
- Placement of overburden within the overburden emplacement areas in a manner that limits the risk of surface erosion;
- Placement of NAF coal reject materials in the open cut pit and / or co-disposed with overburden; and
- Covering of PAF coal reject materials as soon as practical with at least 5 m of NAF overburden material to minimise the length of exposure to oxidising conditions.

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

To monitor the performance of these management measures, surface water flows and seepage from the OEAs and areas where rejects have been emplaced will be monitored for pH, EC, TSS and dissolved metals (including arsenic, molybdenum and selenium). Geochemical characteristics of the coal reject materials will also be confirmed when bulk samples become available from the CHPP.

4.3.6 Rehabilitation and Final Landform

The Project has developed detailed mine plans to obtain the maximum area of rehabilitation available throughout the life of the Project. Management of the rehabilitation will include the development of stable and safe landforms. The OEAs will be progressively rehabilitated over the life of the mine as soon as practical, in order to minimise the mine disturbance area at any one time. All mine areas will ultimately be rehabilitated except for the final void which will be shaped appropriately. Further details are provided in the Rehabilitation Management Plan.

The final void at Year 21 will be designed according to the Final Void and Mine Closure Plan which is to be submitted by December 2020. The size and depth of the final void and the final void catchment area will be minimised as far as is reasonable and feasible. Highwalls will be blasted to a slope of approximately 37 degrees to ensure the landform is stable, non-erosive and revegetated as is practical. Catchment areas that are not free draining will report to the final void, as will any drainage from disturbed areas.

All OEA's external batters will be sloped to 10 degrees or less. Drainage berms will be designed to limit effective slope lengths. The drainage berms will be constructed with gentle cross fall for drainage control. Drains and ponds will collect runoff.

Monitoring actions to ensure rehabilitation objectives are met will include regular inspections to assess structural stability and the effectiveness of erosion and sediment control measures. Monitoring actions for rehabilitation works will be detailed in the Mine Operation Rehabilitation Management Plan.

4.3.7 Construction Water Supply

Details of required water volumes and water sources for construction will be provided in the CEMPs required for various components of Project infrastructure. The CEMPs will include information on the proposed measures to monitor water usage volumes. This will enable MCC to track and account for water that will be utilised from various sources for the annual accounting of water usages.

Initial construction water sources will include the existing bore in the Leard State Forest (WAL 29467, 6 ML/a) and the existing site dam (WAL 90SL101060, 30 ML/a). In addition, there are a number of existing farm dams on the Velyama (906.4 ha) and Teston (1,295.04 ha) properties that are owned by MCC. MCC plans on utilising water from these dams on an infrequent basis for dust suppression for construction activities according to the maximum allowable harvestable rights of 154 ML from these properties. If necessary, these sources will be supplemented with water from licensed external sources, such as potable water supplies.

Once water extraction and pumping infrastructure is completed, water will also be available from the Namoi River allocation (WAL 13050, 3,000 ML/a) which will provide the dominant source of water for construction.

Construction water demands are anticipated to ramp up to approximately 4 ML/day in the peak period of construction activities.

4.4 Performance Criteria

The effectiveness of the implementation of the management actions will be determined by a series of key performance indicators (KPIs) set for each parameter. Table 4.6 summarises the objectives and performance criteria.

Table 4.6 Performance Criteria

Objective	Target	KPI
Minimise draw from the Namoi River	Maximise recycling of water.	All water collected in coal-affected areas such as coal stockpile and the open cut pit is returned to the Mine Water Dam for reuse in mine water management system.
	Minimise high quality water usage.	Water from Mine Water Dam prioritised for CHPP and dust suppression.
Maintain water quality downstream	No releases of mine water from site.	No discharges at Mine Water Dam spillway.
	Any water quality discharges from sediment dams comply with EPL conditions. No adverse impact on receiving water quality.	Any overflows from licensed discharge points comply with conditions specified in EPL 20221. Surface Water Monitoring Plan developed and implemented. An investigation is undertaken to assess potential environmental impacts of the project where discharge from the site occurs and monitored downstream pollutant concentrations exceed both the monitored upstream pollutant concentrations and trigger levels specified in Table 4.10.
	Manage water levels in mine	Cease all pumped inflows to



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Objective	Target	KPI
	water dams effectively to minimise unplanned overflows.	Mine Water Dam when stored water volume exceeds 403 ML.
Minimise impacts on downstream surface water users along Back Creek and Maules Creek.	No measurable change in low flows along Back Creek.	Monitor flow rate in Back Creek downstream of project and undertake annual review of collected hydrologic data to assess any identifiable change in flow over time.
Manage erosion and sedimentation	No increase in erosion and sedimentation is observable in watercourses downstream of the mine. Erosion and sedimentation managed to best practice standard during construction stage.	Disturbed area runoff captured in sediment dams and either transferred to the Mine Water Dam or, if water quality permits, discharged to the receiving environment in compliance with EPL conditions. Construction CEMP developed and implemented for each stage of construction.
Minimise flood impacts on Back Creek and Namoi River	No noticeable increase in erosion during flood events.	Mine infrastructure is located outside of Back Creek floodplain. Bridge and culvert crossings along access road and rail spur, as well as Namoi pipeline intake infrastructure are maintained to ensure no blockage of flood flows. Any community complaints relating to increased flood impacts are investigated.
Minimise impacts on stream and riparian vegetation health	No adverse impact on stream and riparian vegetation health.	Namoi pipeline infrastructure constructed, maintained and operated in accordance with licence conditions.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

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Objective	Monitoring	Timing
	<p>Inspection of the site water management system, in particular sediment control infrastructure.</p> <p>Water quality of sediment dam discharges for parameters with specified concentration limits under EPL 20221.</p> <p>Volume of water released during sediment dam discharges (indirect: measured via water balance calculations for sediment dams)</p> <p>Water levels in Raw Water Dams and Mine Water Dam.</p> <p>Water quality of Back Creek, Maules Creek and the Namoi River.</p>	<p>Monthly or following onsite rainfall greater than 25 mm in 24 hours or 38 mm in 48 hours.</p> <p>As per Surface Water Monitoring Plan.</p> <p>Monthly (when sediment dam overflows occur)</p> <p>Daily</p> <p>As per Surface Water Monitoring Plan.</p>
Minimise risk of, and impact from, uncontrolled spill from Mine Water Dam	<p>Water levels in Raw Water Dams and Mine Water Dam.</p> <p>Spill volume (via spillway rating curve)</p>	<p>Daily</p> <p>Within 24 hours of overflow (Contingency measure only - system is operated so that overflows from Mine Water Dam do not occur)</p>
Manage erosion and sedimentation	<p>Visual checks of discharge points and clean water diversions.</p> <p>Photographic monitoring of points on Back Creek and Maules Creek (as per Figure 4-5) to document potential areas of erosion or</p>	<p>Monthly or following onsite rainfall greater than 25 mm in 24 hours or 38 mm in 48 hours.</p> <p>Annual, as part of stream and riparian vegetation health assessment.</p>



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Objective	Monitoring	Timing
	deposition.	
Minimise flood impacts on Back Creek and Namoi River	<p>Visual inspection for blockage of Back Creek floodplain, bridge and culvert crossings along access road and rail spur, and Namoi pipeline intake infrastructure.</p> <p>Continuous water level/flow monitoring of Back Creek in accordance with Surface Water Monitoring Plan.</p>	<p>Annual</p> <p>Ongoing. Annual maintenance report and review of rating curve.</p>
Minimise impacts on stream and riparian vegetation health	<p>Maintain record of community complaints relating to stream and riparian vegetation.</p> <p>Annual stream and riparian vegetation health assessment, comprising macro-invertebrate monitoring in refuge pools along Back Creek and physical and chemical monitoring according to the AusRivas guidelines. Monitoring locations to take place at upstream and down stream locations along Maules Creek and Back Creek (as per Figure 4-5), and at upstream and downstream locations along the Namoi River.</p>	<p>Ongoing</p> <p>Annual</p>
Validate Water Balance Model (Surface Water Quantity)	<p>Rainfall</p> <p>Water levels in Raw Water Dams and Mine Water Dam.</p> <p>Water volumes in the active mining area</p>	<p>Daily</p> <p>Daily</p> <p>Monthly</p> <p>Monthly (when sediment dam</p>

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Objective	Monitoring	Timing
	Volume of any offsite discharge Pump rates between storages Demand rates for CHPP makeup water, industrial use, dust suppression and vehicle wash-down. Water levels/flow in Back Creek, Maules Creek and the Namoi River. Groundwater inflows General mine site water management practices	overflows occur) Continuous As per Surface Water Monitoring Plan. Monthly (estimated from pump volumes and estimated storage volume) Ongoing

4.5.1 Surface Water Quality and Quantity Monitoring Plan

Monitoring of surface water quality and quantity both within and external to the mine site will form a key component of the surface water management system. Monitoring of upstream, onsite and downstream water quality and quantity will assist in demonstrating that the site water management system is effective in meeting its objective of no adverse impact on receiving water quality and will allow for early detection of any impacts and appropriate corrective action.

The surface water monitoring protocols will:

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

MCC has previously monitored 9 surface water locations in the Maules Creek Mine vicinity (as detailed in Section 4.1.2). The Surface Water Monitoring Plan (SWMP) will include the continued monitoring of a number of these sites to monitor surface water flows and quality upstream and downstream of the mine.

Figure 4-25 shows proposed stream monitoring locations. Details of the proposed monitoring locations, including sample collection frequency and key parameters to be monitored, are shown in

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

Table 4.8. Table 4.8 also shows the proposed monitoring program for water storages on site. All samples should be collected in a manner consistent with the Approved Method for Sampling and Analysis of Water Pollutants in NSW (DEC, 2004).

Surface water monitoring at SW4, SW5, SW8 and SW9 (which are part of the BTM Complex MWS cumulative monitoring network) will be undertaken in accordance with the BTM Complex WMS. The BTM Complex Monitoring Suite will consist of:

- Field parameters, including pH, electrical conductivity, temperature, dissolved oxygen, turbidity, ORP;
- TSS;
- Oil and grease;
- Nutrients, including total phosphorous, reactive phosphorous and total nitrogen; and
- Metals, including:
 - Aluminium;
 - Arsenic (as III);
 - Arsenic (as V);
 - Boron;
 - Cadmium;
 - Chromium (Cr VI);
 - Copper;
 - Iron;
 - Lead;
 - Manganese;
 - Mercury;
 - Nickel;
 - Selenium (total)
 - Silver; and
 - Zinc.

Data from monitoring stations maintained by NOW will also be used to supplement the monitoring program and supply further information on water flows in the Namoi River.

Surface water monitoring during the construction stage will be undertaken in accordance with the relevant CEMP to be prepared by MCC.

Table 4.8 Surface Water Quality and Quantity Monitoring Plan

Location		Parameters	Frequency
Maules Creek	SW1	Suite 1	Daily during runoff events
	SW2	Suite 2	Monthly if flowing
Namoi River	SW5	Flow ^a	Continuous
		BTM Complex Monitoring Suite	Monthly (+ daily during runoff events) until baseline established, then quarterly (+ daily during runoff events)
	SW6	Suite 1	Monthly
	SW7		
	SW8	Flow ^a	Continuous
	BTM Complex Monitoring Suite	Monthly (+ daily during runoff events) until baseline established, then quarterly (+ daily during runoff events)	
Back Creek	SW4	Flow ^a	Continuous
		BTM Complex Monitoring Suite	Monthly (+ daily during runoff events) until baseline established, then quarterly (+ daily during runoff events)
	SW3	Suite 2	Daily during runoff events
	SW10		
	SW9	Flow ^a	Continuous
	BTM Complex Monitoring Suite	Quarterly + Daily during runoff events	
Site Clean Water Discharge Point	SW11	Suite 2	Daily during runoff events
Mine Water Dam		Suite 2	Monthly
Raw Water Dam & Sediment Dams		Suite 2	Monthly until baseline established, then quarterly
Sediment Dam overflows		Suite 1 + Oil & grease	Daily during overflows
Pit Water Seepage		Suite 2	Quarterly
Emplacement Seepage		Suite 2	Quarterly

Suite 1 = pH, EC, TSS, TDS, Turbidity

Suite 2 = Suite 1 + Major Anions, Major Cations, Alkalinity, Metals, Total Nitrogen, Total Phosphorus

^a Automatic water level logger + rating curve to be developed to convert recorded water levels to flow rates, consistent with the BTM Complex Water Management Strategy.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

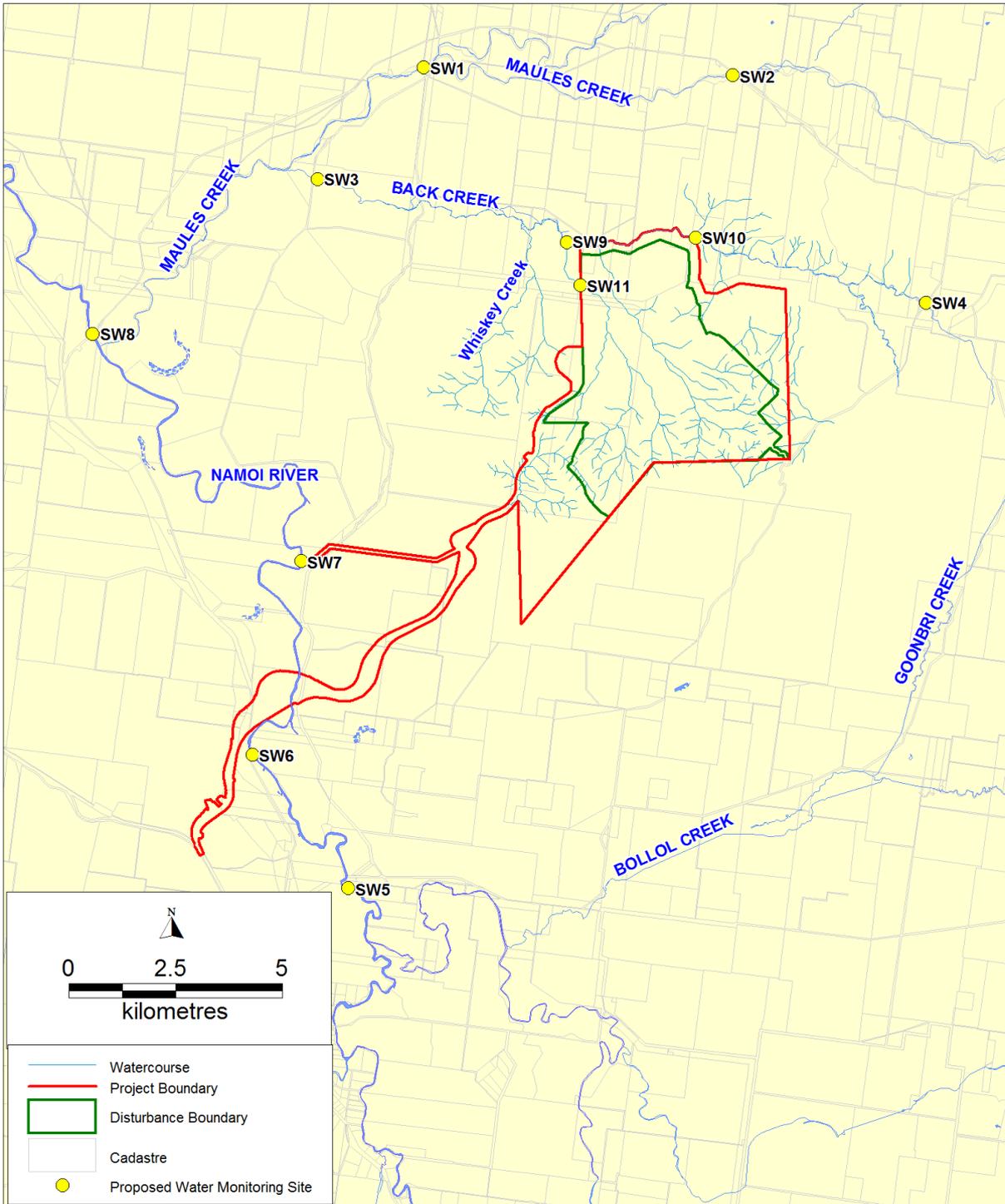


Figure 4-25 Proposed Stream Water Quality Monitoring Locations

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

4.5.2 Impact Assessment Criteria

Surface Water Quality Triggers

Schedule 3, Condition 40 of PA10_0138 requires the Surface Water Monitoring Program (SWMP) to include criteria for surface water quality. Discharge water quality concentration limits from the proposed sediment dams are specified for MCC in EPL 20221 and shown in Table 4.9. The 100th percentile concentration limits has been adopted as the trigger values for discharge water quality. Table 4.10 shows ambient surface water quality impact assessment criteria that will be used as trigger values for assessing the surface water impacts from the Project. These trigger values are consistent with those developed for achieving cumulative impact management objectives in the BTM Complex WMS. Exceedance of the trigger values will initiate an investigation to assess whether the identified exceedance has potentially been caused by the Project.

Table 4.10 shows a preliminary assessment of trigger values for key ambient surface water quality parameters for Maules Creek, Back Creek and the Namoi River. Trigger values have been proposed for 26 parameters. Where insufficient local reference data is available, ANZECC eco-system trigger values have been adopted (11 parameters). Trigger values have been proposed using background data as a basis for selection for 15 parameters. The adopted trigger values will be refined based on further sampling to be undertaken prior to commencement of the Project.

Table 4.9 Sediment Dam Discharge Triggers

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



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Table 4.10 Preliminary Trigger Values for Water Quality Assessment

Parameter	Unit	ANZECC Trigger Value				Recorded Baseline Data (80%ile)			Preliminary Trigger Value			Comment
		Irrigation	Livestock drinking	Eco-system** ^d	Recreational	Maules Creek** ^e	Back Creek** ^b	Namoi River** ^l	Maules Creek	Back Creek** ^k	Namoi River	
pH	pH	6.0 - 9.0	-	6.5 - 8.0	6.5 - 8.5	7.5 - 8.1	7.4 - 7.8	7.9 - 8.7	6.5 - 8.1	6.5 - 8.0	6.5 - 8.7	Lower bound based on ANZECC guideline for ecosystem protection, upper bound based on Baseline data.
EC	µS/cm	1,000 * ^a	-	35-350	-	394 (Field) 430 (Lab)	178	508	400	350	500	Baseline data adopted for Maules Creek & Namoi River. Lack of Baseline data for Back Creek, adopted lowest ANZECC guideline.
DO (% Saturation)	-	-	-	90-110	-	no samples	no samples	no samples	110	110	110	Lack of baseline data, adopted lowest ANZECC guideline.
Total Dissolved Solids (TDS)	mg/L	-	2,000* ^a	-	1,000	239	188	329	300	300	400	Baseline data adopted. Rounded up to nearest hundred.
Turbidity	NTU	-	-	2-25	-	no samples	16,000	no samples	25	25	25	Lack of baseline data, adopted upper ANZECC guideline.
TSS	mg/L	-	-	-	-	22	5,508	77	30	30	80	Baseline data adopted. Rounded up to nearest ten. Maules Ck baseline data adopted for Back Creek.
Calcium (Ca)	mg/L	-	1,000	-	-	30	21	34	30	30	40	Baseline data adopted. Rounded up to nearest ten.
Sodium (Na)	mg/L	115* ^c	-	-	300	32	18	37	40	20	40	Baseline data adopted. Rounded up to nearest ten.
Magnesium (Mg)	mg/L	-	2,000* ^b	-	-	12	5	22	20	10	30	Baseline data adopted. Rounded up to nearest ten.
Sulphate as SO ₄	mg/L	-	1,000	-	400	22	4	34	30	10	40	Baseline data adopted. Rounded up to nearest ten.
Chloride as Cl	mg/L	175* ^c	-	-	400	32	19	45	40	20	50	Baseline data adopted. Rounded up to nearest ten.
Aluminium	mg/L	5* ^f	5	0.055* ^e	0.2	0.12	1.8	0.7	0.12	0.12	0.7	Baseline data adopted. Maules Ck baseline data adopted for Back Creek.
Arsenic	mg/L	0.1* ^f	0.5	0.013* ^{ae}	0.05	0.001* ^j	0.002	0.002	0.013	0.013	0.013	Lowest ANZECC guideline adopted.
Barium	mg/L	-	-	-	1	0.086	0.142	0.068	1	1	1	Lowest ANZECC guideline adopted.
Boron	mg/L	0.5* ^f	5	0.37* ^e	1	0.05* ^j	0.1	0.05* ^j	0.37	0.37	0.37	Lowest ANZECC guideline adopted.
Cadmium	mg/L	0.01* ^f	0.01	0.0002* ^e	0.005	0.0001* ^j	<0.0001	0.0001* ^j	0.0002	0.0002	0.0002	Lowest ANZECC guideline adopted.
Chromium	mg/L	0.1* ^f	1	0.001* ^e	0.05	0.001* ^j	0.002	0.001* ^j	0.001	0.001	0.001	Baseline data adopted for Maules Ck & Namoi River. Lack of baseline data for Back Creek, adopted lowest ANZECC guideline.
Copper	mg/L	0.2* ^f	0.4* ^a	0.0014* ^e	1	0.002	0.007	0.007	0.002	0.007	0.007	Baseline data adopted.
Iron	mg/L	0.2* ^f	-	-	0.3	0.30	1.73	0.85	0.3	1.8	0.9	Baseline data adopted. Rounded up to nearest tenth.
Lead	mg/L	2* ^f	0.1	0.0034* ^e	0.05	0.001* ^j	0.002	0.001* ^j	0.0034	0.0034	0.0034	Lowest ANZECC guideline adopted.
Manganese	mg/L	0.2* ^f	-	1.9* ^e	0.1	0.058	0.066	0.075	0.1	0.1	0.1	Lowest ANZECC guideline adopted.
Nickel	mg/L	0.2* ^f	1	0.011* ^e	0.1	0.001* ^j	0.004	0.004	0.011	0.011	0.011	Lowest ANZECC guideline adopted.
Selenium	mg/L	0.02* ^f	0.02	0.011* ^e	0.01	0.01* ^j	0.01* ^j	0.01* ^j	0.01	0.01	0.01	Lowest ANZECC guideline adopted.
Silver	mg/L	-	-	0.00005* ^e	0.05	0.001* ^j	0.001* ^j	0.001* ^j	0.001	0.001	0.001	Lowest ANZECC guideline below detection limit, detection limit adopted.
Zinc (Zn)	mg/L	2* ^f	20	0.008* ^e	5	0.030	0.03	0.029	0.03	0.03	0.03	Baseline data adopted. Rounded up to nearest hundredth.
Mercury	mg/L	0.002* ^f	0.002	0.0006* ^e	0.001	no samples	no samples	no samples	0.0006	0.0006	0.0006	Lack of baseline data, adopted lowest ANZECC guideline.
Ammonia	mg/L	-	-	0.013	-	0.04	0.03	0.04	0.04	0.03	0.04	Baseline data adopted.
Total phosphorus (Total P)	mg/L	0.05* ^f	-	0.02	-	0.20	0.32	0.16	0.20	0.32	0.18	Baseline data adopted.
Total nitrogen (Total N)	mg/L	5	-	0.25	-	no samples	no samples	no samples	0.25	0.25	0.25	Lack of baseline data, adopted lowest ANZECC guideline.
Nitrite + Nitrate as N	mg/L	-	-	0.015	-	0.28	0.09	0.32	0.3	0.3	0.3	Baseline data adopted. Rounded up to nearest tenth.

Notes:

- No Trigger Value recommended.
- *^a Lowest recommended value.
- *^b Cattle (insufficient information on other livestock)
- *^c Sensitive crops
- *^d Upland River (>150m altitude)
- *^e 95% of species protected
- *^f Long term Trigger Value
- *^g At SW1
- *^h Average of SW3, SW4, LMJ1 & LMJ2
- *ⁱ Average of SW5, SW6, SW7 & SWS.
- *^j Many samples under detection limit.
- *^k Only 3 samples = lack of baseline data.

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

Water Quantity Triggers

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

- Complaints regarding impacts on stock and domestic local surface water catchments
- Complaints regarding perceived unacceptable flooding of downstream properties in local catchments
- For each mine, total water supply < 120% demand
- Photographic survey of downstream drainage system indicates noticeable increase in erosion or deposition

Stream and Riparian Vegetation Health Triggers

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

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

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

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

	<h1>MAULES CREEK</h1>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Table 4.11 Physical and Chemical Variables Commonly Measured in AUSRIVAS

<p>Geographical position</p> <p>Altitude Latitude Longitude Catchment area upstream Distance from source Channel slope</p> <hr/> <p>Riparian vegetation</p> <p>Width of riparian zone Cover of riparian zone by trees, shrubs, grasses Canopy cover of river Native and exotic vegetation cover Riparian vegetation density Continuity of riparian vegetation</p> <hr/> <p>Channel morphology</p> <p>Stream width Stream depth Bank width Bank height</p> <hr/> <p>Water chemistry</p> <p>Temperature Conductivity pH Dissolved oxygen Turbidity Alkalinity Nutrients Ammonium Air temperature Secchi depth</p> <hr/> <p>Hydrology</p> <p>Mean annual discharge Coefficient of variation of mean annual discharge Flow pattern Gauge height</p> <hr/> <p>Habitat composition</p> <p>Percent riffle, edge, pool, macrophytes, run, snags and/or dry bed in sampling area</p> <hr/> <p>Reach organic and inorganic substratum</p> <p>Bedrock Boulder Cobble Pebble Gravel Sand Silt/clay Substratum heterogeneity Detritus cover (CPOM and FPOM) Moss cover Filamentous algae cover Macrophyte cover</p>	<p>Riffle/channel/sand bed habitat characteristics</p> <p>Bedrock Boulder Cobble Pebble Gravel Sand Silt/clay Detritus cover(CPOM and FPOM) Periphyton cover Moss cover Filamentous algae cover Macrophyte cover Water depth Water velocity Overhanging vegetation</p> <hr/> <p>Edge/backwater/macrophyte habitat characteristics</p> <p>Bedrock Boulder Cobble Pebble Gravel Sand Silt/clay Detritus cover (CPOM and FPOM) Periphyton cover Moss cover Filamentous algae cover Macrophyte cover Water depth Water velocity Trailing bank vegetation Macrophyte taxa composition</p> <hr/> <p>Habitat quality assessment (US EPA)</p> <p>Bottom substrate / available cover Embeddedness Velocity / depth category Channel alteration Bottom scouring and deposition Pool/riffle, run/bend ratio Bank stability Bank vegetative stability Streamside cover Total habitat score</p> <hr/> <p>Site observations</p> <p>Water and sediment odours and oils Flow level and restrictions Local bank and catchment erosion Landuse Valley topography Kicknetting plume River braiding and bars Local point source and non point source pollution</p>
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From Parsons *et al.* (2002)

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

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

5.0 SITE WATER BALANCE

5.1 Overview

The GoldSim software (developed by GoldSim Technology Group) was used to simulate and assess the dynamics of the site water balance under varying climatic sequences, catchment conditions and operational stages during the first 5 years of mine life. The model has been configured to simulate the operations of all major components of the water management system, keeping complete account of all site water volumes on a daily time step. The simulated inflows and outflows included in the model are given in Table 5.1.

Table 5.1 Simulated Inflows and Outflows to Mine Water Management System

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

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

- Mine storage inventory;
- Raw water requirements from an external source;
- Uncontrolled spills from the mine water storages; and
- The overall water balance within the water management system.

Details of the water management system infrastructure and configuration are provided in Section 4.3.1. Details of the model configuration, modelling methodology and data inputs are provided in Appendix B.

Figure 4-20 shows the conceptualisation of the mine water management system adopted for the water balance model. Note that the coal process water circuit was not explicitly modelled. However, the estimated net water demand from the CHPP was included in the model (refer Appendix B). The water balance model and WMP will be updated following the completion of water use efficiency investigations.

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

It is important to note that investigation outcomes are dependent on the accuracy of input assumptions. There is inherent uncertainty with respect to some key site characteristics (e.g. catchment yield/rainfall runoff, mining area groundwater inflows) which cannot be accurately determined prior to the commencement of operations.

5.2 Water Sources and Uses

The following sections provide a description of the water sources and their uses on the mine site. Details of the model configuration, modelling methodology and data inputs are provided in Appendix A.

5.2.1 Rainfall Runoff

Source

Rainfall runoff which drains into the mining area and runoff from disturbed areas that comes into contact with coal, such as the ROM and product stockpiles, will be diverted to the Mine Water Dam for re-use on site. Runoff from undisturbed lands will be collected and diverted, or pumped around the mining operation into natural drainage lines.

Runoff from disturbed and rehabilitated areas will be collected in sediment dams to allow the settlement of suspended solids. Runoff from pre-strip areas and other disturbed areas where the runoff does not come in contact with coal will be captured in sediment dams and pumped back into the mine water management system. If a rainfall event occurs that exceeds the design capacity of the sediment control system, then water may be released offsite, in accordance with EPL conditions. Water captured in the sediment control system may also be released offsite at any time, provided water quality meets EPL conditions and water is not required to supply the mine water management system.

The design of dams, pipelines and associated drainage structures allows for catchment water to be captured and diverted within the closed circuit water management system.

Usage

Captured runoff water will be primarily used for coal processing and dust suppression.

Secondary runoff from the vehicle wash down areas is treated by an oil and grease separator prior to re-use in the mine water management system.

5.2.2 Groundwater Inflow

Source

Information from Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) indicates that three aquifer systems exist in the vicinity of the Project Boundary.

As mining progresses, groundwater inflows will vary with the changing mine layout, depending on the intersection of the aquifers. The groundwater modelling undertaken by AGE predicted cumulative inflow of groundwater over the life of the mine is approximately 11,540 ML, which is an average of 550 ML/year over the 21 years of mining. The predicted groundwater inflows into the Project mining void for Years 5, 10, 15 and 21 are 0.2, 1.2, 2.9 and 0.7 ML/day, respectively.

In conjunction, temporary drill holes established within the approved pit shell in advance of the mining progression will be utilised to manage the predicted groundwater inflows.

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

Usage

Groundwater intercepted at Maules Creek will be dewatered from the pit via an in-pit pump where it is pumped to the Mine Water Dam and then reused on site. This water will be used for dust management purposes and as a water source for the CHPP.

5.2.3 CHPP Process Water

Source

Ultimately, process water from the CHPP will become reusable water, added moisture content in product coal or water retained in the washery reject. To increase on-site water use efficiency and reduce any external raw water requirements from the Namoi River, mine affected water will be re-used on site wherever possible.

To process washed coal tailings for the Maules Creek Project, belt press filters have been chosen as the most environmentally sound technology that eliminates the requirement for tailings cells or dedicated emplacement. Tailings underflow from the plant thickener is sent to the belt press filter building where it is flocculated and deposited into a bank of six press filters. The filter dewateres the fine tailings material and forms a cake at approx. 35% moisture. This material is then transferred via conveyor belt to the main reject conveyor stream and is blended with the coarse and fine rejects streams to form a combined reject material. This material is transferred to the plant reject bin for collection by mine haul truck and final deposition at mine overburden dump.

The CHPP is designed to maximise the recycling of process water by dewatering the washery fines reject and collecting all hose down and dirty runoff water. The water balance model and WMP will be updated following the completion of water use efficiency investigations of the CHPP.

Usage

CHPP process water is recycled and re-used in the CHPP. Water is also consumed by the automatic water sprays installed on the ROM hopper, all conveyor transfer points and coal stockpiles for dust suppression.

5.2.4 Water Licences

Source

MCC is permitted under Water Supply Works Approval 90WA801901 and associated Water Access Licence Number WAL13050 to withdraw a maximum of 3,000 units (up to 3,000 ML) of fresh water each year from the Namoi River. Further information on available water licences is provided in Section 2.2.5.

Water required from external sources will be obtained under appropriate Water Access Licences and will be accessed in accordance with the requirements of existing Water Sharing Plans, including adherence to total daily extraction limits. This will ensure no adverse impacts on water availability for other licensed water users.

Table 5.2 shows the predicted groundwater take due to the Maules Creek Coal Mine for each water source, and the water licenses that have been acquired (to date) to account for the predicted water take.

Table 5.2 Predicted Groundwater Takes Versus Water Access Licences

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

Water Source	Predicted Average Annual Water Take (ML)	Predicted Peak Annual Water Take (ML)	Share Component Already Held (Units)	WAL Number
Namoi Groundwater WSP Zone 4	17	40.2	38	27385
Namoi Groundwater WSP Zone 5	5	14.6	135	12811
Namoi Groundwater WSP Zone 11	28	69.4	78	12479
Porous Rock (Gunnedah-Oxley Basin – Other Zone)	550	1,064	306	29467 (6 units)
				29588 (300 units)

Sufficient water licenses have been acquired to offset the average and peak water from the Namoi alluvium in Zone 5 and Zone 11 for the life of the Project. The predicted peak water take in Year 21 at 40.2 ML/year from Zone 4 is slightly above the volume available from licensing at 38 units. It is not considered necessary to acquire any additional water for Zone 4 as regular revision of the groundwater model during the mine life will determine if additional units are required before Year 21.

The water licenses held for the porous rock aquifer are sufficient to offset the predicted seepage rate to the open cut pit for the first 5 years of mining. Similar to the Namoi alluvium, it is not considered necessary to acquire any additional water for the porous rock as regular revision of the groundwater model during the mine life will determine if additional units are required before Year 6.

Usage

Fresh water withdrawn from the Namoi River is primarily used in vehicle wash-down and as a supplementary source for coal processing and dust suppression during construction and operation.

5.2.5 Treated Water

Source

MCC will also operate an on-site Water Treatment Plant which allows for the treatment of some of the water pumped from the Namoi River and other sources for non-potable and potable use.

Usage

Water from the Water Treatment Plant is used primarily in the administration offices and bathhouse for non-potable use.

5.2.6 Waste Water

Source

MCC will operate a Sewage Treatment Plant, which treats sewage from the office buildings on site and recycles the effluent water into the water management system.

Usage

Treated effluent from the Sewage Treatment Plant will be utilised in the water management system and also on rehabilitation/garden areas following the receipt of the relevant approval from Narrabri Shire Council. The

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

by-product of the waste water treatment plant process will either be placed on the rehab areas (subject to relevant approvals) or removed from the site for the appropriate disposal by a licensed waste contractor.

5.2.7 Potable Water

Source

Potable water will be either trucked to site by a local water carrier as required or treated to potable usage on-site and stored in water tanks supplying the main office and work shop areas.

Usage

This water is used for drinking and shower purposes within the main office, bathhouse and adjacent workshop areas.

5.3 Forecast Simulation Results Interpretation

In interpreting the results of a forecast simulation, it should be noted that this simulation type provides a statistical analysis of the water management system's performance over its first 5 years of mine life, based on different climatic conditions. The 50th percentile probability represents the median results, the 1st and 10th percentile represent 1% and 10% exceedance and the 90th and 99th percentile results represent 90% and 99% exceedance. There is an 80% chance that the result will fall within the 10th and 90th percentiles and a 98% chance the result will fall between the 1st and 99th percentiles. Importantly, the percentile trace shows the percentile chance of a particular value on each day, and does not represent continuous results from a single model realisation e.g. the 50th percentile trace does not represent the model time series for median climatic conditions. See Appendix B for a more detailed explanation of modelling methodology.

A single realisation can also be selected from the 106 modelled realisations in order to show the water management system's actual performance (not a statistical representation) for a particular climate sequence.

5.3.1 Overall Water Balance

An annual water balance for the first 5 years of mine life is presented in

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

Table 5.3. Note that the results provided are only for a single realisation from the 106 realisations modelled. This single realisation, which has the median rainfall and runoff inflows over the initial 5 years of mine life, has been selected to provide an indication of the water balance under the specific operating rules adopted for that year of operation and allows for a direct comparison of inflows and outflows between the first 5 years of mine life. It should be recognised that the following items are subject to climatic variability:

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

The results show that for the realisation with median catchment yield:

- Total mine water demand supplied from either raw or recycled water ranges between approximately 640 ML/a and 1,955 ML/a;
- Evaporation from dam water surfaces ranges between approximately 80 ML/a and 248 ML/a;
- No overflows of mine water occurred in the simulation period; and
- Combined runoff and direct rainfall contribute between approximately 854 ML/a and 1,780 ML/a;
- Groundwater contributes between approximately 36 ML/a and 226 ML/a; and
- The net input corresponds to the change in stored water inventory.

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

Table 5.3 Annual Water Balance for Realisation with Median Runoff Inflows

Annual Water Balance (ML/a)					
	Year 1 (2014)	Year 2 (2015)	Year 3 (2016)	Year 4 (2017)	Year 5 (2018)
Water Inputs					
Direct Rainfall + Catchment Runoff	1,674	1,235	854	1,180	1,783
Raw Water (Namoi Pipeline)	110	110	361	933	620
Groundwater Inflow	175	226	185	111	36
Total	1,958	1,571	1,399	2,224	2,439
Water Outputs					
Evaporation from Dams and Ponds	194	248	142	80	107
Sediment Dam Overflows (off-site)	100	45	0	0	0
Highwall Dams Pumped Off-site	323	184	97	147	199
CHPP Makeup Demand					
<i>Raw Water</i>	0	0	184	651	457
<i>Mine Water</i>	357	1001	1001	950	1120
Total	357	1,001	1,186	1,601	1,577
Dust Suppression Demand					
<i>Raw Water</i>	0	0	61	172	66
<i>Mine Water</i>	193	280	250	125	220
Total	193	280	312	298	286
Vehicle Wash	91	91	91	91	92
Total	1,259	1,849	1,828	2,216	2,261
Net Input	700	-278	-428	7	178

An annual water balance for the first year of operation under different climatic sequences is provided in

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

Table 5.4. Note that the results provided are for three separate realisations from the 106 realisations modelled. These realisations have been selected for the 10th percentile (wet), median and 90th percentile (dry) rainfall and runoff inflows over the first year of mine life. This allows a direct comparison of the inflows and outflows of the mine water management system under different climatic sequences.

The following is of note:

- Groundwater inflow, vehicle wash-down demand and the total CHPP demand do not change under the different climatic sequences, as they are not subject to climatic variability;
- The proportion of the total CHPP and dust suppression demands able to be supplied by mine water varies depending on climatic conditions;
- Evaporation is higher in the wetter years due to storages remaining fuller, providing a greater surface area for evaporation;
- The wetter simulation of Year 1 (10th percentile rainfall and runoff inflows) has more than 4 times the catchment yield than the dryer simulation of Year 1 (90th percentile rainfall and runoff inflows). As a result, the raw water requirement from the Namoi Pipeline is almost 3 times higher for the dryer simulation than for the wetter simulation.

	<h1>MAULES CREEK</h1>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Table 5.4 Year 1 Water Balance – Wet, Average and Dry Conditions

	Water Balance (ML/a)		
	Year 1 - Wet (10%ile Rainfall & Runoff Inflow)	Year 1 - Average (Median Rainfall & Runoff Inflow)	Year 1 - Dry (90%ile Rainfall & Runoff Inflow)
Water Inputs			
Direct Rainfall + Catchment Runoff	1,532	794	314
Raw Water (Namoi Pipeline)	120	141	330
Groundwater Inflow	175	175	175
Total	1,827	1,110	819
Water Outputs			
Evaporation from Dams and Ponds	241	136	94
Sediment Dam Overflows (off-site)	91	0	0
Highwall Dams Pumped Off-site	294	125	40
CHPP Makeup Demand			
<i>Raw Water</i>	0	2	106
<i>Mine Water</i>	357	355	252
Total	357	357	357
Dust Suppression Demand			
<i>Raw Water</i>	0	8	82
<i>Mine Water</i>	193	196	135
Total	193	204	217
Vehicle Wash	91	91	91
Total	1,267	913	799
Change in Storage Inventory	560	197	20
Water Balance	0	0	0

5.3.2 Mine Site Storage Inventory

Figure 5-1 and Figure 5-2 show the predicted probability of the modelled out-of-pit and in-pit storage volume at the Maules Creek Mine site over the first 5 years of mine life. A build-up of water in the active pits generally occurs when the out of pit storages are too full to accept additional pit water. The primary out-of-pit storage is the Mine Water Dam, which is made up of 2 separate dams and has a capacity of 553 ML. The MOV of the Mine Water Dam is set at 403 ML to prevent uncontrolled spills. When the stored volume in the Mine Water Dam is below 403 ML, water can be pumped in from the active pits. If Mine Water Dam stored capacity exceeds 403 ML, water will need to be managed within the pit. The following is of note:

- The 50th percentile Mine Water Dam volume on any given day in the first 5 years of mine life is below 300ML, well below the maximum operating volume of 403ML.
- There is at least a 50% chance that the active pit will be completely dewatered at any point in time over the first 5 years of mine life.
- There is at least a 10% chance that:

- The Mine Water Dam will reach the MOV after about half a year of mine site operations;
- The Mine Water Dam will be at the MOV or higher at any point in time for the majority of the next 4 years;
- The active pit will not be completely dewatered at any point in time after commencing operations.
- There is a 1% chance that:
 - The Mine Water Dam will reach the MOV after about 1 month of mine site operations;
 - The Mine Water Dam will be at the MOV or higher at any point in time for the majority of the first 5 years;
 - The in pit inundation will reach a maximum of at least 1,500 ML in 5 years. This level of in pit inundation may affect production.

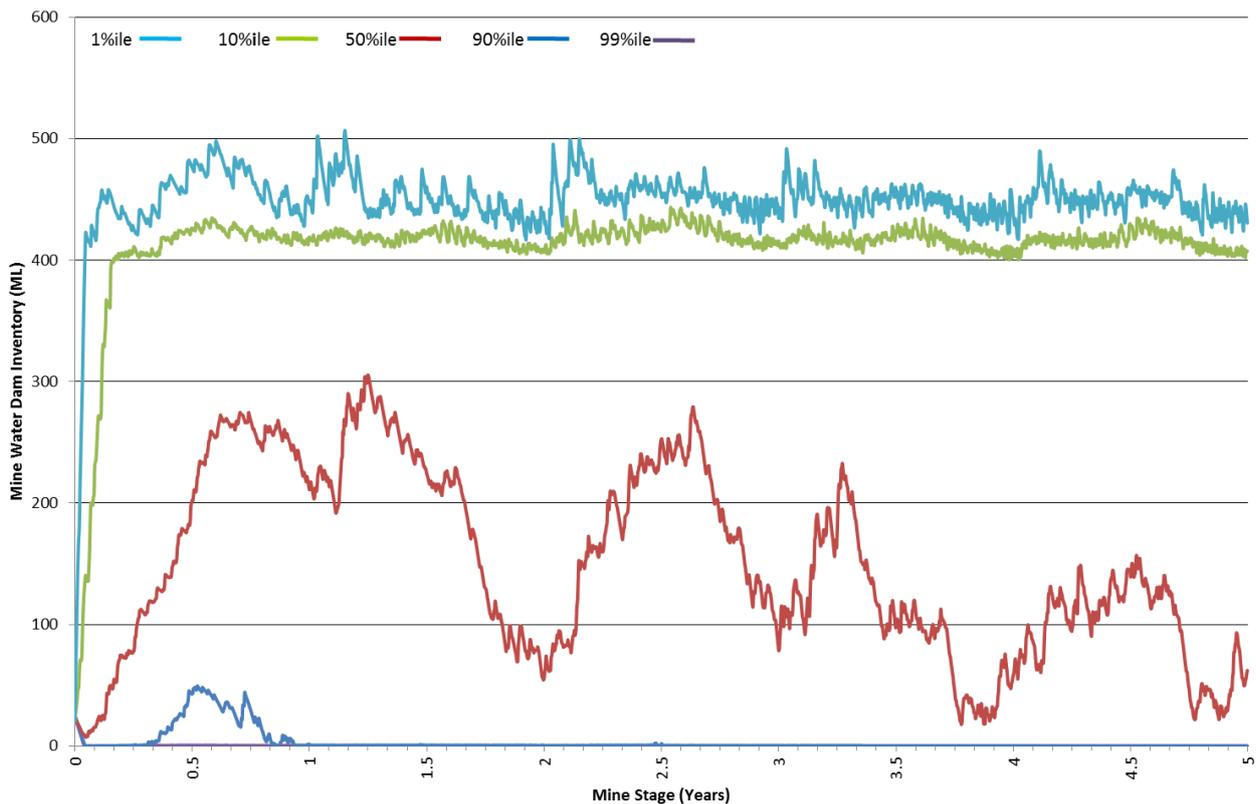


Figure 5-1 Forecast Mine Water Dam Inventory, 99th (very dry), 90th (dry), 50th (median), 10th (wet) and 1st (very wet) Percentile conditions.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

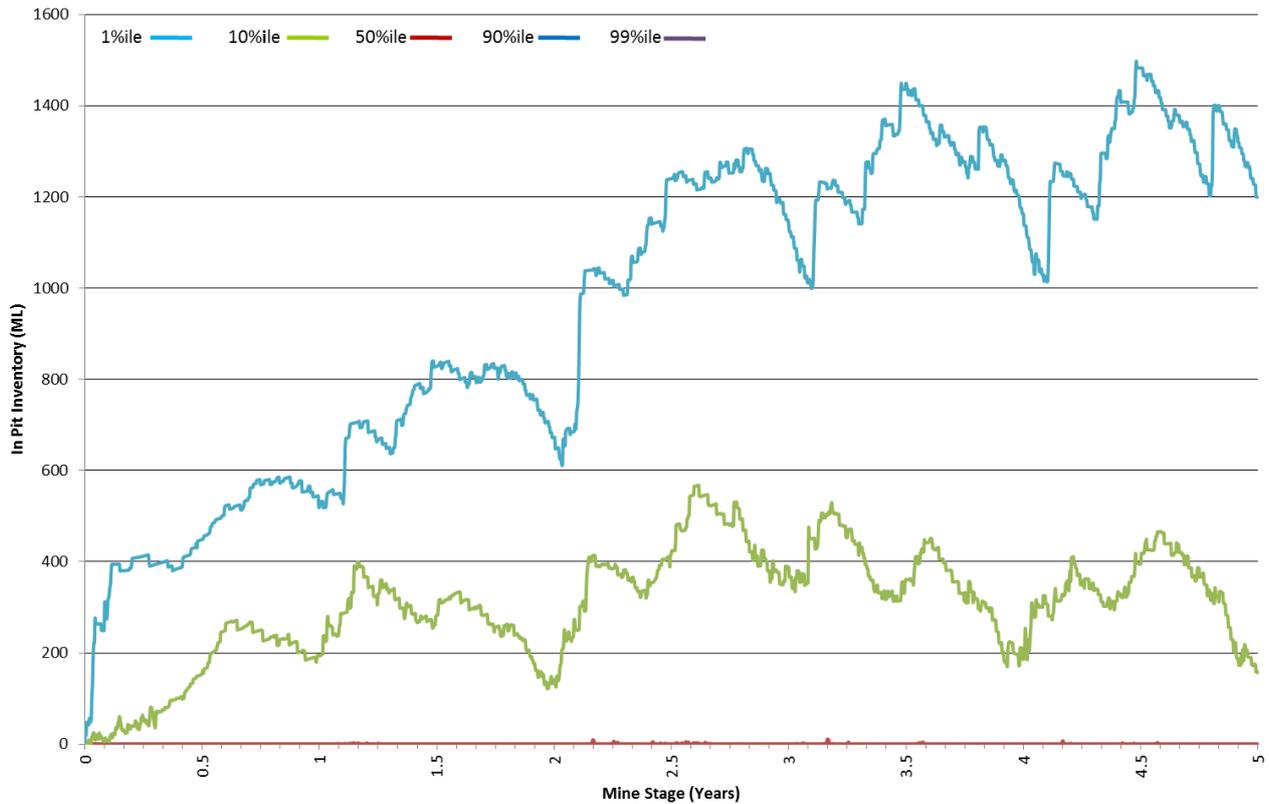


Figure 5-2 Forecast In-Pit Storage Inventory, 99th (very dry), 90th (dry), 50th (median), 10th (wet) and 1st (very wet) Percentile conditions.

Figure 5-3 shows a ranked plot of stored volume in the Mine Water Dam for five discrete climate sequences. The discrete sequences were selected based on the 1st percentile, 10th percentile, median, 90th percentile and 99th percentile total catchment runoff inflows. The following is of note:

- For the discrete sequence with median catchment runoff inflows, the Mine Water Dam is full approximately 2.5% of the time.
- For the discrete sequences with 1st percentile, 10th percentile and 90th percentile catchment runoff inflows, the Mine Water Dam is full approximately 27%, 17% and 1% of the time, respectively.
- For the discrete sequence with 99th percentile catchment runoff inflow, the Mine Water Dam does not reach its maximum operating capacity, indicating that for this sequence pit dewatering would not be limited by the Mine Water Dam volume.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

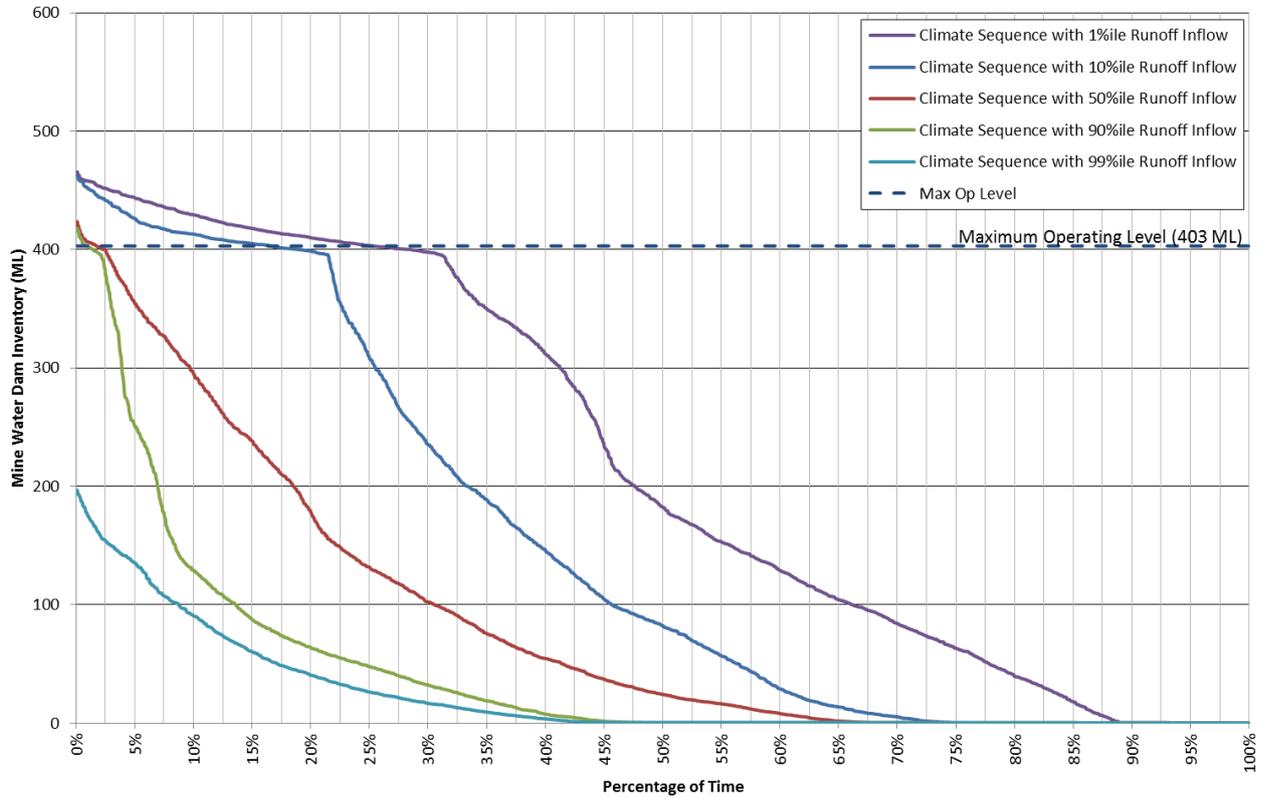


Figure 5-3 Distribution of Mine Water Dam Stored Volume Over First 5 years of Mine Life

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

5.3.3 Off-site Water Requirements

As the vehicle wash-down demand is drawn exclusively from the Raw Water Dam, and subsequently the Namoi Pipeline, there is a constant raw water draw. Once the vehicle wash-down demand and evaporation draws the Raw Water Dam below a low trigger level, water will be demanded from offsite. The effect of this is evident in Figure 5-4, which shows that even for the 10th and 1st percentile traces (wetter conditions), offsite supplies are required. Additional demand from the Raw Water Dam is required to supplement the supply for CHPP make up demand and dust suppression demand. The following is of note:

- There is a 50% chance that:
 - a total volume of at least 150 ML of offsite supplies will be required to supply operational demand in the first year;
 - a total volume of at least 635 ML of offsite supplies will be required to supply operational demand in Year 5;
- There is a 10% chance (90th percentile results) that:
 - a total volume of at least 285 ML of offsite supplies will be required to supply operational demand in the first year;
 - a total volume of at least 1,260ML of offsite supplies will be required to supply operational demand in Year 5;
- There is 1% chance (99th percentile results) that:
 - a total volume of at least 390 ML of offsite supplies will be required to supply operational demand in the first year;
 - a total volume of at least 1,600 ML of offsite supplies will be required to supply operational demand in Year 5;

As a result of evaporation and the vehicle wash-down demand, offsite supplies are required even for the 10th and 1st percentile traces (wetter conditions) in order to maintain a minimum volume available in the Raw Water Dam. Water required from external sources will be obtained under appropriate Water Access Licences to ensure no adverse impacts on water availability for other licensed water users. MCC is permitted under Water Supply Works Approval 90WA801901 and associated Water Access Licence Number WAL13050 to withdraw a maximum of 3,000 units (up to 3,000 ML) of fresh water each year from the Namoi River. This Water Access Licence will be sufficient to supply the projected raw water demand from the Namoi River.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

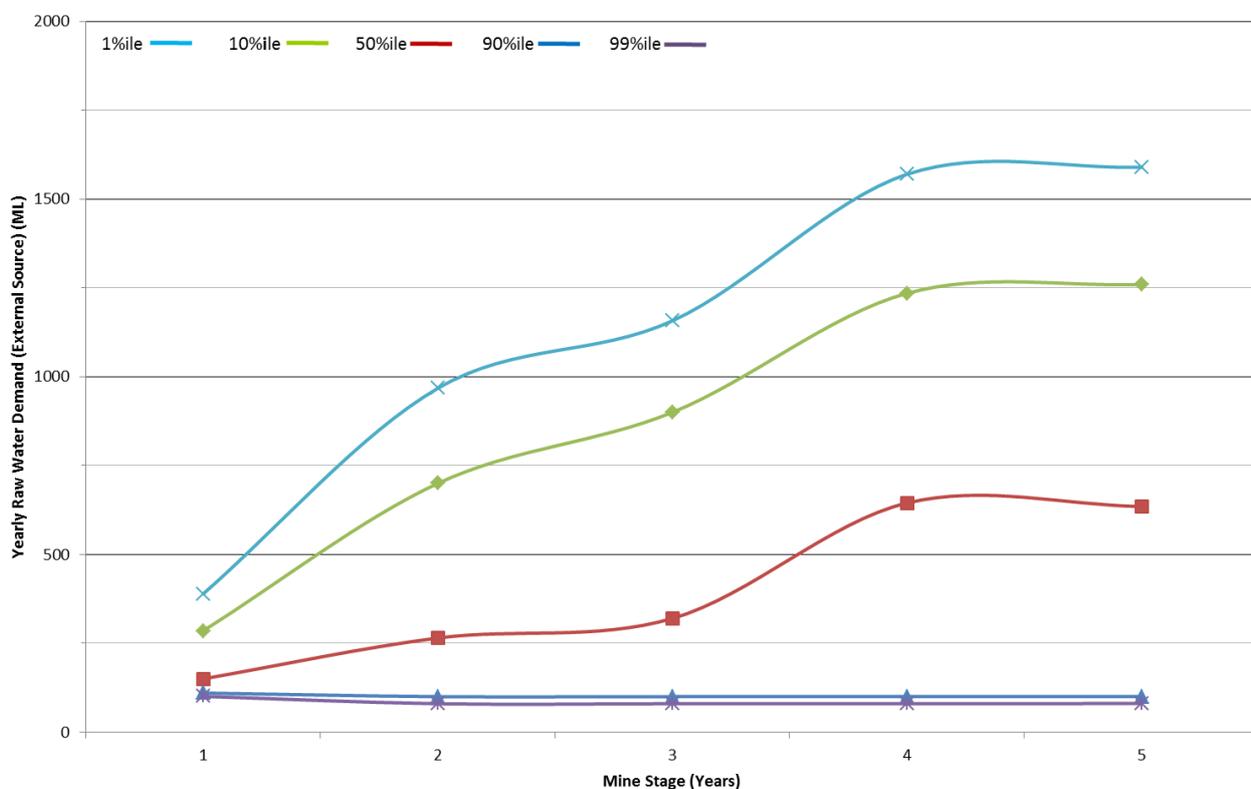


Figure 5-4 Forecast Cumulative Pipeline Inflows, 99th (very dry), 90th (dry), 50th (median), 10th (wet) and 1st (very wet) Percentile conditions.

5.3.4 Uncontrolled Spills

Table 5.5 shows the predicted spills from the mine site storages over the first 5 years of mine life for the median as well as the 90th and 10th percentile confidence limits. The results show the following:

- There is at least a 90% chance that the main mine site storages (Mine Water Dam and Raw Water Dam) do not spill in the first 5 years of operations.
- There is a 50% chance that there would be at least 6 spill days from the sediment dams.
- There is a 10% chance that there would be a minor number of spills days for Highwall Dams 1A and 2, and no spills from Highwall Dams 1B and 3.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Table 5.5 Predicted Spills from Mine site Storages

Dam	Probability	No. Days of Spill	Ave. Spill Volume per spill day (ML)
Mine Water Dam	10%ile	0	0
	50%ile	0	0
	90%ile	0	0
Raw Water Dam	10%ile	0	0
	50%ile	0	0
	90%ile	0	0
Sediment Dams (Combined)	10%ile	19	43
	50%ile	6	33.8
	90%ile	0	0
Highwall Dam 1A	10%ile	2	37.7
	50%ile	0	0
	90%ile	0	0
Highwall Dam 1B	10%ile	0	0
	50%ile	0	0
	90%ile	0	0
Highwall Dam 2	10%ile	1	0.1
	50%ile	0	0
	90%ile	0	0
Highwall Dam 3	10%ile	0	0
	50%ile	0	0
	90%ile	0	0

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

5.3.5 Adaptive Management of Mine Water Balance

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

5.4 Water Balance Model Validation

The site water balance will be reviewed and updated as additional and / or newer information becomes available with the progression of the mine. Recording the following parameters will assist in validating the assumptions of the water balance model, particularly the AWBM runoff parameters:

- dam and in-pit volumes;
- site rainfall;
- volume of any offsite discharges;
- pump rates between storages;
- actual demand rates for CHPP makeup water, industrial use, dust suppression and vehicle wash-down during operation of the mine;
- flow in Back Creek to assess catchment yields;
- actual groundwater inflow rates during mining; and
- general mine site water management practices.

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

6.0 GROUNDWATER MANAGEMENT PLAN

6.1 Baseline Groundwater Data

6.1.1 Aquifer Systems

The hydrogeological regime in the Project region consists of the following hydro stratigraphic units:

- Quaternary alluvium associated with river and creek systems that forms a productive aquifer system;
- Weathered bedrock (regolith) that is generally unsaturated but acts as a temporary water store during sustained wet periods;
- Permian sandstone/siltstone interburden that is typically an aquiclude/aquitard; and
- Permian coal seams of the Maules Creek Formation that form a low yielding aquifer.

The alluvial aquifers are localised around the rivers and creeks that are located to the north, south and west of the Project Boundary, and include the following creeks and rivers:

- North: Maules Creek, Middle Creek, Horsearm Creek;
- South: Bollol Creek, Driggle Draggle Creek, and Barneys Spring Creek; and
- West: Namoi River.

The alluvial aquifer has two stratigraphic units, the basal Gunnedah Formation and the overlying Narrabri Formation. The Narrabri Formation is up to 70 m thick and is comprised of clayey flood deposits with interbedded sand and gravel which typically form low yielding aquifers. The underlying Gunnedah Formation is a productive aquifer used for irrigation, being up to 115 m thick and is dominated by sand and gravel deposits that fill paleo-channels. Finer grained sediments in the Narrabri Formation can act as a storage zone for salts with water quality varying from fresh to saline. The coarser sediments in the underlying Gunnedah Formation generally contain better quality low salinity groundwater. A deeply incised paleo-channel, up to 125 m deep is present to the west of the Project along the course of the Namoi River, which forms a high yielding aquifer. The thickness of the alluvial material thins out along the Maules Creek and Bollol Creek flood plains to the north and south of the Project area. The alluvial aquifers exhibit variable groundwater yields of between 0.1 L/s and 33 L/s. Water quality is generally fresh within the alluvial aquifer, ranging between 300 – 800 $\mu\text{S}/\text{cm}$ for the northern creeks. It has been identified that the upper region of Maules creek is a gaining system, with groundwater actively discharging into the creeks and tributaries. The lower zones become a losing system where irrigation is more intensive and draws down groundwater levels below creeks.

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

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

The Permian sedimentary deposits occur as a regular layered easterly to north-easterly dipping sedimentary sequence and are underlain by the Boggabri Volcanics. The basal Boggabri Volcanics outcrop in the western area of the Project. Hydraulic packer testing was carried out at four core holes within the Project area. The investigation found that the hydraulic conductivity of the coal seams varies between 0.01 m/day and 0.1 m/day. Low yields within the coal seams, of between 0.42 L/s and 0.76 L/s, were also documented.

6.1.2 Existing Monitoring Network

MCC established a monitoring bore network in 2010 to gather information on the groundwater regime in the vicinity of the Maules Creek Project. The monitoring data was used to develop a numerical model to predict the impacts of mining on the groundwater regime. Eight groundwater monitoring bores and four vibrating wire piezometers were installed within former exploration holes. The monitoring network is located within close proximity to the proposed mining areas with most of the bores screened across coal seams. The bore construction details are summarised in Table 6.1, and the locations shown on Figure 6-1. Appendix C contains the borehole construction logs.

Table 6.1 Baseline Monitoring Network Details

Drill Hole ID	NOW Licence No.	Easting MGA94	Northing MGA94	Elevation (mRL)	Hole Depth (m)	Type	Screen or VWP Depth	Screen or VWP Zone Geology
MAC252	90BL255780	226231	6614775	340.63	260	Stand -pipe	92.5 – 98.5	Braymont Seam
MAC1218	90BL255788	224015	6613693	361.40	110	Stand -pipe	107 – 110	Nagero, Upper/Lower Northam, Therribri and Flixton Seams
MAC1219	90BL255789	224172	6613678	370.41	163	Stand -pipe	107 – 110	Jeralong and Merriown Seams
MAC1259	90BL255783	224959	6615286	316.95	98	Stand -pipe	94 – 97	Boggabri Volcanics
MAC1261	90BL255781	226750	6614872	382.28	180	Stand -pipe	161 – 164	Braymont Seam
MAC1279	90BL255782	226446	6616312	326.85	144	Stand -pipe	70 – 73	Jeralong Seam
MAC1280	90BL255785	226525	6616503	323.50	146	Stand -pipe	56 – 59	Conglomerate/ Interburden
MAC1283	90BL255779	224989	6615291	318.22	91	Stand -pipe	61 – 64	Velyama Seam
MAC263	90BL255784	226037	6614513	348.26	234	VWP	105 183	1. Braymont Seam, 2. Velyama, Nagero, Upper Northam

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Drill Hole ID	NOW Licence No.	Easting MGA94	Northing MGA94	Elevation (mRL)	Hole Depth (m)	Type	Screen or VWP Depth	Screen or VWP Zone Geology
MAC267P	90BL255786	227440	6615472	405.56	299	VWP	154 260	1. Braymont Seam, 2. Velyama, Nagero, Upper Northam
MAC268P	90BL255787	227498	6614521	416.77	318	VWP	280	Velyama, Nagero, Upper Northam



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

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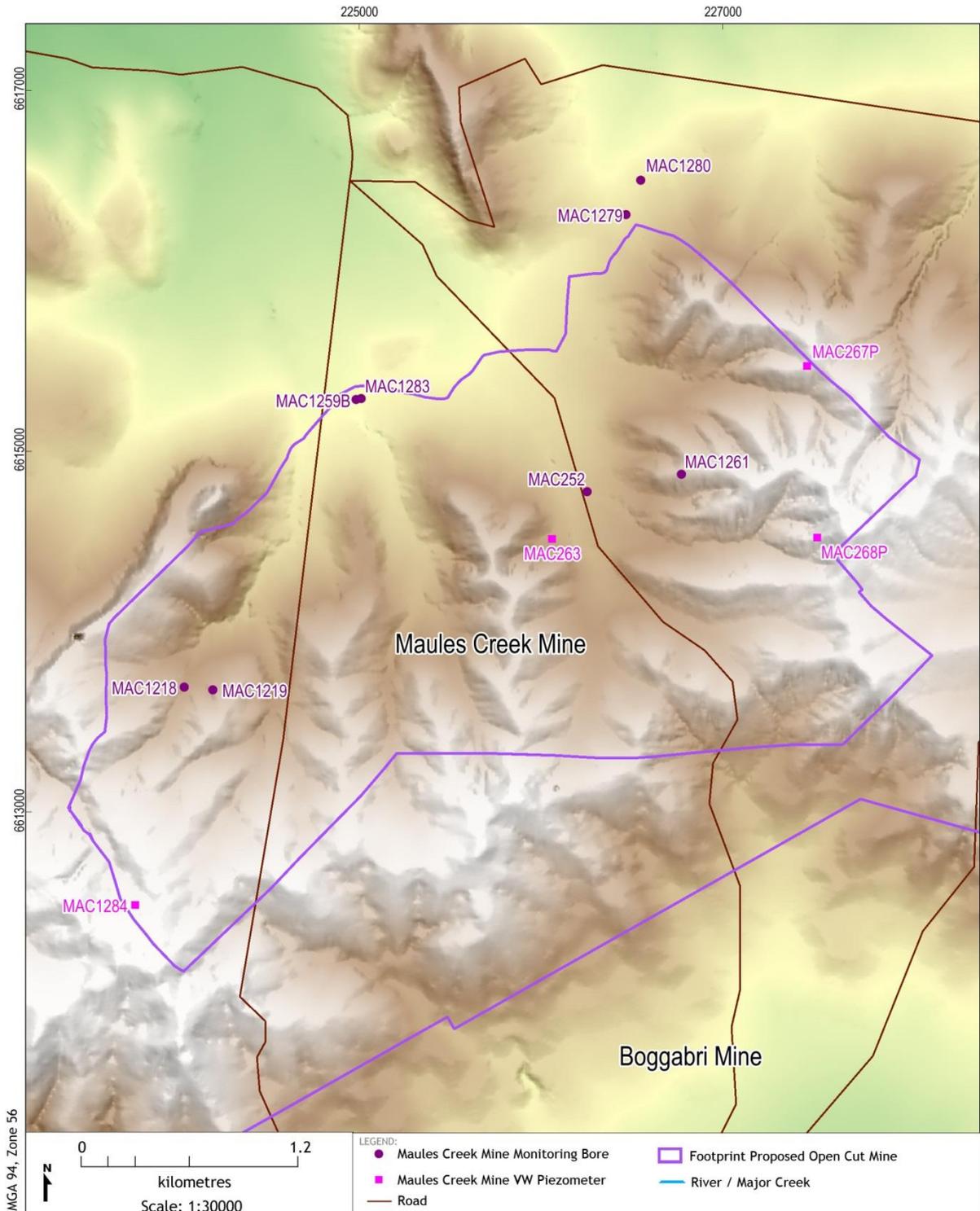


Figure 6-1 Monitoring Bore Locations

6.1.3 Groundwater Levels

MCC have measured groundwater levels in the existing monitoring network on a two to three monthly basis since October 2010. VWP sensor data has also been collected automatically via data loggers from three VWPs, MAC263, MAC267P and MAC268P. The VWP in MAC1284 failed shortly after installation and no ongoing data has been collected at this site. The sensor in MAC267 installed at the Velyama/Upper Northam Seams failed in July 2013. It is not possible to replace these sensors as they are cemented in the borehole.

A recent review indicated pressure readings from the VWP in MAC268 were anomalously level and not representative. It is considered likely the VWP sensor in this hole has dislodged during installation and is located about 25 m higher than indicated by the historical data. The water level measured by this sensor has been adjusted by 25 m to account for this.

Figure 6-2 shows a hydrograph of groundwater level records from the monitoring network.

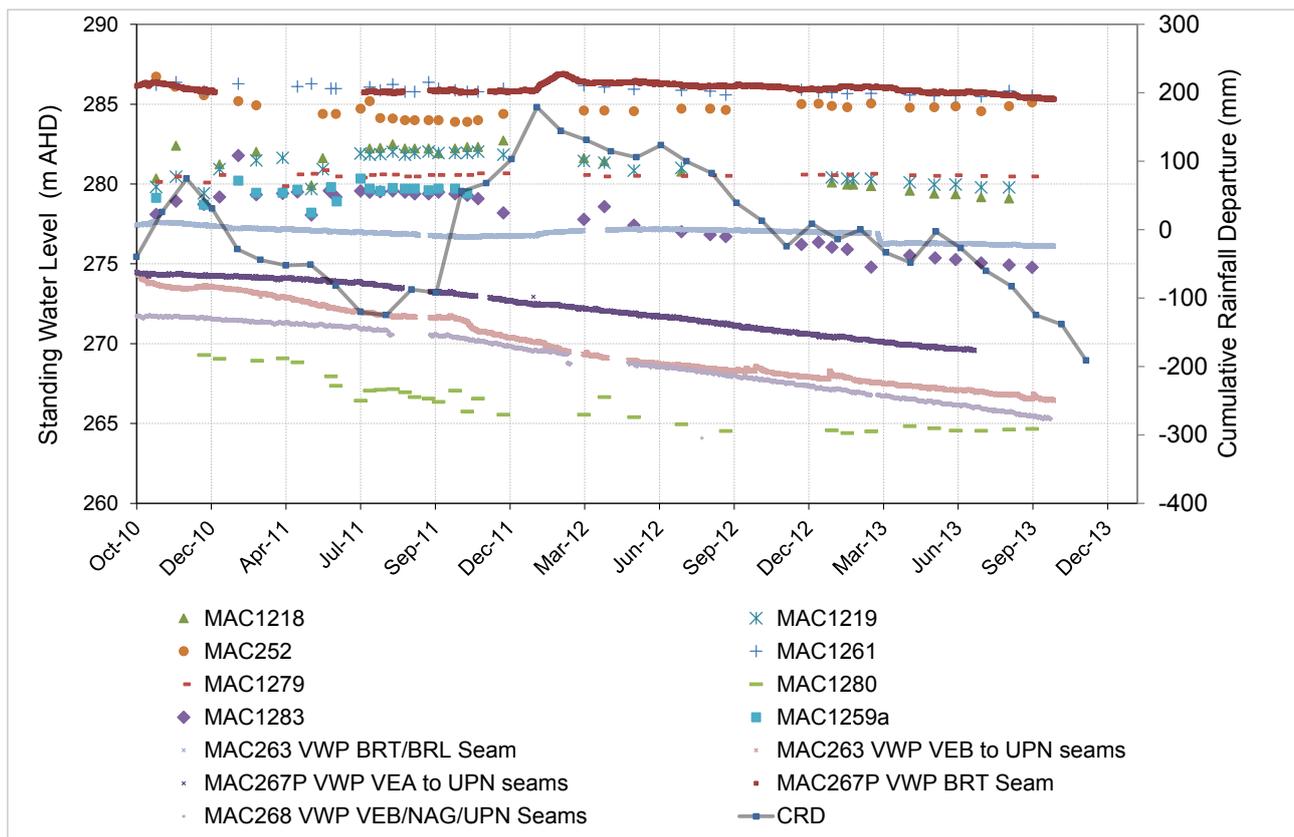


Figure 6-2 Maules Creek Coal Project - Groundwater Levels

The groundwater levels are plotted along with the Cumulative Rainfall Departure (CRD), which shows monthly rainfall compared to averages. The CRD was calculated for the Boggabri Post Office (Station No. 55007) from January 1900 through to December 2013. A rising trend indicates above average rainfall, while falling trends are due to below average rainfall.

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

Figure 6-2 indicates generally stable water levels with a very subdued rising trend in some of the bores in response to the above average rainfall of summer 2011/2012. A declining trend is clearly established in MAC1280, MAC1283, MAC267, MAC263 and MAC268. Three of these sites are established in the Velyama Seam, and indicate adjacent mines are depressurising the coal seams. The shallower Braymont seam targeted by shallower sensors in VWP MAC263 and VWP MAC267 recorded relatively stable pore pressures over the monitoring period.

6.1.4 Groundwater Quality

Baseline groundwater quality data has been collected since 2010 from the eight open monitoring bores. Water quality samples were collected on a monthly to two monthly basis and analysed for:

- major cations and anions;
- nutrients - ammonia, nitrate, nitrite; and
- full suite of metals, including but not limited to– aluminium (Al), Antimony (Sb), Arsenic (As), Barium (Ba), Beryllium (Be) Bismuth (Bi), Boron (Bo), Bromine (Br), Cadmium (Cd), Caesium (Cs), Cerium (Ce), Chromium (Cr), Cobalt (Co), Copper (Cu), Iron (Fe), Lead (Pb), Lithium (Li), Manganese (Mn), Molybdenum (Mo), Nickel (Ni), Selenium (Se), Uranium (U) and Zinc (Zn).

The long-term baseline water quality results for pH (field and laboratory), EC (field and laboratory), Total Dissolved Solids (TDS), Sulphate (SO₄), and the ten key metals are shown in Appendix D. Limited water quality results are available for MAC1259, which was only sampled up until November 2011.

The full suite of results collected from the seven monitoring bores was also compared against the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000* (ANZECC and ARMCANZ 2000) for Fresh Waters, Drinking Water (Health and Aesthetic) and Long-Term Irrigation, in order to highlight any major changes in water quality. Most fell below the limit of reporting and/or ANZECC (2000) guideline levels, except for ten key metals, including Al, Ba, Bo, Cd, Fe, Pb, Li, Mn, Mo and Ni.

The field results for pH, EC and laboratory results for sulphate are also shown in Figure 6-3 to Figure 6-5.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

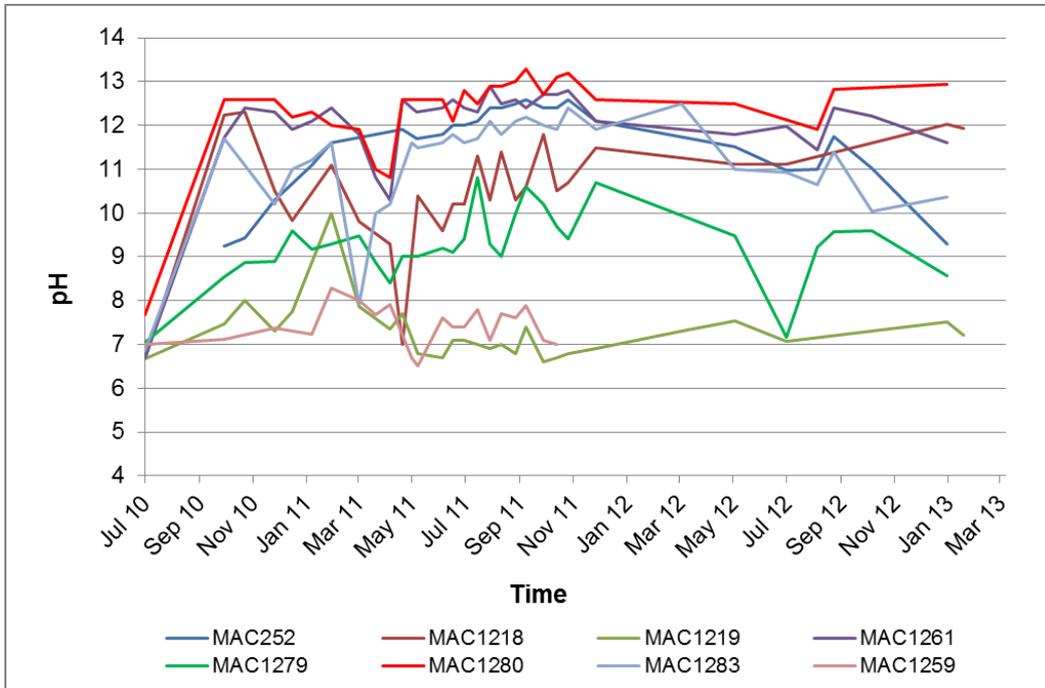


Figure 6-3 pH versus time

Groundwater quality results for pH (Figure 6-3) indicate that all bores, except MAC1219 and MAC1259, recorded consistently elevated/alkaline (above 8.5) pH levels over the baseline monitoring period. These results are not considered consistent with water quality within the coal seams. The monitoring bores were constructed in holes that had been first drilled for coal exploration before the open hole being converted to a monitoring bore. Whilst unknown at the time, further investigation has revealed that during exploration unstable coal seams had been stabilised with cement grout to prevent hole collapse. It appears cement grout infiltrated the coal seams altering the groundwater quality in a zone around the affected monitoring bores.

As the effected bores are not yielding groundwater samples representative of the water in the coal seams, these bores to be used for monitoring water levels only, not water chemistry.

Figure 6-4 displays electrical conductivity results from the monitoring bore network for the baseline period.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

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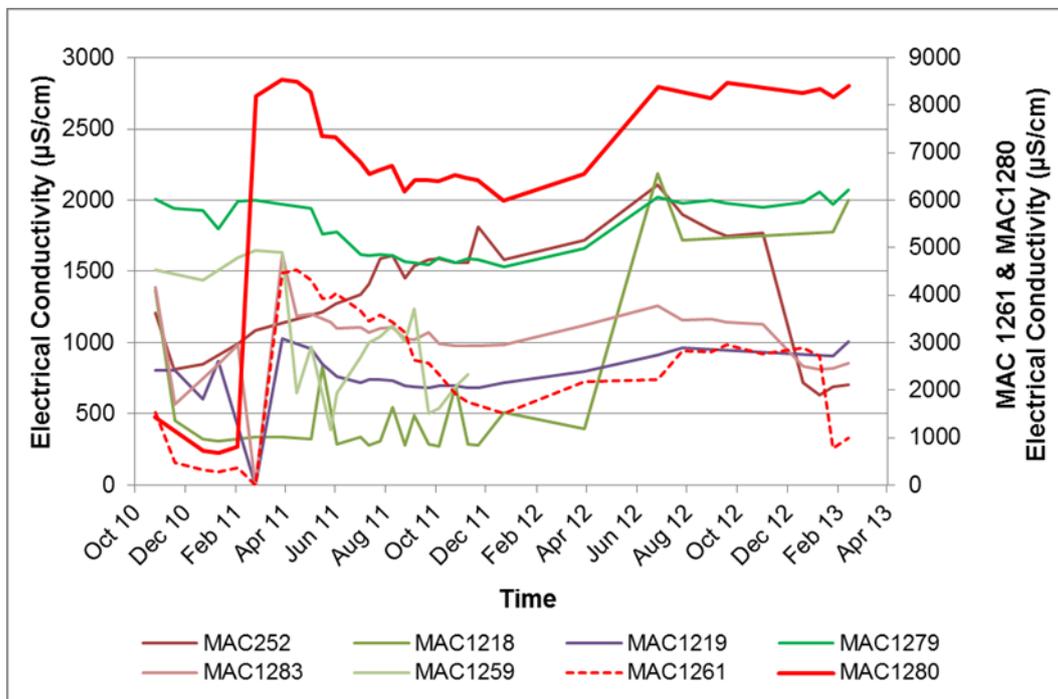


Figure 6-4 Electrical conductivity (µS/cm) versus time

The field EC results for most of the bores indicates that groundwater within the Permian coal seams is fresh to slightly brackish, with electrical conductivity typically ranging between about 500 µS/cm and 2000 µS/cm. It is too early to discern trends in salinity at this stage, although a cyclic trend appear to be emerging within the dataset.

Concentrations of sulphate are relatively low within all seven monitoring bores, generally below 100 mg/L (Figure 6-5). The highest sulphate concentrations were recorded within MAC1279, which is screened within the Jeralong Seam and recorded an average sulphate concentration of 162 mg/L. ANZECC (2000) guidelines indicate that adverse effects to stock could be expected if the concentration of sulphate exceeds 1,000 mg/L.

The results for the major cations and anions are shown in the Piper diagram (Figure 6-6) below.



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Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

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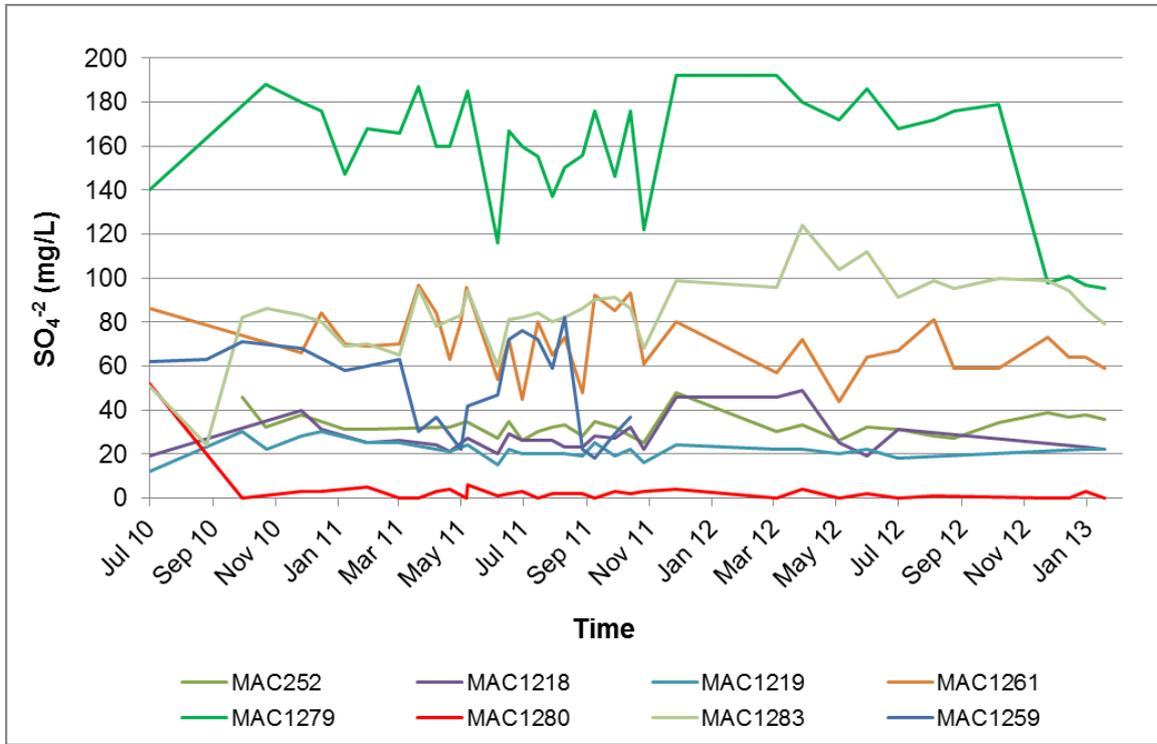


Figure 6-5 Sulphate (mg/L) versus time



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Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

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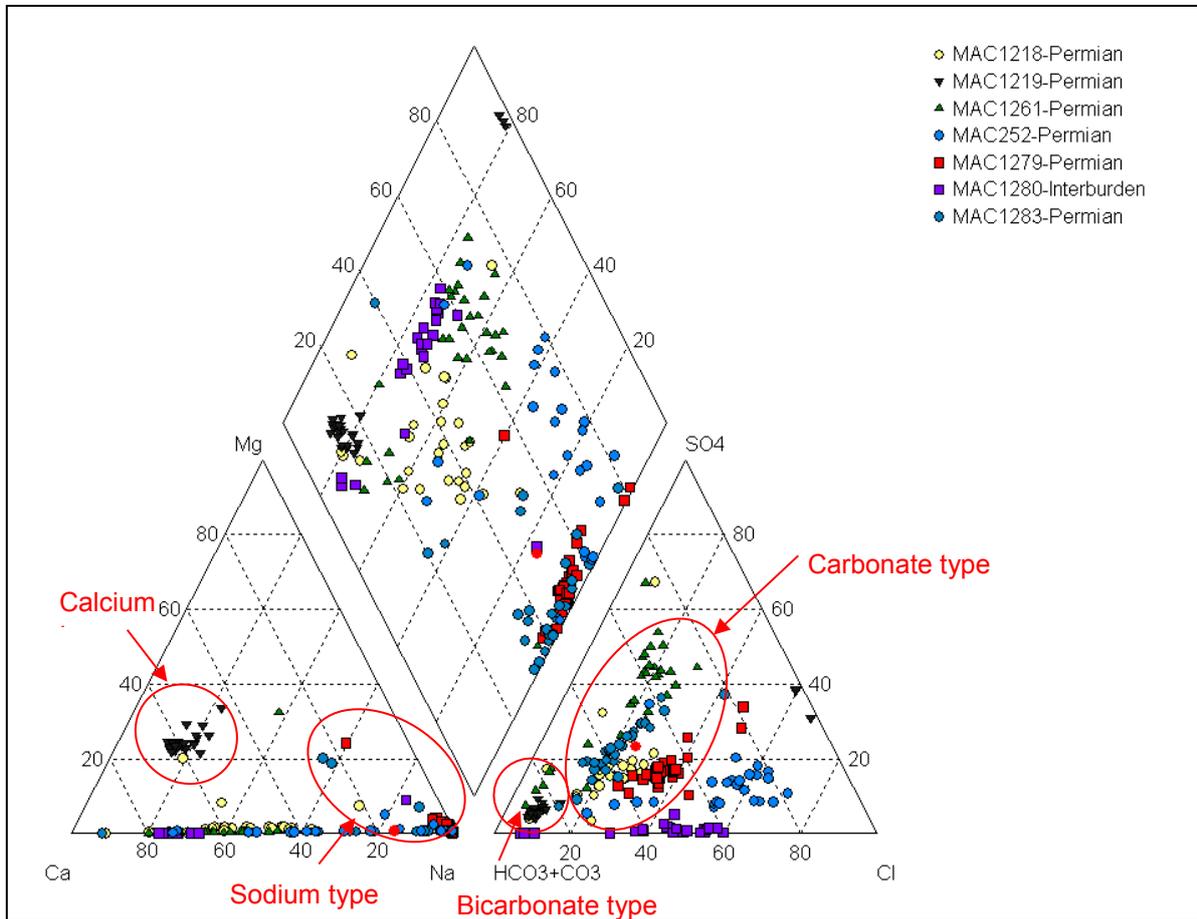


Figure 6-6 Piper Plot Showing Major Ions

The Piper diagram shows the relative concentrations of cations (sodium ion (Na^+), potassium ion (K^+), calcium ion (Ca^{2+}), magnesium ion (Mg^{2+})), and anions (chloride ion (Cl^-), sulphate ion (SO_4^{2-}) and hydrogen carbonate and carbonate ion ($\text{HCO}_3^- + \text{CO}_3^{2-}$)) as percentage meq/L, in a trilinear diagram.

Figure 6-6 indicates that most bores, except MAC1219, have a high carbonate (CO_3) concentration, which is due to the cement grout invading the coal seams as discussed previously. Water quality results for bore MAC1219 show consistently high bicarbonate (HCO_3) concentrations and no detectable carbonate ($<1\text{mg/L}$) indicating this bore is not affected by the cement grouting process.

The laboratory water quality results, including standard water quality parameters (EC, TDS, and SO_4) and the ten key metals, are shown in Table 6.2. Table 6.2 shows the geometric mean of water quality results collected from July 2010 to March 2013 for EC, TDS and SO_4 and from December 2010 to July 2012 for the metals. Also shown in Table 6.2 is the standard deviation (Stdev) and geometric mean plus 3x standard deviation (mean + 3s). These results were used in order to calculate baseline trigger levels for groundwater quality within the Project Boundary, which is further detailed in Section 6.3.4.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

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Table 6.2 Water Quality Results - Summarised

Analyte	Field EC [‡]	TDS [‡]	Sulphate [‡] as SO ₄	Al [†]	Ba [†]	Bo [†]	Cd [†]	Fe [†]	Pb [†]	Li [†]	Mn [†]	Mo [†]	Ni [†]
	µS/cm	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 Drinking Water (Health & Aesthetic)	900**		-500* 250**	0.2**	0.2*	4*	0.002*	0.3**	0.01*	-	0.5* 0.1**	0.05*	0.02*
ANZECC Livestock Drinking Water	7500 - 15000 [†]	5000 - 10000	1000 - 2000	5	-	5	0.01	-	0.1	-	-	0.15	1
ANZECC Long-Term Irrigation Water			-	5	-	0.5	0.01	0.2	2	2.5	0.2	0.01	0.2
Limit of Reporting	1	1	1	0.01	0.001	0.05	0.0001	0.05	0.001	0.001	0.001	0.001	0.001
1218	Mean	445	408	29	0.239	0.061	0.0001	0.1	0.004	0.02	0.005	0.002	0.005
	Stdev	493	500	68	0.5	0.1	0.02	0.0000	0.1	0.005	0.02	0.003	0.004
	mean + 3s	1925	1908	233	1.6	0.2	0.1	0.0001	0.4	0.02	0.1	0.05	0.02
1219	Mean	600	533	22	0.0	0.3	0.1	0.0003	0.2	0.01	0.1	0.06	0.002
	Stdev	187	101	5	0.1	0.1	0.1	0.0002	0.5	0.01	0.03	0.04	0.001
	mean + 3s	1160	836	38	0.2	0.4	0.3	0.0008	1.7	0.05	0.2	0.2	0.04
252	Mean	1437	589	34	0.1	0.3	0.1	0.0001	0.2	0.003	0.2	0.003	0.003
	Stdev	334	140	36	0.1	0.1	0.03	0.0001	0.1	0.01	0.03	0.01	0.002
	mean + 3s	2439	1009	143	0.5	0.7	0.2	0.0004	0.6	0.04	0.3	0.02	0.004
1261	Mean	1775	948	71	0.3	0.4	0.1	<LoR	0.1	0.003	0.1	0.003	0.004
	Stdev	1327	390	43	0.2	0.1	0.02	<LoR	0.1	0.001	0.04	0.003	0.001
	mean + 3s	5755	2118	200	0.8	0.7	0.2	<LoR	0.4	0.01	0.2	0.01	0.005
1279	Mean	1753	1208	162	0.2	0.1	0.1	0.0003	0.8	0.002	0.1	0.004	0.01
	Stdev	184	167	59	1.5	0.1	0.02	0.0009	3.3	0.01	0.05	0.06	0.002
	mean + 3s	2307	1709	340	4.6	0.2	0.1	0.0030	10.8	0.02	0.3	0.2	0.02
1280	Mean	5145	2139	3	0.3	1.1	<LoR	0.0003	0.4	0.005	0.2	0.003	0.01
	Stdev	2362	506	10	0.7	0.1	<LoR	0.0003	1.0	0.01	0.03	0.03	0.001
	mean + 3s	12230	3656	35	2.4	1.4	<LoR	0.001	3.4	0.04	0.3	0.09	0.05
1283	Mean	822	546	82	0.7	0.1	0.1	0.0002	0.1	0.002	0.1	0.01	0.01
	Stdev	265	223	17	0.3	0.03	0.03	0.0003	0.1	0.003	0.01	0.01	0.003
	mean + 3s	1618	1215	134	1.6	0.2	0.2	0.001	0.5	0.01	0.1	0.03	0.02

Notes:

ANZECC guideline levels for EC based on [†] Freshwater and [‡] Beef Cattle

ANZECC trigger levels for * Health and **Aesthetic purposes

[†] Metals results are for dissolved / filtered samples. Results for all bores excluding 1219 may be unrepresentative due to elevated pH levels

[‡]Field EC, TDS and SO₄ results for data from – July 2010 to March 2013.

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
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6.2 Groundwater Monitoring

6.2.1 Maules Creek Complex

The Maules Creek Coal Project is in close proximity to the operating Boggabri and Tarrawonga Mines. These mines, along with the NSW Office of Water (NOW) operate a groundwater monitoring network in the area as shown in Figure 6-7. Figure 6-7 shows the monitoring network at the Maules Creek installed for the EIS. The NOW groundwater monitoring network illustrated in Figure 6-7 Regional Monitoring Bore Network

includes three bores with automated water level logging (GW41027, GW967137 and GW967137) to the north of the open cut mine along Maules Creek.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

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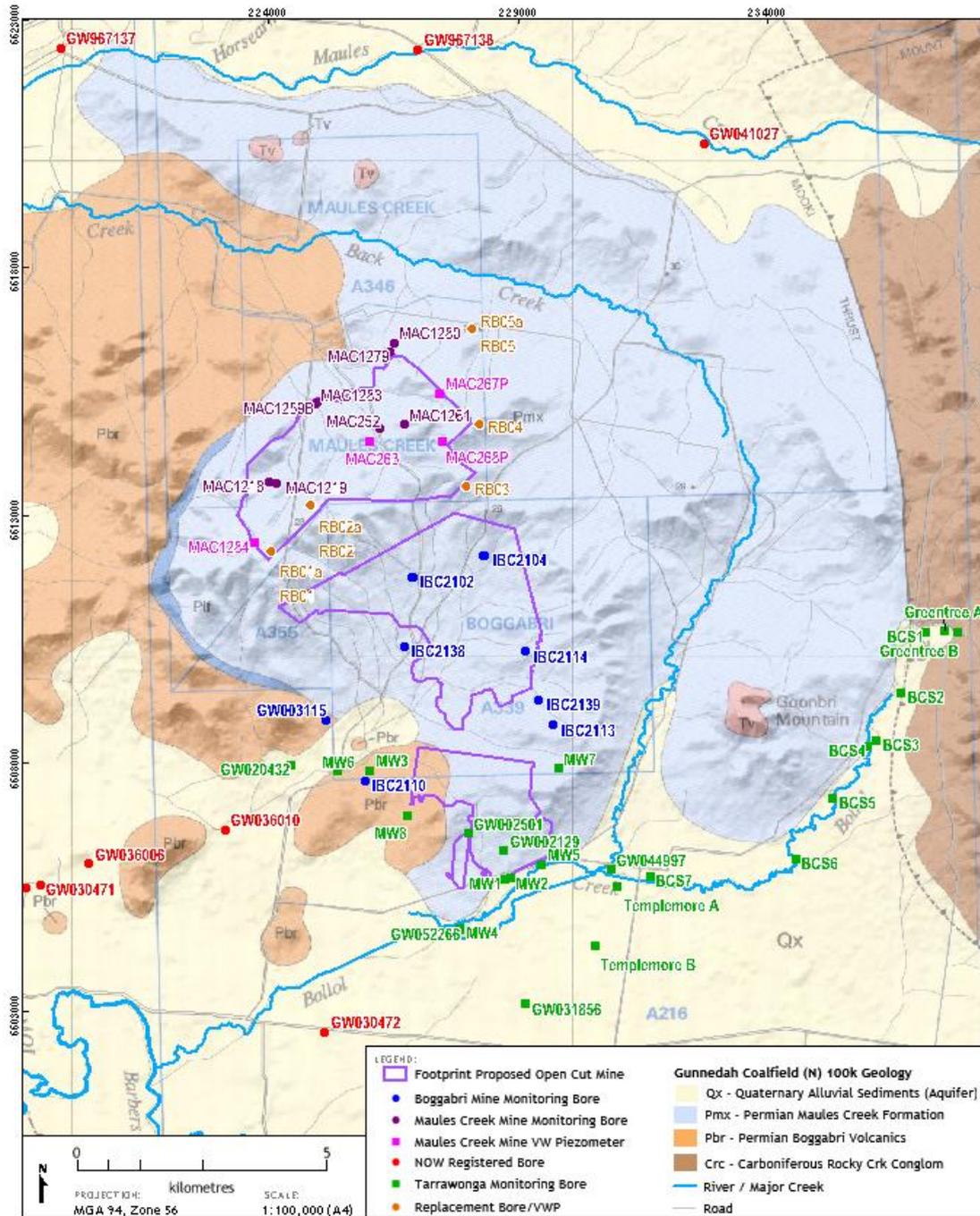


Figure 6-7 Regional Monitoring Bore Network

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
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6.2.2 Replacement Bores

As discussed above, mining will remove the monitoring bores within the Project footprint, and a number of these bores are yielding alkaline water that does not represent water within the coal seams. MCC engaged with Officers from Tamworth NOW to discuss the replacing these bores. In late 2013, agreement was reached with NOW on the locations for new monitoring bores be installed to replace the bores affected by cement grout, and the locations of the cumulative monitoring network.

MCC installed the new monitoring bores between October 2013 and February 2014.

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

Table 6.3 provides details of the replacement bores and VWPs. Appendix C includes the bore construction logs. Figure 6-8 shows the locations of the existing and replacement monitoring bores.

	<h1>MAULES CREEK</h1>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

Table 6.3 Replacement Monitoring Network Details

Drill Hole ID	NOW Licence No.	Easting MGA94	Northing MGA94	Elevation (mRL)	Hole Depth (m)	Type	Screen or VWP Depth	Screen or VWP Zone Geology
RB01		224058	6612333	433.05	205	VWP	1. 97m 140m 194.5m	1. Braymont 2. Merriown 3. Flixton
RB01a		224058	6612341	432.41	220.5	Standpipe		Templemore Seam
RB02		224860	6613267	398.17	270	VWP	110m 162m 225m	1. Braymont 2. Merriown 3. Nagero
RB02a		224853	6613266	398.08	234	Standpipe		Nagero
RB03		227947	6613635	407.89	324.4	VWP	164m 242m 289m 317m	1. Braymont 2. Merriown 3. Nagero 4. Templemore
RB04		228213	6614910	437.53	354	VWP	209m 272.5m 309m 339m	1. Braymont 2. Merriown 3. Nagero 4. Lower Northam
RB05		228065	6616810	328.40	382	VWP	107m 213m 280m 382m	1. Braymont 2. Jeralong 3. Nagero 4. Templemore
RB05a		228067	6616812	328.40		246.5	Standpipe	Merriown



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

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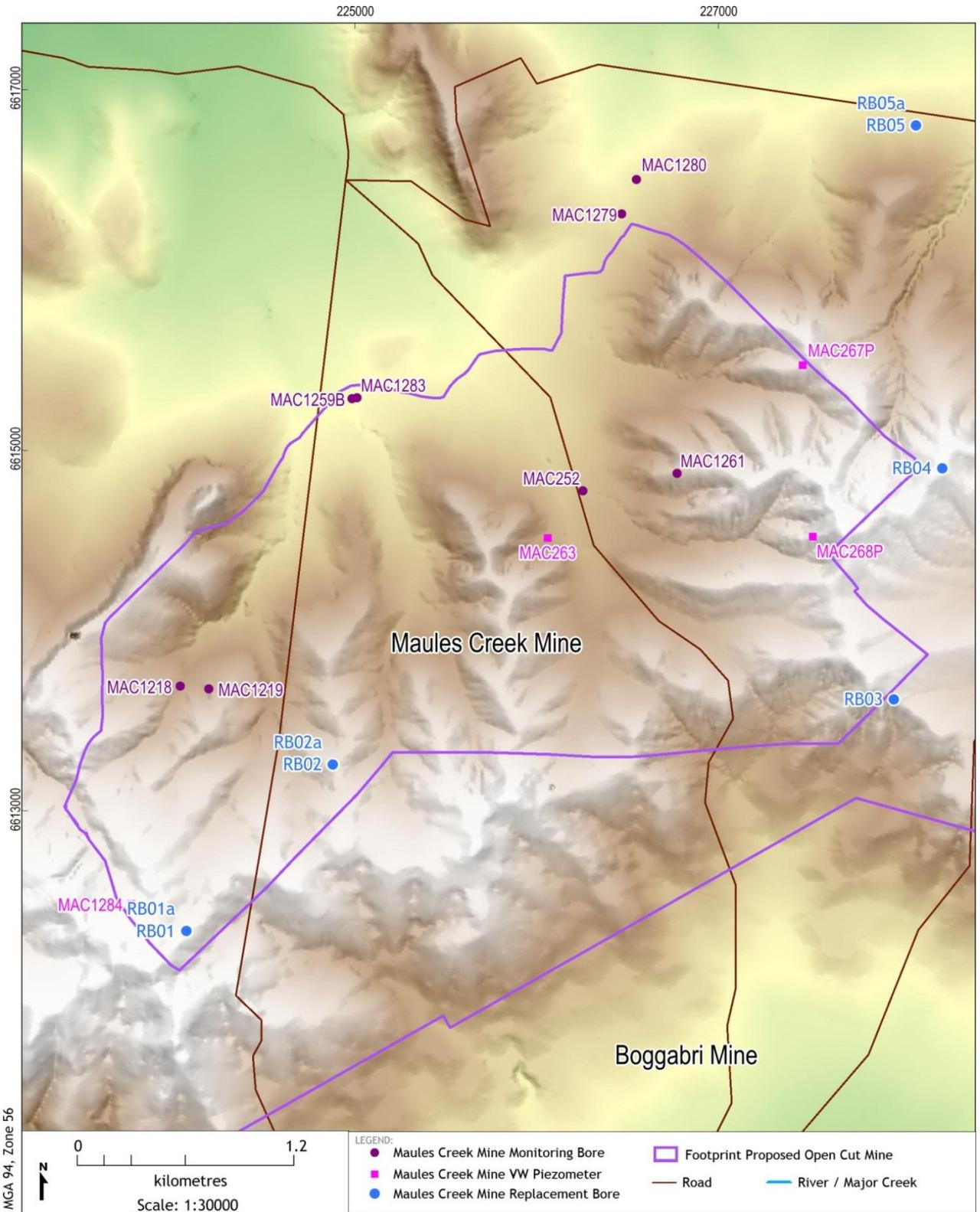


Figure 6-8 Replacement Monitoring Bore Network

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
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6.2.3 Cumulative Impacts and Monitoring Locations

The close proximity of the mining operations will result in a cumulative impact whereby the zones of depressurisation produced by the Maules Creek, Boggabri and Tarrawonga mines will overlap. The existing monitoring network will detect this impact, but further sites were installed to monitor and manage groundwater impacts resulting from multiple mining operations.

MCC expanded the existing monitoring network in late 2013 as per the recommendations of the Groundwater Impact Assessment presented in the Maules Creek Coal Project Environmental Impact Statement (Hansen Bailey 2011). The locations of new bores are based on reviews conducted by AGE (2011) and Heritage Computing (2012) and liaison with the neighbouring coal mines (Boggabri Coal Mine and Tarrawonga Coal Mine).

MCC engaged Heritage Computing (2012) to review the monitoring bore network proposed in the 2011 EA, and recommended any changes to effectively monitor cumulative impacts from the three mines. Heritage Computing recommended some changes to the monitoring network proposed in the EA, which have been adopted in this management plan. MCC also engaged with Officers from Tamworth NOW to discuss the proposed monitoring network. Agreement was reached with NOW on the locations for new monitoring bores be installed to replace the bores affected by cement grout, and the locations of the cumulative monitoring network.

Table 6.4 summaries the locations of the bores installed for monitoring the cumulative groundwater impacts of the three mining projects. Figure 6-9 shows the locations of the bores on a geology basemap.

	<h1>MAULES CREEK</h1>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Table 6.4 Cumulative Impacts Groundwater Monitoring Locations

Drill Hole ID	NOW Licence No.	Easting MGA94	Northing MGA94	Elevation (mRL)	Hole Depth (m)	Type	Screen or VWP Depth m	Screen or VWP Zone Geology
BCM01		223835	6618367	273.5	10	Standpipe		Alluvium
BCM03		230091	6617544	311.5	10	Standpipe		Alluvium
Reg1		226946	6622396	286.17	294.4	VWP	118.7	Jeralong
							134.5	Merriown
							193.5	Nagero
							281.5	Therribri Upper
Reg2		232722	6620459	317.01	276	VWP	60	Leard formation
							120	Leard formation
							200	Leard formation
							260	Leard formation
Reg3						Standpipe		Boggabri Volcanics
Reg4		219323	6612763	259.95	72.5	Standpipe		Boggabri Volcanics
Reg5		220649	6609521	252.17	78.7	Standpipe		Boggabri Volcanics
Reg5a		220646	6609514	252.03	22	Standpipe		Alluvium
Reg6		223100	6606534	250.65	96	Standpipe		Boggabri Volcanics
Reg7 ¹		233543	6605348	291.62	255.2	VWP	67.5	Braymont ¹
							148.2	Merriown ¹
							242.5	Nagero ¹
Reg7a		233545	6605359	291.71	36	Standpipe		Alluvium
Reg8 ²		230030	6615113	341.60		VWP	91.50	Braymont Middle
							221	Merriown
							274	Nagero
Reg9 ¹		234233	6610591	346.81	279.2	VWP	115.75	Braymont ¹
							175.2	Merriown ¹
							269.5	Nagero ¹
Reg10		226723	6618261	287.12	189.4	VWP	55	Braymont

	<h1>MAULES CREEK</h1>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Drill Hole ID	NOW Licence No.	Easting MGA94	Northing MGA94	Elevation (mRL)	Hole Depth (m)	Type	Screen or VWP Depth m	Screen or VWP Zone Geology
							144.2	Merriown
							178	Nagero
							185.5	Upper Northam
Reg10a		226717	6618260	287.12	10	Standpipe		Alluvium
Reg11 ²						Standpipe		Boggabri Volcanics
Reg11a ²						Standpipe		Alluvium
Reg12		222632	6617358	285.61	48.3	Standpipe		Boggabri Volcanics
Reg13		219713	6611129	277.08	133	Standpipe		Boggabri Volcanics
Reg14		225547	6602649	250.18	102	Standpipe		Alluvium

Notes: 1 - seams yet to be correlated in geological model

2 - yet to be drilled



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

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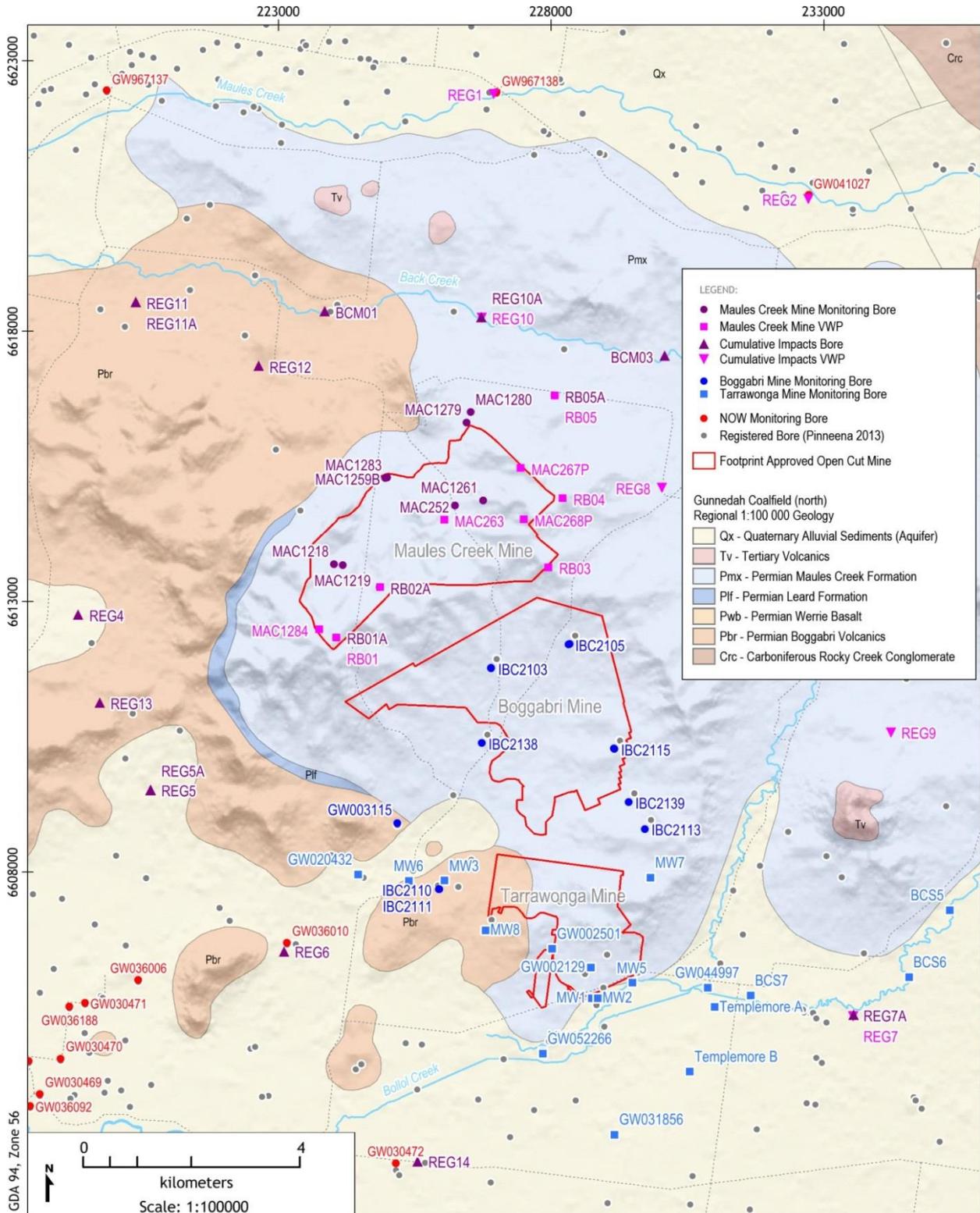


Figure 6-9 Cumulative Impacts Bore Network

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

As shown in Table 6.4, six of the proposed locations are vibrating-wire (VWP) installations, with three to four sensors on each string placed across coal seams. REG02 is the only exception which is screened within the underlying Leard Formation, as a structure in this area faulted out the Maules Creek coal seams. The other sites are standpipes providing information on vertical head gradients between shallow and deep hydrostratigraphic units. Where possible the sites are aligned with existing NOW bores that are already monitoring the alluvium.

Three bores are installed along Back Creek to assess the potential for shallow groundwater and the presence of groundwater dependent ecosystems (BMC1, BMC3 and REG10a).

6.2.4 Groundwater Level Monitoring Plan

Groundwater levels are currently measured in the existing monitoring network on a monthly basis. Manual monitoring is suitable for identification of long term trends in groundwater levels but does not provide data on short term events such rainfall recharge or depressurisation that can occur within a three monthly monitoring cycle. Electronic water level loggers will be progressively installed during 2014 in all existing and future monitoring bores. Downloads and database updates will occur monthly, and record interval times should be synchronised for all bores.

Registered private bores identified as being within the simulated zone of depressurisation will be inspected to determine if the bores are still operational and in-use. Monitoring will continue in conjunction with the landholders.

6.2.5 Groundwater Quality Monitoring Plan

In order to establish baseline groundwater quality data, water samples will be collected from the monitoring bores on a three monthly basis for the first 12 months of sampling, while on-going sampling should be collected on a six monthly basis. Collected samples will be analysed in the laboratory for:

- pH, EC, TDS
- major cations and anions;
- nutrients - ammonia, nitrate, nitrite; and
- metals – aluminium, arsenic, barium, boron, cadmium, copper, iron, lead, lithium, manganese, molybdenum, nickel and zinc.

All groundwater sampling will be conducted in accordance with the following guidelines:

- *Murray Darling Basin Groundwater Quality Sampling Guidelines Technical Report No. 3*; and
- *Groundwater Sampling and Analysis: A Field Guide* (Geoscience Australia, 2009).

The water quality monitoring will continue for the life of the mining operation.

6.3 Groundwater impacts & mitigation measures

The groundwater flow model developed by AGE for Maules Creek Coal Project (AGE, 2014) was recalibrated using water level data collected from 2006 to 2013, including the cumulative impact monitoring bores recently installed by Whitehaven. The recalibrated model was able to replicate the major trends in the groundwater system including responses attributed to recharge, private bore pumping and mining.

The recalibration required increasing the hydraulic conductivity of the Permian sequence, and reducing the Boggabri volcanics. The recalibrated model simulated all mining projects in the area, the only change from

previous versions being that extraction of first coal at Maules Creek was delayed until 2015. The modelling indicated very similar impacts to those predicted in the EA, with a slightly reduced zone of depressurisation in the Boggabri volcanics, and a minor increase in the seepage rate from the alluvium. The predicted groundwater impacts and mitigation measures from the most recent model (AGE, 2014) are detailed below.

6.3.1 Neighbouring Privately Owned Bores

The Groundwater Impact Assessment identified the potential impacts of the Maules Creek Coal Mine on neighbouring privately owned bores. A total of 25 existing registered bores are encompassed within the zone of influence of the Project, with the potential for failure of three of these bores. The existing water bores predicted to be impacted by the Project are listed in Table 6.5.

Table 6.5 Registered Bores within Zone of Influence

Work No.	Land Ownership	Usage	Bore Depth (m)	Standing Water Level (mbgl) [†]	Estimated Maximum Available Drawdown in Bore (m)	Simulated Water Level Drawdown (m)		Outcome
						Maules Creek Mine only	Total Cumulative – all mines	
GW000583	MJ Brennan ^{**}	Stock	98.7	20.31	78.39	1.44	4.53	
GW020434	Boggabri Coal	Monitoring	85.3			13.7	15.45	
GW002748	Aston Coal 2 Pty Limited	Stock	72.2	20.9	51.3	50.65	60.33	Bore failure
GW002831	PF Murphy ^{**}	Stock	33.2	18.66	14.54	1.22	1.3	
GW003115	Boggabri Coal	Monitoring	82.9	23	59.9	1.63	16.35	
GW003466	VA and MA Younger [‡]	Stock	50	9.36	40.64	16.78	18.12	
GW003478	DJC Watson [‡]	Stock and domestic	33.8	25.29	8.51	12.88	13.46	Bore failure
GW003483	DJC Watson [‡]	Stock	32.9	22.85	10.05	13.62	14.03	Bore failure
GW003489	MJ & ML Nott [‡]	Stock and domestic	45.4	21.16	24.24	6.49	6.81	
GW006529	Aston Coal 2 Pty Limited		34.7		34.7	3.12	4.7	

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Work No.	Land Ownership	Usage	Bore Depth (m)	Standing Water Level (mbgl)†	Estimated Maximum Available Drawdown in Bore (m)	Simulated Water Level Drawdown (m)		Outcome
						Maules Creek Mine only	Total Cumulative – all mines	
GW006567	PF Murphy ^{##}	Stock	59.1	19.13	39.97	4.9	5.3	
GW008221	Aston Coal 2 Pty Limited	Cannot locate	108.2			32.04	36.64	
GW008255	MJ Brennan ^{##}	None	91.4	7.5	83.9	1.27	3.07	
GW001869	CM & RRF Morse ^{##}	No access	63.1			1.45	7.03	
GW020607	JM Morris ^{##}	No access	29.9			1.98	2.19	
GW028893	Aston Coal 2 Pty Limited	Stock	54.9			1.15	1.51	
GW028894	Aston Coal 2 Pty Limited	Stock	48.8	20.24	28.56	2.56	4.31	
GW053825	NSW State Forest	None	257	13.21	243.79	142.51	159.57	
GW900043	JM Morris ^{##}	No access	32.9			3.63	4.02	
GW967856	NSW State Forest	Monitoring	66.5	61.7	4.8	1.55	79.13	
GW967861	NSW State Forest	Monitoring	59	49.4	47.62	1.78	107.15	
GW967862	NSW State Forest	Monitoring	85	70.3	68.52	1.78	107.09	

Notes:[†] Water levels measured in January 2011

[‡] Whitehaven have reached agreement to purchase these properties

^{##} Whitehaven are in ongoing discussions with this landholder over impacts of Project

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
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MCC have undertaken monitoring of the landholder bores highlighted in yellow. Land upon which three of these privately owned bores are located has since been purchased by Maules Creek Coal, and as such is no longer privately owned.

Groundwater levels and quality will be monitored in selected private bores which are relatively close to the mining area. The monitoring frequency and analytical testing will be the same as for the existing monitoring bore network.

Liaison with some landholders is currently underway. It should be recognised that monitoring of all bores may not be possible if agreement with the landholders cannot be reached.

Should the Project be determined to impact on the water supply at any privately owned bore, Maules Creek Coal will provide a suitable alternative water supply in consultation with the landholder. The process of determining the impact on the privately owned bore will also be undertaken in consultation with NOW and to the satisfaction of the Director-General, consistent with Statement of Commitment no 24 and Condition 40 of PA 10_0138.

Should drawdown attributable to mining be detected within any private bores within the predicted zone of depressurisation, the need to expand the bore census beyond the area visited as part of the 2011 EA will be assessed. A more expansive bore census will also be undertaken should any updates to the groundwater model indicate a more extensive zone of depressurisation.

6.3.2 Groundwater Inflows to Pit

The Groundwater Impact Assessment (AGE, 2011) estimated the rate of groundwater seepage to the open cut pits in the mining complex using a numerical model. AGE (2014) updated the groundwater model and seepage estimates. Figure 6-10 shows the predicted pit seepage rates over time for Maules Creek Coal Project and surrounding mines.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

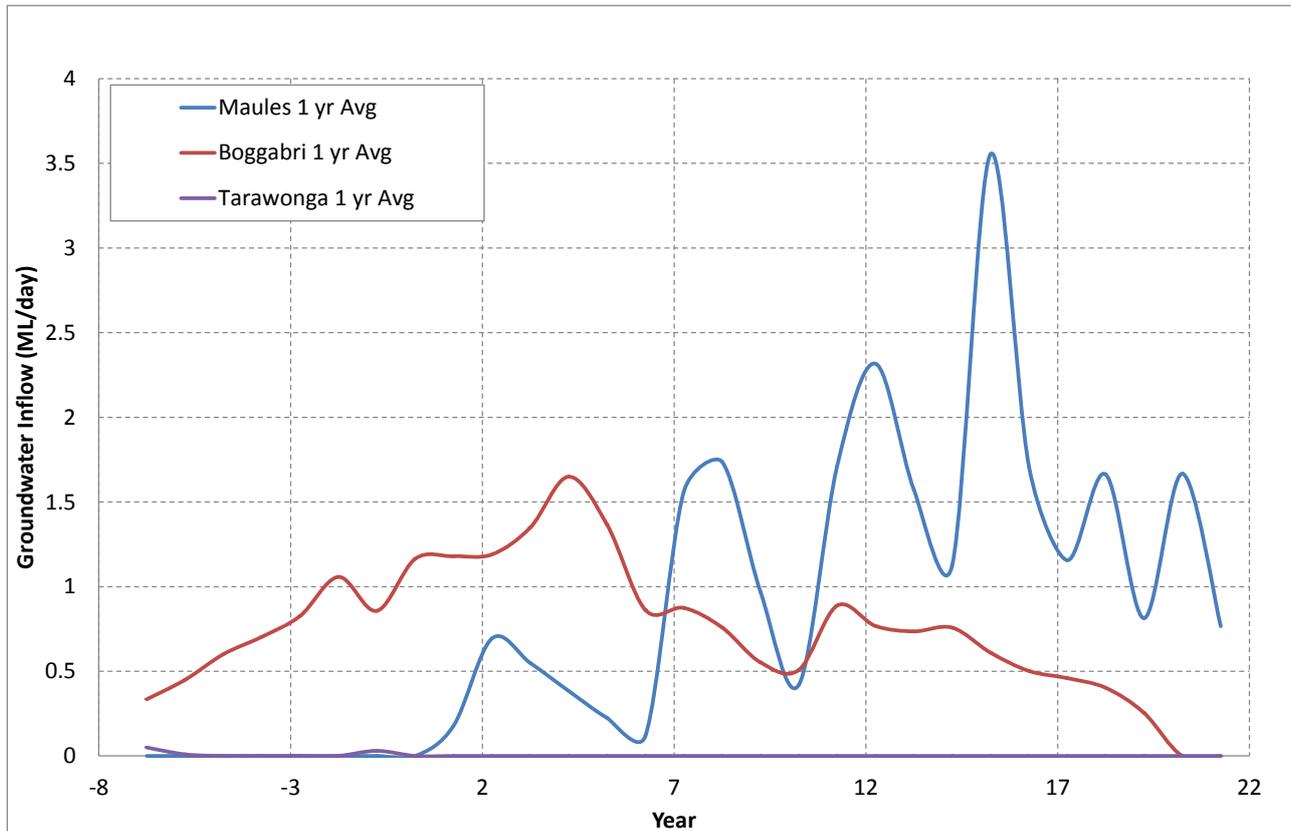


Figure 6-10 Simulated Seepage into the Maules Creek Coal Project and Neighbouring Mines

Figure 6-10 indicates seepage typically ranges between 0.5 and 2.5 ML/day at Maules Creek Mine. The groundwater seepage to the proposed open cut pit is largely sourced from storage in the Permian overburden/interburden and the coal seams. The seepage will also result in a reduction in the volume of groundwater flow from the Permian bedrock into the alluvial aquifer.

The updated model presented by AGE (2014) predicts the average loss of recharge to the alluvial aquifer of about 50 ML/year (from underflow). The modelling indicates this 50 ML/year water is sourced from Groundwater Management Zone 4 (17 ML/year), Zone 5 (5 ML/year) and Zone 11 (28 ML/year).

Monitoring of groundwater inflows into the pit will be undertaken to provide data to validate the groundwater model and to assist in the accounting for “*water take*” from the relevant groundwater water source as per requirements under the *Water Management Act 2000*.

Pit seepage monitoring program will include:

- recording of the time, location and volume of any unexpected increased groundwater outflow from the highwall and endwall;
- measurement of all water pumped from the pits particularly using flow meters or other suitable gauging apparatus;
- monitoring of water pumped from the pits for the same analytical suite outlined in Section 6.2.5.
- correlation of rainfall records with pit seepage records so groundwater and surface water can be separated; and

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

- monitoring of coal moisture content.

In addition to groundwater seepage into the pit, there will also be rainfall runoff from the mining area, and also some areas of natural catchment that will present to the open cut pit. Water that presents to the open cut pit will be pumped to the Mine Water Dam for reuse in the mine water management system.

Due to the various water sources being collected within the pit, it will be essential to calculate the rainfall runoff from the various catchments and the quantity of water that is pumped (and or stored) within the open cut pit. This will enable groundwater inflows to be estimated and be included with the reporting requirements under the Annual Review and obligations under the *Water Management Act 2000*.

The volume of groundwater that evaporates directly from the coal seams in the highwall cannot be measured, but will be estimated every three years when the groundwater model is updated. A pan evaporation rate, corrected for the shading on the pit face, will be applied across the area of exposed coal seams below the saturated zone during each mine strip to estimate the volume of groundwater evaporated.

6.3.3 Groundwater Dependent Ecosystems

The Ecology Impact Assessment undertaken for the Maules Creek Coal Project EA identified *Melaleuca sp.* along the alignment of Back Creek. These species are likely to have a root zone extending up to 2 to 3 m below the land surface. The groundwater model has predicted groundwater levels are potentially within 2 m of the land surface in some zones along Back Creek. New bores installed in alluvium along Back Creek were dry at a depth of 10m below surface, and suggest groundwater vegetation along the creek is not likely to be reliant on groundwater. Monitoring of water levels in the bores along Back Creek will continue for the life of the Project.

In addition to the *Melaleuca sp.* on Back Creek, Stygofauna are known to exist within the area, primarily within the Namoi River and Maules Creek alluvium. The groundwater model for Maules Creek Coal Mine predicted some reductions in discharge to the alluvial aquifers, however it was not predicted to materially change the groundwater levels within the alluvial aquifer and Stygofauna are not expected to be impacted as a result of the Maules Creek Coal Mine.

Maules Creek Coal will implement a monitoring program for Stygofauna within the bores in the vicinity of the Maules Creek Coal Mine. A single round of monitoring of Stygofauna will be undertaken across the alluvial groundwater monitoring network as described in Section 6.2.3 and listed in Table 6.4. Stygofauna monitoring is conducted in accordance with the Western Australia Environmental Protection Authority's Guidance Statements 54 and 54a (WA EPA 2003, 2007). Stygofauna monitoring will only be required to be revisited in the event that groundwater quality and level monitoring show a substantial deterioration in water quality or reductions in water levels within the alluvial aquifer.

6.3.4 Impact Assessment Criteria

Schedule 3 Condition 40(c) of the PA 10_0138 stipulates that the groundwater monitoring program must have groundwater assessment criteria, including trigger levels for investigating any potentially adverse impacts on the groundwater regime. Impacts of the Maules Creek Coal Mine have previously been predicted and assessed under the Groundwater Impact Assessment (AGE, 2011) and have been accepted by the NSW Government to occur as a result of the Project.

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

The relevant predictions from the Groundwater Impact Assessment that will be monitored and reviewed throughout the operations including:

- Average groundwater seepage rates typically ranging between 0.5 ML/day and 2.5 ML/day
- Average loss of recharge to the neighbouring alluvial aquifers gradually increasing to 50 ML/year at end of mining;
- Groundwater levels within the alluvial aquifers not changing beyond the natural rates of fluctuation as a result of the Maules Creek Coal Mine;
- Groundwater pressures within the coal seam Permian coal measures declining in the vicinity of the mining operations as mining progresses; and
- Water quality of the Permian coal seam aquifer being unaffected by the Maules Creek Coal Project.

Should monitoring results be outside of the predictions made within the Groundwater Impact Assessment (as summarised above) and indicate a substantial variation beyond the trigger levels presented, then an investigation into the data will be implemented to confirm the reason for the variation and to implement the relevant actions. The process of investigation that will be implemented is described further in Section 7.0.

The reduced transfer of groundwater from the Permian bedrock to the overlying alluvium cannot be directly measured during mining. It will however be estimated by the groundwater model every three years by recalibrating the model to observed changes in groundwater levels and seepage rates to the open cut pits.

Groundwater levels will be compared to the 5th and 95th percentile value for the available dataset (see Appendix E). The use of a 5th percentile rule means that groundwater elevations can be expected to be below this threshold for five percent of measurements, if future climatic conditions match what has occurred during the baseline monitoring period.

To counteract spurious measurements, which could occur for example during maintenance of a sensor or downloading or water sampling, a 7-day average will be calculated to cover such events. In addition, to ensure the "breach" of a trigger is sustained and is therefore significant, a 1-month exceedance duration will be adopted to allow water levels to stabilise. This would "trigger" an investigation in the first instance, not an immediately reportable incident.

Groundwater quality will be monitored against trigger levels generated in accordance with the control chart assessment procedure. The control chart assessment procedure is based on the geometric mean and standard deviation(s) for initial, validated baseline water quality data (i.e. EC).

Once mining commences, monitoring results for each parameter (i.e. EC) is plotted against time, with control limits of mean +1s, mean + 2s and mean + 3s. Control criteria are set such that one observation above mean + 3s, or two consecutive observations above mean + 2s, or five successive observations above mean + 1s would constitute a trigger alarm. If there is a period of no alarms (i.e. after 12 observations), the mean and standard deviation could be recalculated and the control lines adjusted to provide better precision.

Appendix E shows the EC control charts for the eight Maules Creek monitoring bores. It is essentially a plot of the EC data over time, with the addition of lines marking the control limits. The mean and standard deviation were calculated from the initial baseline data, with invalidated, erroneous data excluded.

Control charts are most useful for parameters such as EC that vary significantly on a spatial basis. No control charts have been produced for metals as these are typically less variable, and can be compared to

	<h1>MAULES CREEK</h1>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

the most appropriate guidelines depending on the environmental value of the groundwater. The metals data will be compared to the most appropriate trigger levels for stock, domestic, irrigation and aquatic ecosystems.

Should the measured annual groundwater seepage rate to the open cut mine be more than 50 % greater than predicted by the 2011 EA, the cause of this higher rate will be assessed and reported in the annual review. If it is considered the water licenses held by the project will be insufficient to offset groundwater taken, then the groundwater model will be rerun to determine the volume of additional licensing required.

Should the measured annual groundwater seepage rate to the open cut mine be lower than predicted in the 2011 EA, no action will be taken as there will be sufficient water available to offset the water take due to mining.

6.3.5 Data Management and Reporting

Data management and annual reporting will include:

- Review of depressurisation of coal measures and drawdown within alluvial aquifers;
- Comparison of observed depressurisation with model predictions;
- Review of data and comparison to the defined trigger levels;
- Actions and responses taken if trigger levels are exceeded; and
- Review of trigger levels and baseline data.

Further to this, the digital groundwater monitoring data will be provided to the local NOW hydrologist.

6.3.6 PAC Recommendations

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

As per Schedule 6 of PA 10_0138, the expert advisor to the PAC recommended gathering further hydro geochemical data at the Maules Creek Coal Mine, including:

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

MCC will engage a suitably qualified Geochemist to undertake a hydro geochemical study that will consider the PAC recommendations of PA 10_0138 Schedule 6, and will provide recommendations that will allow

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

MCC to characterise the mineralogy of interburden, porous rock permeability and water storage characteristics of interburden across the site. The recommendations of the study will be implemented within the first five years of mining to meet the requirements of the PAC. The study will include collecting core samples for permeability testing, XRD-XRF analyses, batch reaction testing and hydro chemical modelling.

As required by Schedule 3, Condition 40(c) of PA 10_0138, Maules Creek Coal will implement the above measures to the monitoring program. The core testing and XRD-XRF analyses will be undertaken in conjunction with exploration drilling programs to be undertaken during the initial years of mining operations.

6.4 Validation of Groundwater Model

As required by Schedule 3, Condition 40(c) of PA 10_0138, Maules Creek Coal will commission an Independent Consultant to complete a review of the groundwater monitoring results against the predictions made within the groundwater model versus the model. This review will be commissioned annually. Should the annual review indicate that the observed versus modelled data is diverging the groundwater model will be progressively updated and refined to ensure that any possible impacts can be predicted. This model re-calibration and validation will be required prior to an independent review every three years.

6.5 Final Void Management & Design Parameters

Schedule 3, Condition 71 of PA 10_0138 provides the rehabilitation objectives that need to be implemented to the operations. The key objectives to be achieved for the final void include:

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

The ultimate final landform (including final void) is presented within the Rehabilitation Management Plan as required under Schedule 3, Condition 73 of PA 10_0138. Further mine planning work will be undertaken as the mining operations progress and as part of the work required under the Rehabilitation Management Plan to ensure that the objectives from the Project Approval have been met. This WMP will be updated to reflect the work completed as part of the Rehabilitation Management Plan.

7.0 SURFACE AND GROUNDWATER RESPONSE PLAN

7.1 Criteria Exceedance Protocol

In accordance with Condition 40 of Schedule 3 of PA 10_0138, should an exceedance of the monitoring criteria listed in this WMP occur, then MCC will follow the procedure outlined in

Table 7.1. This procedure will also apply in the event of an exceedance of allocated water volumes under the site's Water Access Licence for the Namoi River (WAL13050) or the measurement of a substantial change in groundwater quality more than the trigger levels defined within this WMP.

Table 7.1 Exceedance Response Protocol

Stage	Procedure
1	Confirm the timing of the exceedance(s)
2	Confirm the general location of the exceedance(s)
3	Confirm the climatic conditions at the time of the exceedance(s) (where relevant)
4	Identify any potential contributing factors
5	Assess the monitoring results for any anomalies or causes
6	Develop appropriate mitigation and management strategies
7	Implement the mitigation and management strategies
8	Review of follow up results
9	Report the exceedance to the appropriate regulatory authorities.

7.2 Unforeseen Impacts

The procedure outlined in Table 7.2 will be followed in the event that any unforeseen surface or groundwater impacts are detected. The procedure will be in general accordance with the criteria exceedance protocol in Section 7.1.

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

Table 7.2 Unforeseen Impacts Protocol

Stage	Procedure
1	Review the unforeseen impact, including consideration of: <ul style="list-style-type: none"> ▫ Any relevant monitoring data; and ▫ Current mine activities and land management practices in the relevant catchment;
2	Commission an investigation into the unforeseen impact by an appropriate specialist selected in consultation with appropriate regulatory authorities;
3	Develop appropriate ameliorative measures based on the results of the above investigations, in consultation with the relevant authorities; and
4	Implement additional monitoring where relevant to measure the effectiveness of the ameliorative measures.

Contingency actions for a number of specific trigger events are provided in Table 7.3.

Table 7.3 Contingency Actions

Trigger	Action
Raw water supply Pipeline flow meters indicate abnormally low flow rate	Check for pipeline damage and leakage.
Mechanical failure of pumping equipment prevents scheduled transfers	Ensure adequate spares are available. Source temporary equipment if possible.
Damage to water storage infrastructure	Regular visual inspection of infrastructure, especially following significant rainfall.
Spills from Highwall Dams	Closely monitor dam water levels to ensure dam stability. Implement safety measures for pit operations to consider inflows from Highwall Dams.
Failure of water storage structure	Notify downstream residents, Director General, EPA and Dam Safety Committee (if applicable) of the failed structure.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Trigger	Action
	<p>Investigate the downstream impacts of the failure and complete a detailed report on the impacts of the failure, including an assessment of likely water volume and quality, and required remedial actions.</p> <p>Investigate the reason for failure of the structure and ensure the stability of other water storages at risk.</p> <p>Assess the effects of the failure on the water management system and implement mitigation measures.</p>
Forecasts of significant rainfall or storm event	Pump water from any storage at risk of unlicensed discharges.
Water demands or catchment yield depart from assumed values used in modelling	<p>Investigate reasons.</p> <p>Revisit site water balance modelling if required.</p>
Routine monitoring indicates siltation is causing loss of water storage capacity in water management dams	Undertake desilting operation to reinstate design storage volume.
Short-term water demand forecast may approach the entitlement under high security water licences	<p>Further improvements in water use efficiency.</p> <p>Investigate Procurement of additional water licences.</p> <p>Extraction of groundwater from existing or new bores (within licence conditions).</p> <p>Increased retention of site runoff without discharge.</p>
Extended period of drought reduces the reliability of site water supplies	Access Namoi River water allocation as required.
Water monitoring indicates an exceedance of the surface water licence conditions in the EPL, shown in Table 4.9.	<p>Cease any controlled discharges which may be causing the non-compliance.</p> <p>Contain any contaminated water where possible to prevent environmental harm.</p> <p>Continue to monitor water quality in the area of interest.</p>



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Trigger	Action
	<p>Undertake an investigation, where necessary, to ascertain the cause of the non-compliance.</p> <p>Report the non-compliance to the EPA and other relevant parties.</p>
Receiving water quality monitoring indicates exceedance of trigger values shown in Table 4.10.	<p>Cease any controlled discharges which may be causing the non-compliance until further analysis is undertaken.</p> <p>Check recorded data for location on watercourse upstream of project. If the upstream water quality is similar to or higher than the recorded downstream value, then no further action is required.</p> <p>If the downstream value is higher than upstream, check if any water overflowed or was released from the site. If it is confirmed that no overflows or releases occurred, then no further action is required.</p> <p>If the downstream value is higher than upstream, undertake an investigation in accordance with Unforeseen Impacts Protocol (Table 7.2).</p>
Community complaints received of exacerbated downstream flooding.	Undertake an investigation in accordance with Unforeseen Impacts Protocol (Table 7.2).
Community complaints received of impacts to stock and domestic water supply.	Undertake an investigation in accordance with Unforeseen Impacts Protocol (Table 7.2).
Stream and riparian vegetation health monitoring indicates measurable declining vegetation health.	Undertake an investigation in accordance with Unforeseen Impacts Protocol (Table 7.2).
Site inspections or community complaints indicate unexpected erosion or sedimentation downstream of the project.	Undertake an investigation in accordance with Unforeseen Impacts Protocol (Table 7.2).
Uncontrolled discharge	<p>Monitor water quality and quantity of the discharge and assess the potential for environmental harm.</p> <p>Contain any contaminated water where possible to prevent environmental harm.</p>

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Trigger	Action
<p>Oil/chemical spill event</p> <p>Annual CHPP demand and dust suppression demand exceed water balance estimates by more than 20%.</p>	<p>Investigate the cause of the discharge and modify the water management system where necessary to prevent future uncontrolled discharges.</p> <p>Undertake an investigation in accordance with Unforeseen Impacts Protocol (Table 7.2).</p> <p>Undertake an assessment of site water data to review site water balance and determine reasons for additional water take and document findings of review. Develop, implement and review mitigation measures if appropriate.</p>

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

8.0 REPORTING AND REVIEW

8.1 Water Management Plan Review

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

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

As required by Schedule 5, Condition 5 of PA 10_0138, the Water Management Plan will be reviewed within three months of the submission of the Annual Review and updated to the satisfaction of the Director-General where necessary. The plan will also be reviewed within three months of an incident report (as specified in the consent conditions and the EPL), the completion of an independent environmental audit or any modification to the consent conditions. Following the review process, actions will be taken to address any recommendations, within three months of the finalised review.

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

8.2 Reporting an Incident

The *Protection of the Environment Operations Act 1997* (POEO Act) requires any material environmental incident (threatened or actual) to be reported immediately to each relevant authority as defined in section 148 of the POEO Act. In accordance with Schedule 5, Condition 8 of PA 10_0138, MCC shall notify the Director-General and any other relevant agencies of any incident that has caused, or threatens to cause, material harm to the environment at the earliest opportunity, and shall notify of any other incident as soon as practicable. Within 7 days of the date of the incident, MCC shall provide the Director-General and any relevant agencies with a detailed report on the incident and such further reports as may be requested.

	<h1>MAULES CREEK</h1>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

Further information on reporting procedures are provided in the Maules Creek Pollution Incident Response Management Plan.

8.3 Public Access to Information

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

8.4 Responsibilities

Table 8.1 shows responsibilities for implementation of various aspects of the Water Management Plan.

Table 8.1 Water Management Plan Responsibilities

Role	Responsibility / Accountability
Principal Contractor Environment Manager (Construction phase)	<ul style="list-style-type: none"> ▪ Prepare CEMP for construction period which is consistent with the requirements of the Water Management Plan. ▪ Undertake construction activities in accordance with the CEMP. ▪ Collect and maintain records and monitoring data as required under the CEMP.
Mine Manager	<ul style="list-style-type: none"> ▪ Ensure a site Water Management Plan is prepared, implemented & maintained. ▪ Ensure water management projects are planned and budgeted for. ▪ Ensure adequate storage is available to enable ongoing production through wet & dry climatic conditions. ▪ Manage implementation of water management improvement projects. ▪ Ensure that water is managed in compliance with the Water Management Plan. ▪ Ensure water storage dams are designed in accordance with this Water Management Plan. ▪ Design, budget for & arrange the construction of sediment, erosion control & mine water drains & dams ▪ Communicate the Water Management Plan to the Project Management team and other relevant stakeholders. ▪ Ensure the Mine Life Plan addresses water management. Specifically plan to ensure that: <ul style="list-style-type: none"> - Adequate storage is available to enable ongoing production through wet and dry climatic conditions; - Contingencies are in place for climatic extremes; - Interactions with tailings strategies are understood and planned for; - Closure planning is incorporated. ▪ Ensure that planned infrastructure is in compliance with the Water Management Plan. ▪ Communicate the Water Management Plan to Planning team. ▪ Incorporate Mine Life Plan surface and ground water management into short and medium term plans. Implement short and medium term plans, specifically ensure that: <ul style="list-style-type: none"> - The open cut is protected from sudden inrushes of water. - Adequate room is planned for pump setup and in pit water management. - Contingency plans are in place for climatic extremes.

	<h1>MAULES CREEK</h1>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Role	Responsibility / Accountability
	<ul style="list-style-type: none"> ▪ Ensure that water is managed in compliance with the Water Management Plan. ▪ Ensure planned maintenance schedules are implemented to maximise the availability of fixed and mobile pumps in the mining area. ▪ Ensure all water pipelines & control structures in the maintenance area are regularly inspected, maintained & promptly repaired. ▪ Ensure contingency plans for climatic extremes are adhered to. ▪ Communicate the Water Management Plan to Maintenance team.
CHPP Manager	<ul style="list-style-type: none"> ▪ Ensure that water is managed in compliance with the Water Management Plan. ▪ Ensure all water pipelines & control structures in the CHPP and Coal Loader catchment area are regularly inspected, maintained & promptly repaired. Specifically: <ul style="list-style-type: none"> - Prevent spills, leaks and unlicensed discharges. - Maintain adequate dewatering capability for high rainfall events. - Ensure systems to protect against sudden inrushes of water are fully operational at all times. - Maintain storage capacity in runoff capture dams. - Prevent spills, leaks and unlicensed discharges. - Ensure efficient recycling and preferential use of mine water. ▪ Ensure water supply meets supply demands of the CHPP. ▪ Ensure all storages are maintained and operated in accordance with the Environmental Protection Licence ▪ Ensure contingency plans for climatic extremes are adhered to. ▪ Communicate the Water Management Plan to CHPP team.
Environment Manager	<ul style="list-style-type: none"> ▪ Preparation, implementation & maintenance of the site Water Management Plan. ▪ Review CEMPs for consistency with the Water Management Plan. ▪ Advise the Project Manager on water management control & planning requirements. ▪ Prepare site water balances to define water use, storage & discharges; and to monitor and forecast site water management needs. ▪ Arrange the inspection & maintenance of clean, sediment, erosion control & mine water drains & dams. ▪ Communicate requirements for incident reporting to Project team. ▪ Advise Operations Managers on water metering requirements. ▪ Design, implement and maintain the water monitoring program. ▪ Report on and communicate performance against water plans and targets. ▪ Audit record report.

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

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MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

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	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

APPENDIX A

REGULATORY CORRESPONDENCE

	<h1>MAULES CREEK</h1>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN



Development Assessment Systems & Approvals
Mining & Industry Projects
 Contact: Stephen O'Donoghue
 Phone: 0477 345 626
 Email: stephen.o'donoghue@planning.nsw.gov.au

Mr Daniel Martin
 Environmental Manager – Maules Creek Coal
 Whitehaven Coal Limited
 PO Box 56
 BOGGABRI NSW 2382

Dear Mr Martin

Maules Creek Coal Mine (MP 10_0138)
Staged approval of the Water Management Plan

I refer to the revised Water Management Plan (Edition 1, Revision 2 dated April 2013) for the Maules Creek Coal Project. The Department has completed its review and considers the plan complies with the applicable conditions of approval, and provides a sound basis for the management of water quality impacts at the Maules Creek Coal Mine for the construction stage of the project. Accordingly, the Director-General has approved the Water Management Plan for the construction stage of the project.

However, the Water Management Plan will need to be further revised and submitted for approval prior to mining operations commencing (that is prior to the box cut being developed) including:

- detailed baseline data on hydrology across the downstream drainage system of the Namoi river floodplain from the mine site to the Namoi river;
- finalising groundwater/ piezometer monitoring locations and target monitoring depths in consultation with NSW Office of Water (this needs to be completed as a priority and at least prior to end July 2013 to ensure baseline monitoring data is collected as soon as possible);
- integration and consistency with the final Leard Forest Mining Precinct Water Strategy;
- commitment for and installation of monitoring of discharge volumes from the site;
- program for monitoring and assessing the interconnectivity between alluvial and bedrock aquifers;
- program to monitor background changes in groundwater quality and yield against mine induced changes;
- providing further clarification and details of monitoring methodology and locations, and performance criteria and triggers for assessing riparian vegetation health, impacts on GDE and downstream flooding impacts;
- agreement on the extent of the private bore census and monitoring outside the predicted groundwater draw down zone;
- any relevant revisions following review by SEWPaC;
- relevant requirements related to rehabilitation (final void, reinstatement of drainage lines, management of sodic and dispersible soils) to be reviewed and updated as necessary following approval of the Rehabilitation Management Plan by DRE.

Department of Planning and Infrastructure, Mining and Industry Projects, GPO Box 39, SYDNEY NSW 2001
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MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

2

In addition it is noted that the groundwater model predicts that the volume of groundwater take from the Permian porous rock aquifer would exceed current licensed allocations under the *Water Management (WM) Act* by year 5 of mining operations, subject to ongoing validation and calibration of the model. In accordance with statutory requirements under the WM Act, Maules Creek Coal will need to ensure that appropriate licences are obtained prior to the take of water.

Should you have any enquiries in relation to the above, please contact Stephen O'Donoghue.

Yours sincerely

DKilto 26/4/13

David Kilto
Director
Mining & Industry Projects
as the Director-General's nominee

	<h1>MAULES CREEK</h1>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN



**Office of
Environment
& Heritage**

Date: 8 May 2013
 Our reference: DOC13/20173
 Contact: Renee Shepherd
 02 6883 5358

Nathan Cooper
 Senior Environmental Scientist
 Hansen Bailey
 6/127-129 John Street
 Singleton NSW 2330



Dear Mr Cooper

Re: Office of Environment and Heritage comments on the Maules Creek Water Management Plan

I refer to your email requesting feedback from the Office of Environment and Heritage on the Maules Creek Water Management Plan.

OEH believes that two of the conditions in the Project Approval granted by the Planning Assessment Condition have not been adequately addressed by the Water Management Plan, namely:

1. performance criteria, trigger levels and related monitoring actions have not been developed to investigate any downstream flooding impacts associated with the project; and
2. performance criteria, trigger levels and related monitoring actions have not been developed to investigate any impacts on stream and riparian health associated with the project.

In addition, OEH recommends that trigger levels should be adopted to investigate potentially adverse impacts on the condition of the *Melaleuca* species that are present as a result of the project.

Any monitoring that is undertaken to determine impacts of the project should be compared against control sites – that is, sites that are not impacted by the Project.

Further detail on these issues is provided in **Attachment A**.

If you have any questions regarding this matter please contact Renee Shepherd on 02 6883 5358.

Yours sincerely

ROBERT TAYLOR
 Manager, Environment and Conservation Programs
 Regional Operations

Attachment A: Maules Creek Water Management Plan comments

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	<h1>MAULES CREEK</h1>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN



Catchment Management Authority Namoi



14th January 2013

Maules Creek Coal Pty Ltd
 PO Box 56
 BOGGABRI NSW 2382
 Attention Mr Daniel Martin, Environment Manager

Dear Daniel

Re: Maules Creek Coal Project – Water Management Plan

As per Project Approval (PA 10_0138) for the above project, Schedule 3 condition 40 requires Maules Creek Coal to consult with Namoi CMA during the preparation of the Water Management Plan.

Namoi CMA received the draft Water Management Plan on the 19th December 2012 just prior to the Christmas / New Year holiday break, consequently work on the review did not commence till early January 2013.

Namoi CMA is aware of the requirements in condition 40, including the requirements to prepare a Site Water Balance, Surface Water Management Plan, Groundwater Management Plan and a Leard Forest Mining Precinct Water Management Strategy.

The following comments are provided in relation to the above sections of the Water Management Plan. Namoi CMA will leave any comments on the Groundwater Management Plan to the NSW Office of Water.

Surface Water Management Plan

Namoi CMA is satisfied with the baseline data supplied for both water quantity and quality.

Namoi CMA is also satisfied with the planned Site Water Management System including the proposed water management infrastructure, erosion and sediment controls, clean and mine water management systems, emplacement and final landform water management proposals.

Namoi CMA has concerns over the design of the sediment dams and the potential for off site discharges from these dams. Section 2.3.2 states that the sediment basin settling zone volume is based on a 90th percentile 5-day duration rainfall depths. The 90th percentile referred to in this statement is from the Landcom 2004 Blue book and refers to very wet periods, whereas 90th percentile in the rest of the Water Management Plan is for dry periods, which results in some confusion that needs to be clarified for consistency.

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MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Namoi CMA is partially satisfied with the proposed performance criteria. The draft Water Management Plan makes no mention of the targets, triggers and performance indicators for investigating adverse impacts associated with downstream flooding or with loss of riparian vegetation, as per condition 40 (a).

Namoi CMA is also satisfied with the proposed monitoring program for the surface water management plan as detailed in section 2.5.

Site Water Balance

Namoi CMA finds this section confusing and overly complex. Appendix B provides some additional detail and clarification.

Namoi CMA agrees with the 4 inflows and 5 outflows as stated in section 3.1 Overview. However, section 3.2 Water Sources and Uses, details 6 water sources. Namoi CMA believes there are really only 3 water sources, rainfall and runoff, Groundwater inflow and Namoi River water licence, that supply significant amounts of water for mine operations. This assertion is supported by Appendix B Water Sources.

Section 3.2.1 Rainfall Runoff needs to be clarified as to whether runoff from disturbed areas that is collected in sediment dams is re-used on site or released from the site. Table 2.4 indicates that substantial volumes will be pumped back to other storages while other sections indicate runoff volumes will be released from the site.

In regard to section 3.3 Forecast Simulation Results, Namoi CMA believes that this section is useful from an operational perspective to determine the likely volumes contained in the mine water dam and the in pit areas at any time over the initial 5 year period.

Namoi CMA understands that due to the number of iterations from the water balance model that it is difficult to produce the results a meaningful manner, however a simple table with inflow and outflow balances along with the net water requirements for median and above / below average conditions would be beneficial in this section.

Table 3.2 indicates that the sediment dams (combined) will spill for in median and wet years for between 19 and 40 days with significant volumes of water. The sediment dams are likely to be exposed to high sediment loads in the first 5 years as there is little rehabilitation occurring within this time. Namoi CMA is concerned with the predicted spill days and volumes and the potential high sediment loads within the spilling waters. Namoi CMA believes that the spilling waters will have extremely high sediment loads compared to receiving water even during high flow events. Namoi CMA recommends that the predicted spills days and volumes be reduced through larger and more sediment dams to better protect receiving waters and aquatic ecosystems.

Table 1.1 in section 1.1 of the Water Management plan refers to the condition 40 requirements and where those requirements are addressed in the Water Management Plan. Under requirement (a) Site Water Balance there are a number of condition requirements including:

- that site water balances be prepared for each calendar year. Table 1.1 indicates that this is addressed in section 4. Following reading section 4, I failed to find the yearly site water balances,

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MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

- that a program to validate the surface water model, including monitoring discharge volumes from the site and comparison of monitoring results with modelled predictions be prepared. Table 1.1 indicates that this is addressed in section 4. Following reading section 4, I failed to find the validation program.

Leard Forest Mining Precinct Water Management Strategy

Following reading the requirements of condition 40 (d) for the above strategy and section 4.2.2 of the Water Management plan, it would appear that the requirements have not been addressed within the Water Management Plan at this time. It is hoped that further work will be done on this strategy in future.

Conclusion

Namoi CMA believes that the draft Water Management Plan should be improved through providing additional detail especially with regard to the Site Water Balance along with some additional clarification regarding the Surface Water Management plan. Namoi CMA looks forward to receiving a modified Water Management Plan.

If you wish to discuss this matter further please do not hesitate to contact Glenn Bailey on 6742 9204.

Yours Sincerely

Glenn Bailey, Catchment Coordinator
Namoi Catchment Management Authority



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN



Department of
Primary Industries
Office of Water

Whitehaven Coal
PO Box 56
Boggabri NSW 2382

Attention: Daniel Martin

Contact Christie Jackson
Phone 02 6701 9652
Mobile 0459 805 979
Fax 02 6701 9682
Email christie.jackson@water.nsw.gov.au
Our ref ER21096

Dear Mr Martin,

Maules Creek – Water Management Plan

I refer to your letter dated the 11 December 2012 seeking comment on the Draft Water Management Plan (WMP) for the Maules Creek Coal Project. The Office of Water apologises for our delayed response. The Office of Water comments are outlined below.

Issue 1. Site Water Balance and Licences Required.

The WMP should include a single collation (table) of actual water volume requirements for the whole project i.e. coal washing volumes, dust suppression, truck washing, ablutions etc listed in the report. Appendix B lists formulas on dust suppression for haul roads and presents a graph for the Coal Handling Processing Plant Water Demand. Total maximum projected water use data would be best presented in a table in the main body of the report.

Not all of the licences owned by the mine are listed in the report including volumes and water sources. This information should also be presented in a single table listing existing licence numbers and volumes.

Groundwater licences currently held by the proposed mine include the following:

Holder	Licence Number	Unit Shares	Water Source	Comments
ASTON COAL 2 PTY LTD	90AL801900 WAL 13050	3,000	Lower Namoi Regulated River Water Source	Regulated High Security. Attached to 90WA801901
ASTON COAL 2 PTY LTD	90WA801901			Water Supply Works
ASTON COAL 2 PTY LTD	90AL826924 WAL 29588	300	Gunnedah – Oxley Basin MBD Groundwater Source	Attached to 90CA826925
ASTON COAL 2 PTY LTD	90CA826925			Bores are currently located away from the mine site. Will require a dealing to point it to a CA located on the mine site

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MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

ASTON COAL 2 PTY LTD	90AL822411 WAL 29467	6	Gunnedah – Oxley Basin MBD Groundwater Source	Attached to 90WA822412
ASTON COAL 2 PTY LTD	90WA822412			Water Supply Works

The combination of usage requirements, existing licensed water availability, and sources of onsite mine water availability such as groundwater seepages to the mine void, would clearly demonstrate if there are any short fall in the actual water requirements and any shortfall as to what is currently licensed and what needs to be licensed.

Information regarding water use volumes provided in the document is not clear. In section 3.2 "Usages" are identified but no projected volumes of usage are given. Consequently it is difficult to determine if sufficient volumes are held in current licence volumes, if the proposed rainfall harvested will be adequate, or if extra water will be required.

The maximum annual groundwater inflow to the void is estimated to be up to 1064 ML (4 ML/day) (p 81); sufficient licenced volumes will be required.

Groundwater Modelling indicates that the mine will impact on the Upper Namoi Alluvial Aquifers to the order of 50 to 128 ML/yr; licences to account for this volume of impact, within the appropriate water source, will be required.

The NSW Aquifer Interference Policy states on p7 Section 2.1 *"It is the proponent's responsibility to ensure that the necessary licences are held with sufficient share component and water allocations to account for all take from a groundwater or surface water source as a result of an aquifer interference activity, both for a the life of the activity and after the activity has ceased."*

The Water Management Report requires more information to show that sufficient licenses are held to meet the water demands of the project.

Issue 2. Groundwater Monitoring Bores

The location and depth of any additional groundwater monitoring bores will have to be discussed with the Office of Water as to their adequacy. Table 4.3 of the WMP provides no estimate of bore depth and does not identify the targeted formations. Accurate stratigraphic cross sections need to be provided to determine the adequacy of the proposed monitoring bores.

Issue 3. Offsite Water Overflows

Page 42 Part 2 of the report states that when "rainfall events exceed the design standard, it is possible that the sediment dams may overflow with sediment concentrations that exceed the water quality objective of the Environment Protection Limit (EPL). Note however that such overflows are likely to occur during large rainfall events when background suspended solids concentrations in receiving waters are likely to be well above objectives". Off site water flows during large rain events need to be monitored to ensure that the water quality from the overflow water does not exceed the water quality of the receiving waters.

Issue 4. Reporting and review

As well as the monitoring results being made publically available on the Maules Creek website, an electronic copy in excel format of monitoring data must be made available to the local hydrogeologist in the Office of Water.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

Issue 5. Acronyms used

A list of acronyms used in the report would make for easier reading.

The Office of Water recommends the following:

- A Site Water Balance table be presented in the report which includes all operational water requirements, sources of water to meet the demand including existing licences their volumes and water sources, incidental water not currently licensed, impacts on other water sources. Any shortfalls or excesses must be accounted for.
- Additional monitoring bores locations, depths, etc be discussed with the Office of Water prior to implementation.
- Contingency plans be developed should the quality of offsite water flows exceed the water quality of receiving waters
- Electronic copies of annual monitoring results must be made available to the Office of Water.
- List all acronyms used in the report to aid understanding of the report.

If you require any further information please contact Christie Jackson on (02) 6701 9652 at the Tamworth Office.

Yours sincerely

Mark Simons
Acting Manager Major Projects, Mines and Assessment
21 February 2013



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

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**THE HON MARK BUTLER MP
MINISTER FOR CLIMATE CHANGE
MINISTER FOR THE ENVIRONMENT, HERITAGE AND WATER**

B13/1148

2010/5566

Mr Paul Flynn
Chief Executive Officer and Managing Director
Whitehaven Coal
PO Box R1113, Royal Exchange
SYDNEY NSW 1225

- 3 JUL 2013

Dear Mr Flynn

Maules Creek Coal Project (EPBC 2010/5566), Aston Coal 2, P/L

I am writing to you in relation to the Water Management Plan for the Maules Creek Coal Mine and other material submitted by your Executive General Manager, Mr Brian Cole, as required under conditions 20-22 of the approval decision dated 11 February 2013.

The Water Management Plan has been reviewed by officers of the Department of Sustainability, Environment, Water, Population and Communities (the department) and has been found to meet the requirements of the condition. I have considered the plan and advice from the department and I have decided to approve the Plan.

In approving the Maules Creek Water Management Plan, I understand that conditions 20, 21 and 22 of the approval decision will have been met. I am advised also, that you have received approval from the New South Wales Government for the construction phase of the project. I understand that construction of your proposal is now able to commence.

I note that in accordance with condition 40 of the project approval you must publish the management plan on your website within one month of this approval date. Under condition 36, if Aston Coal 2 seeks to act other than in accordance with the approved plans, a revised plan must be submitted for my approval.

In regard to condition 23 of the approval decision, I note that a report is currently due on 11 August 2013. This report relates directly to information from the approved surface and groundwater management plans. To ensure information for this report can incorporate data from bores that are not yet established, I have decided to change the timeframe for this condition. The revised timeframe for the report required to meet condition 23 is now twelve months from the date of approval (11 February 2014).

The department has an active monitoring program which includes monitoring inspections, desk top document reviews and audits. As part of this program we will be undertaking a review of our records to ascertain the present status of this project in relation to its conditions of approval. We will contact you again if we require further information.

Parliament House, Canberra ACT 2600

Telephone: 02 6277 7920

Facsimile: 02 6273 7330

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

APPENDIX B

WATER BALANCE MODEL DEVELOPMENT AND CALIBRATION

B.1 OVERVIEW

A computer-based simulation model (Goldsim) was used to assess the dynamics of the mine water balance under conditions of varying rainfall and catchment conditions during the first 5 years of operation of the Project. The Goldsim model dynamically simulates the operation of the water management system and keeps complete account of all site water volumes and representative water quality on a daily time step.

The model has been configured to simulate the operations of all major components of the water management system. The simulated inflows and outflows included in the model are given in Table B 1.

Table B 1 Simulated Inflows and Outflows to Mine Water Management System

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

B.2 CLIMATE DATA

A representative long-term rainfall sequence for the Project Boundary was obtained from the Bureau of Meteorology's SILO Data Drill. These data are derived by interpolation of recorded rainfall data between stations as described by Jeffrey *et al* (2001). Rainfall data from the SILO Data Drill is available from the late 1800s and is corrected for missing data and accumulated totals. Hence, this data is more reliable and easier to use for computer modelling than raw recorded rainfall data. Figure B 1 shows a comparison of mean monthly rainfall recorded at the Boggabri (Kanownda) rainfall station (No. 055076) from 1900 to 2010 the SILO Data Drill rainfalls. The comparison indicates that the SILO data provides a good representation of recorded rainfall data in the Project Boundary. The mean annual rainfall from the SILO data (589 mm) is within 2% of the mean annual rainfall from the Boggabri (Kanownda) station (577 mm).

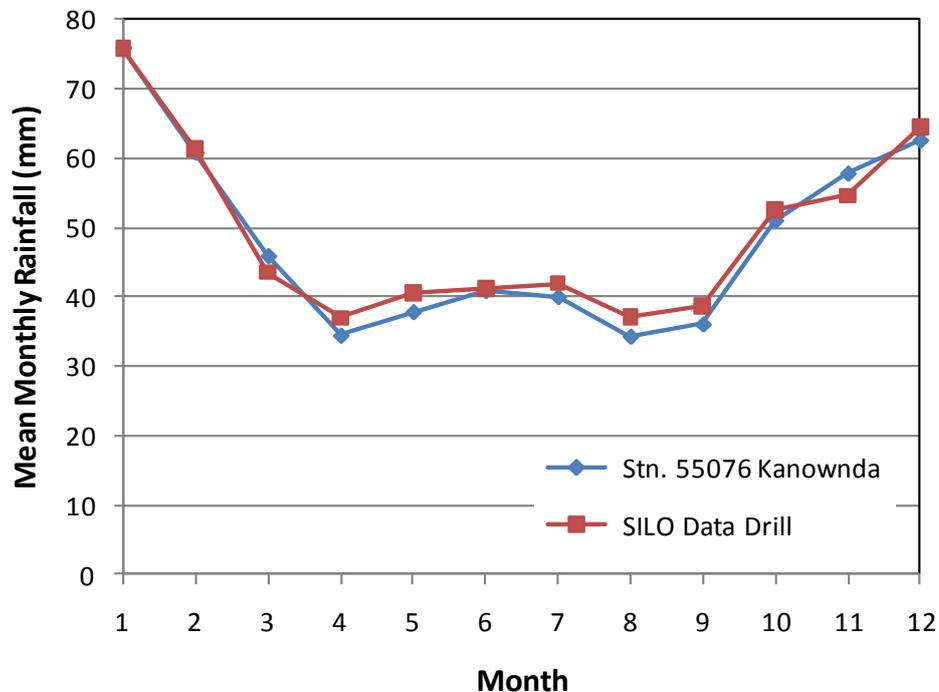


Figure B 1 Comparison of Mean Monthly Rainfalls from SILO Data Drill and Boggabri Kanownda (55076), 1900 to 2010

Synthetic historical rainfall and evaporation data for the Maules Creek site from the SILO Data Drill service (Jeffrey et al. 2001) was adopted to simulate the behaviour of the site water management system and for calibration of AWBM Parameters. Morton’s Lake evaporation was used to estimate evaporation loss from storages. Soil moisture evapotranspiration losses in the AWBM model were estimated using Morton’s Lake evaporation with an evapotranspiration factor.

Table A2 shows Morton’s lake evaporation estimates (Morton, 1983) for the area of interest which was adopted for the water balance model. Morton’s method is regarded as suitable for the estimation of lake evaporation in non-arid areas (Mulder, 1997).

The values shown in Table A2 were adopted to estimate evaporation from the Mine Water Dam, Raw Water Dam and sediment dams. For the Open Cut Pit, the values shown in Table A2 were factored by 0.7 to reflect the likely reduction in evaporation due to the depth of the open cut below surface level (ACARP, 2001).

Table B2 Mean Monthly Evaporation Depths from Storages

Month	Morton's Lake Evaporation, Mean Monthly (mm)
Jan	202
Feb	168
Mar	151
Apr	103
May	67
Jun	47
Jul	54
Aug	78
Sep	111
Oct	150
Nov	175
Dec	200
Total	1,505

B.3 SIMULATION METHODOLOGY

The GoldSim software (developed by GoldSim Technology Group) was used to simulate the water balance of the mine over the first 5 years of mine life. The model was configured as a dynamic forecast simulation using historical climatic data. This method allows the model configuration to change over the modelled mine life, reflecting changes in the water management system over time. Five different stages of the mine life (representing each of the first 5 years) were linked in the model to reflect variations over time such as catchments, ROM coal production and groundwater seepage inflows. The changes in the physical layout are represented in the mine stage plans given in Section 4.3.1.

To assess the effects of varying climatic conditions, the model was run for 106 realisations (with each realisation corresponding to the first 5 years of mine life) sampled from the historical climatic data set. A different rainfall input sequence was applied to each realisation. The first realisation adopted climatic data from 1900 to 1904, the second from 1901 to 1905 and so on through the 110 years of historical climatic data available from January 1900 to December 2009. A statistical analysis of the resultant 106 realisations was then undertaken to assess the behaviour of the various storages over extended dry and wet periods, reflecting the full range of climatic conditions experienced in the last 110 years.

In interpreting the results of a forecast simulation, it should be noted that this simulation type provides a statistical analysis of the water management system's performance over its 21 year mine life, based on different climatic conditions. The 50th percentile probability represents the median results, the 1st and 10th percentile represent 1% and 10% exceedance (i.e. wet conditions) and the 90th and 99th percentile results represent 90% and 99% exceedance (i.e. dry conditions). There is an 80% chance that the result will fall within the 10th and 90th percentiles and a 98% chance the result will fall between the 1st and 99th percentiles. Importantly, the percentile trace shows the percentile chance of a particular value on each day, and does not represent continuous results from a single model realisation e.g. the 50th percentile trace does not represent the model time series for median climatic conditions.

B.4 OPERATING RULES

The operational strategy for the mine's water management system is represented in the site water balance model as a set of pumping rules that describe the interactions between the various water storages. Table B3 provides a summary of the adopted pumping rules for the water balance model, which are based on the following operational strategy:

- The Mine Water Dam is used as the first priority storage for supply of all mine site demands, excluding the vehicle wash-down demand which is exclusively drawn from the Raw Water Dam;
- Water accumulating in the active mining area, from groundwater and surface water runoff, is pumped to the Mine Water Dam in preference to the out of pit storages. The pump rate increases with the volume of water within the Open Cut Pit;
- Runoff accumulating in the sediment dams is pumped to the mine water dam. The adopted pump rate for the sediment dams was selected to ensure that the dams could be dewatered within 5 days after a runoff event, in accordance with DECC (2008); and
- Pumped inflows from all storages cease when the Mine Water Dam reaches its maximum operating volume (MOV). The MOV has been selected to ensure no spills from the Mine Water Dam.

This operational strategy is designed to meet the objectives of the water management system outlined in Section 4.2.

Table B3 Adopted Pumping Rules for Water Balance Model

Pump From	Pump To	Pump Rate (ML/d)	Pumping Rule (All pumps cease when Mine Water Dam Volume > MOV)
Open Cut Pit	Mine Water Dam	7 ML/d	Pit stored volume < 100 ML
		14 ML/d	Pit stored volume > 100 ML
		21 ML/d	Pit stored volume > 200 ML
SD6	Mine Water Dam	5 ML/d	
SD2	Mine Water Dam	17 ML/d	

Pump From	Pump To	Pump Rate (ML/d)	Pumping Rule (All pumps cease when Mine Water Dam Volume > MOV)
SD3	Mine Water Dam	11 ML/d	
SD4	Mine Water Dam	5 ML/d	
SD5	Mine Water Dam	3 ML/d	

MOV = Maximum Operating Volume = 403 ML

B.5 WATER DEMANDS

a. Haul Road Dust Suppression

The daily haul road dust suppression demand was calculated using the historical rainfall and evaporation data at the mine site. The following formulas were used to calculate the daily demand:

- Daily Haul Road water demand = $\max(0, \text{Evaporation} - \text{Rainfall}) \times \text{Haul Road Surface Area}$; and
- Haul Road Surface Area = Haul Road Length x 30 m.

The haul road length varies from about 2 km in the early stages of mining to a maximum length of about 13.8 km in the final stage of mining.

b. Coal Preparation Plant

The adopted water demand for the CHPP was based on a water requirement of 140 L/ROM tonne for washed coal, and 74 L/ROM tonne for bypass coal, with production increasing from 2.9 Mtpa in Year 0 to 13 Mtpa by Year 4. A 'worst-case' of 25% bypass and 75% washed coal was adopted. The adopted production schedule is as follows:

- Year 1 = 2.889 Mtpa
- Year 2 = 8.131 Mtpa
- Year 3 = 9.625 Mtpa
- Year 4 = 13.000 Mtpa
- Year 5 = 12.738 Mtpa

The adopted time series of CHPP demand is shown in Figure B2.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

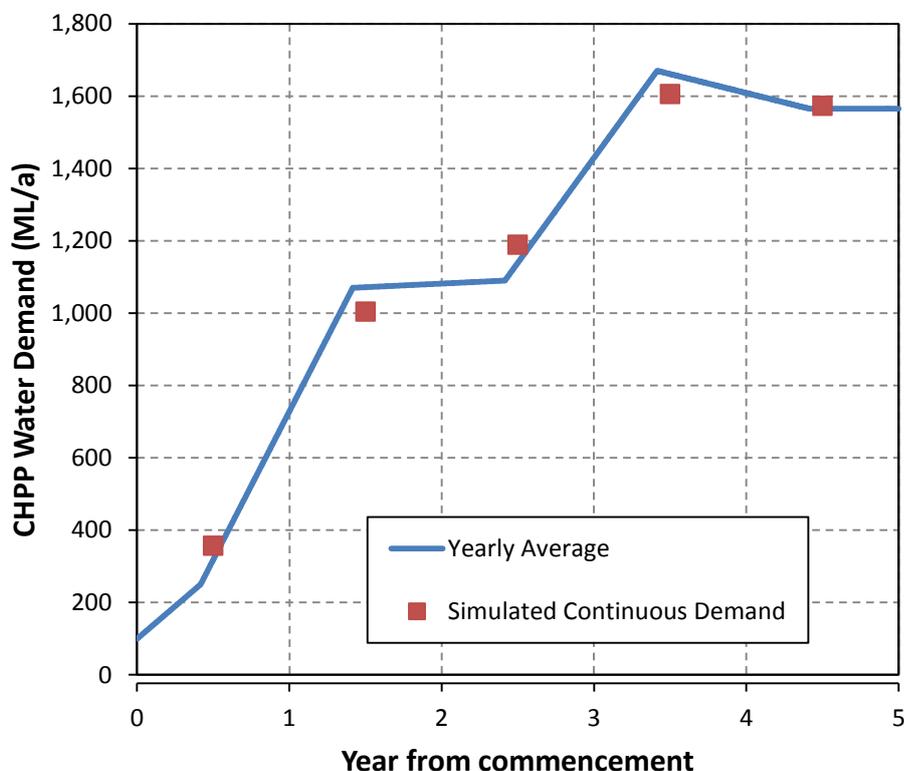


Figure B2 Adopted Time Series of CHPP Water Demand

c. Vehicle Wash-down

The water demand for the vehicle wash-down area was adopted at 91 ML/a (~0.25ML/d) based on advice from the Project personnel.

d. Potable Water

Potable water demands for the Project will be negligible compared to the process water demands and have not been included in the water balance model.

B.6 WATER SOURCES

a. Groundwater Inflows

Figure B3 shows the adopted time series of groundwater inflows to the Open Cut Pit over the 21 year life of the Project. The groundwater inflows shown in Figure B3 were taken from modelling undertaken by the project groundwater consultant (AGE, 2011). The volumes shown in Figure B3 are estimated pumpable volumes after subtraction of 0.1 ML/d to allow for evaporation from the coal face.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

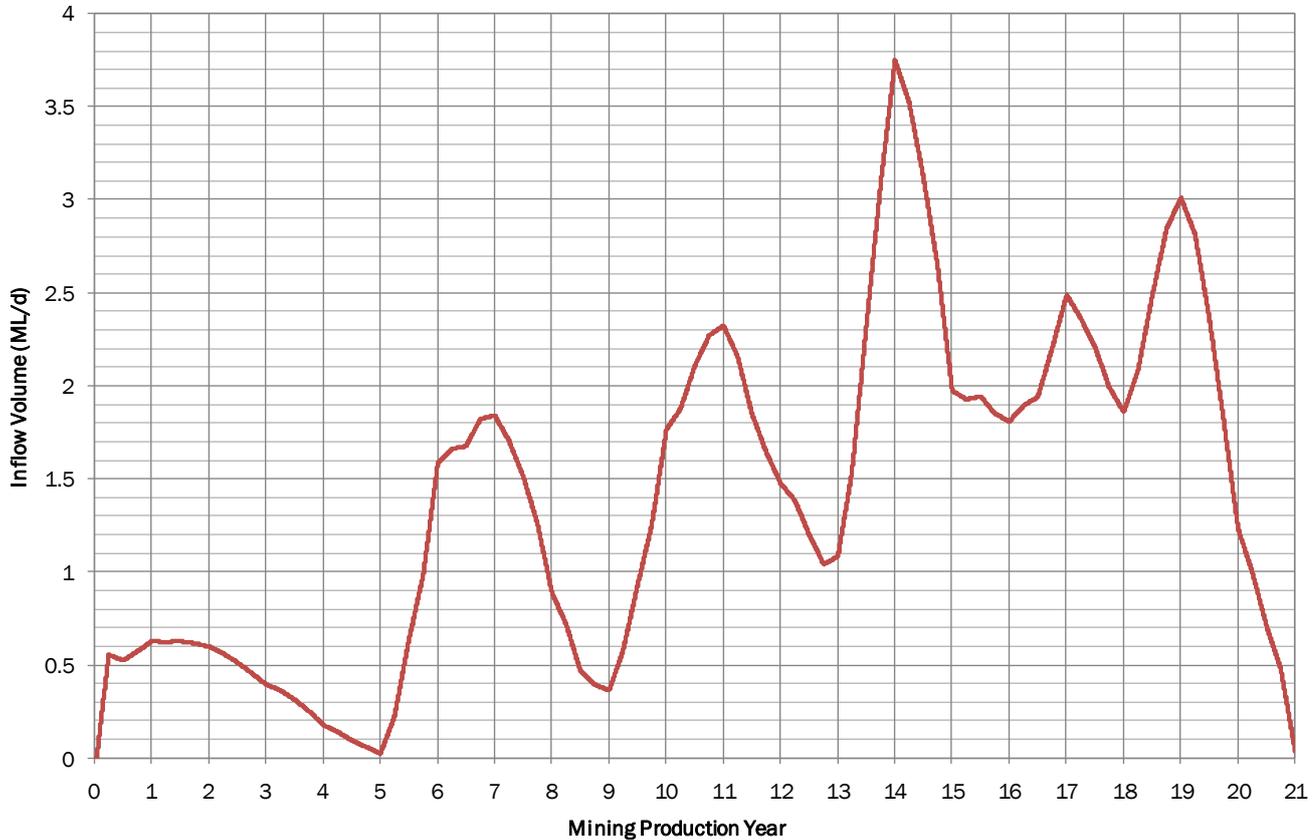


Figure B3 Adopted Time Series of Groundwater Inflow to Open Cut Pit

b. Catchment Runoff

Adopted Rainfall-Runoff Model

The AWBM model (Boughton & Chiew 2003) was used to estimate runoff volumes from on-site catchments, based on available rainfall and evaporation data. AWBM is a saturated overland flow model which allows for variable source areas of surface runoff. The model uses daily rainfalls and estimates of catchment evapotranspiration to calculate daily values of runoff using a daily water balance of soil moisture. The model has a base flow component which simulates the recharge and discharge of a shallow groundwater store. Runoff depth calculated by the AWBM model is converted into runoff volume by multiplying by the contributing catchment area. The various parameters of the AWBM model are shown in Table B 4.

Table B4 Summary of AWBM Model Parameters

Parameter Specification	Description
Partial Area Fractions	Parameters A1, A2 & A3. Fraction of catchment area represented by surface storages No. 1, 2 & 3.
Soil Store Capacities	Parameter C1, C2 & C3. Soil moisture storage capacities for smallest store (No. 1), middle store (No. 2) and largest store (No. 3).
Base Flow Index	Parameter BFI. Proportion of runoff directed to base flow store.
Daily Base flow Recession Constant	Parameter K. Rate at which water discharges from base flow store.

To estimate catchment runoff inflows to the mine water management system, separate AWBM model parameters were developed for the following catchment types:

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

Details of the available data for calibration of the AWBM model and the adopted model parameters for each catchment type are provided below.

AWBM Model Calibration

Streamflow data was recorded at two monitoring stations along local watercourses draining the Project Boundary in the early 1980s (LMJ, 1986). The locations of the historical streamflow monitoring stations are shown in Figure 2.3. Station LMJ 1 is located along Back Creek near the downstream boundary of the Project Boundary and has a catchment area of approximately 6,600 ha. Station LMJ 5 is located in the upper reaches of a tributary draining the Project Boundary and has a catchment area of approximately 300 ha.

A total of 12 runoff events were recorded at the two stations between January 1983 and December 1984. Summary details of the recorded runoff events are shown in Table B5. Due to the small number of runoff events available at each of the monitoring stations, the data from both the LMJ 1 and LMJ 5 sites was combined to produce a single data set against which to calibrate the AWBM model for site catchments.

The AWBM model was calibrated using the average surface storage capacity approach described by Boughton & Chiew (2003). The adopted average storage capacity was 120 mm.

Figure B4 shows a comparison of recorded and simulated event runoff volumes for the runoff events listed in Table B5.

Table B5 Recorded and Simulated Runoff Events from On-site Catchments

Event Date	Event Rainfall (mm) ^a	Event Number	Recorded Runoff Depth (mm)		Simulated Runoff Depth (mm)
			LMJ 1	LMJ 5	
3/01/1983	33.0	1	0.5	nd	2.7
5/02/1983	12.5	2	0.5	nd	0.0
24/05/1983	14.5	3	3.7	nd	3.6
28/05/1983	23.5	4	6.2	nd	2.4
2/01/1984	6.0	5	nd	>0	0.0
16/01/1984	6.0	6	nd	4.0	2.6
28/01/1984	63.0	7	10.5		6.5
16/02/1984	28.5	8	nd	0.2	2.0
22/02/1984	30.5	9	nd	4.8	2.9
27/07/1984	87.0	10	nd	17.0	19.6
6/11/1984	33.0	11	nd	2.5	2.5
12/12/1984	55.0	12	nd	1.0	5.5

^a Recorded on site nd = No data

The adopted AWBM model parameters and volumetric runoff coefficients for the three catchment types are shown in Table B6. Note that the volumetric runoff coefficient for on-site natural catchments is almost double the observed value for runoff in Maules Creek. The lower value for Maules Creek may reflect the effect of processes that operate at the larger catchment scale, such as streambed storage and infiltration, which are not observed in the small on site catchments.

AWBM model parameters for compacted areas were selected by adopting values to provide a volumetric runoff coefficient similar to typical values for urban catchments which have similar characteristics.

AWBM model parameters for spoil catchments were adopted from a previous study of runoff from disturbed mine catchments in the Hunter Valley region (ACARP, 2001). For spoil placed within the Open Cut Pit, it was assumed that the base flow component of spoil runoff (20% of total runoff) percolated into the Open Cut Pit even if surface flows were directed away from the pit.



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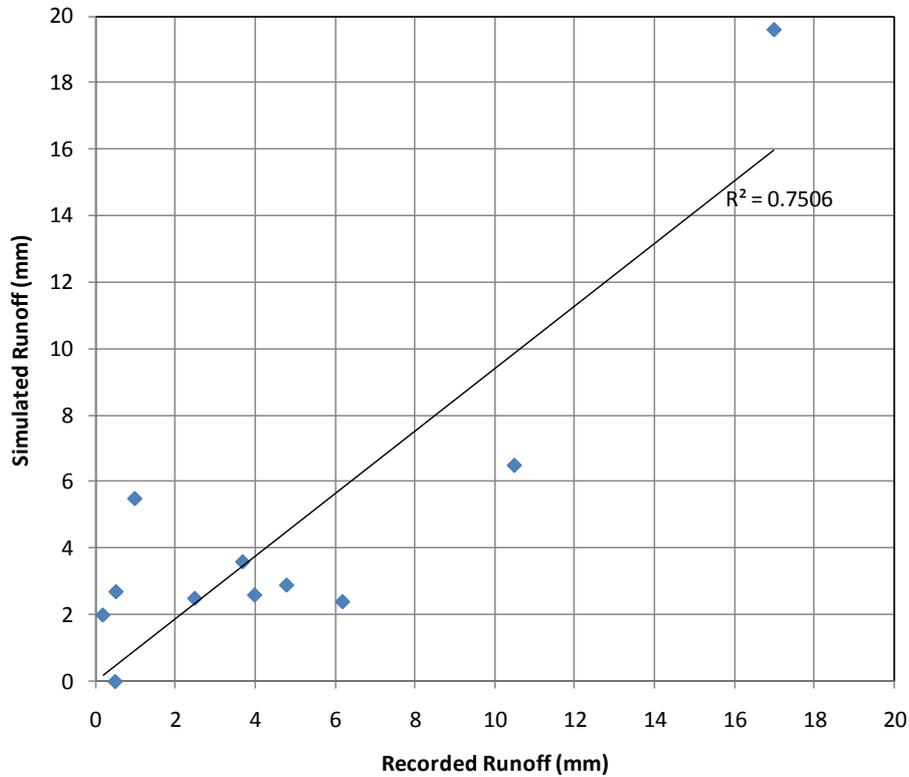


Figure B4 Comparison of Recorded and Simulated Surface Runoff for Back Creek and Site Tributary Catchment, 1983/84

Table B6 Adopted AWBM Parameters

AWBM Model Parameter		Natural	Compacted	Spoil
Partial Areas	A1	0.134	0.33	0.1
	A2	0.433	0.33	0.3
Base flow index	BFI	0	0	0.2
Surface Store Depth (mm)	C 1	9	2	15
	C 2	91	10	50
	C 3	183	30	110
Base flow recession constant	Kb	0	0	0
Volumetric Runoff coefficient for period 1900 - 2010	RC	9.3%	42%	10.8%

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		Issue:	2
		Last Revision Date:	March 2019
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Catchment Areas

Table B7 shows the adopted catchment areas draining to the various mine site storages represented in the water balance model. Catchment types are represented as follows:

- **Spoil.** Overburden emplacement;
- **Pit.** Pit floor;
- **Roads/Hardstand.** Roads, coal stockpiles and mine infrastructure areas;
- **Natural.** Undisturbed areas; and
- **Rehabilitated Spoil.** Fully rehabilitated areas.

Table B7 Catchment Areas and Land Types

Storage	Contributing Catchment (ha)				
	Rehabilitated Spoil	Spoil	Roads/ Hardstand	Natural	Mining Pit
All Years					
Raw Water Dam	0	0	7.7	3.2	0
Mine Water Dam	0	0	67.0	28.8	0
Sediment Dam 6	0	0	2.2	8.7	0
Highwall Dam 1A ^a	0	0	0	201.1	0
Highwall Dam 3 ^b	0	0	0	228.7	0
Highwall Dam 1B ^c	0	0	0	137.9	0
Highwall Dam 2	0	0	0	93.2	0
Year 1					
Mining Pit	0	0	2.1	131.1	97.3
Sediment Dam 2	0	105.0	6.7	179.3	0
Year 2					
Mining Pit	0	0	2.1	100.2	167.3
Sediment Dam 2	0	201.3	5.9	28.8	0
Sediment Dam 5	0	39.7	0.3	5.8	0



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Storage	Contributing Catchment (ha)				
	Rehabilitated Spoil	Spoil	Roads/ Hardstand	Natural	Mining Pit
Year 3					
Mining Pit	0	0	2.1	88.1	242.6
Sediment Dam 2	0	207.7	5.9	43.9	0
Sediment Dam 3	0	157.5	2.0	9.7	0
Sediment Dam 4	0	59.8	1.4	20.6	0
Sediment Dam 5	0	35.7	0.3	5.8	0
Year 5					
Mining Pit	0	0	2.0	55.0	336.7
Sediment Dam 2	0	220.3	5.9	22.4	0
Sediment Dam 3	61.4	132.4	2.0	0	0
Sediment Dam 4	44.2	37.7	1.4	0	0
Sediment Dam 5	17.0	15.5	0	0	0

^a Year 1 to 3

^c Year 5

^b Year 3 to 5

c. Raw Water

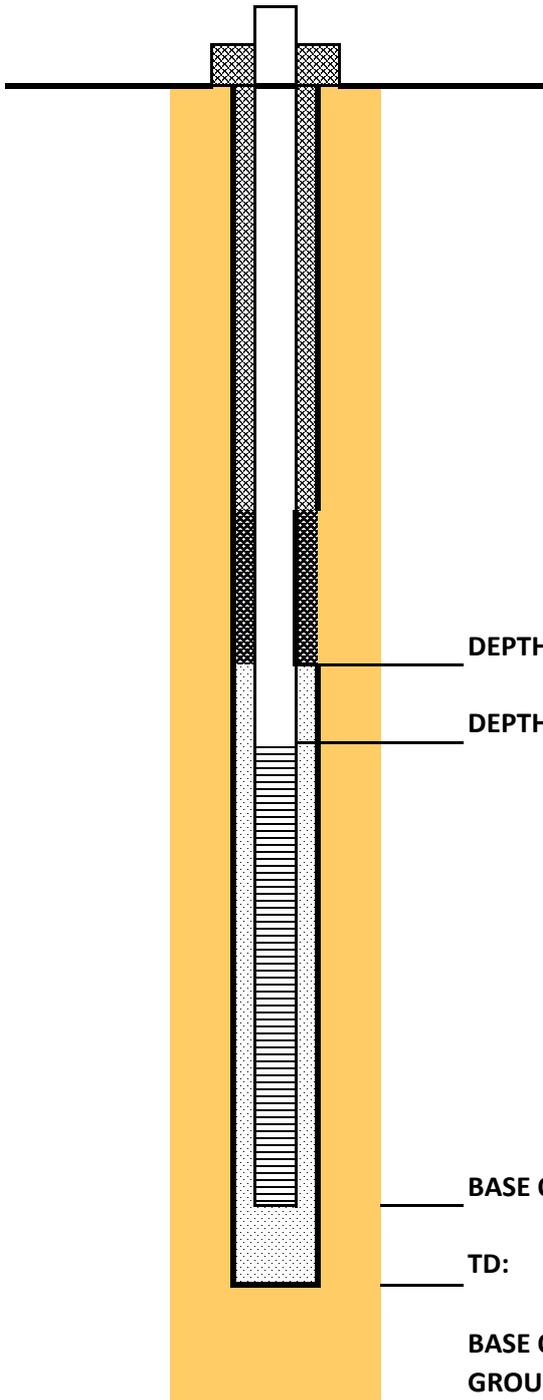
For the purposes of current investigations, the term 'raw water' refers to water imported from an external, offsite source that is required to sustain the nominated design production rate and associated operational demands for the Project. Any shortfall in mine water is made up from imported raw water – that is, during dry periods imported raw water is used to ensure that all operational demands are met. It is assumed that water collected on site is used before water is imported. Raw water, if required, will be pumped to the Raw Water Dam.

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		Last Revision Date:	March 2019
		Date Printed:	
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APPENDIX C

BOREHOLE CONSTRUCTION LOGS

BOREHOLE: BCM03



DEPTH OF BENTONITE SEAL: 5.5-6.5m

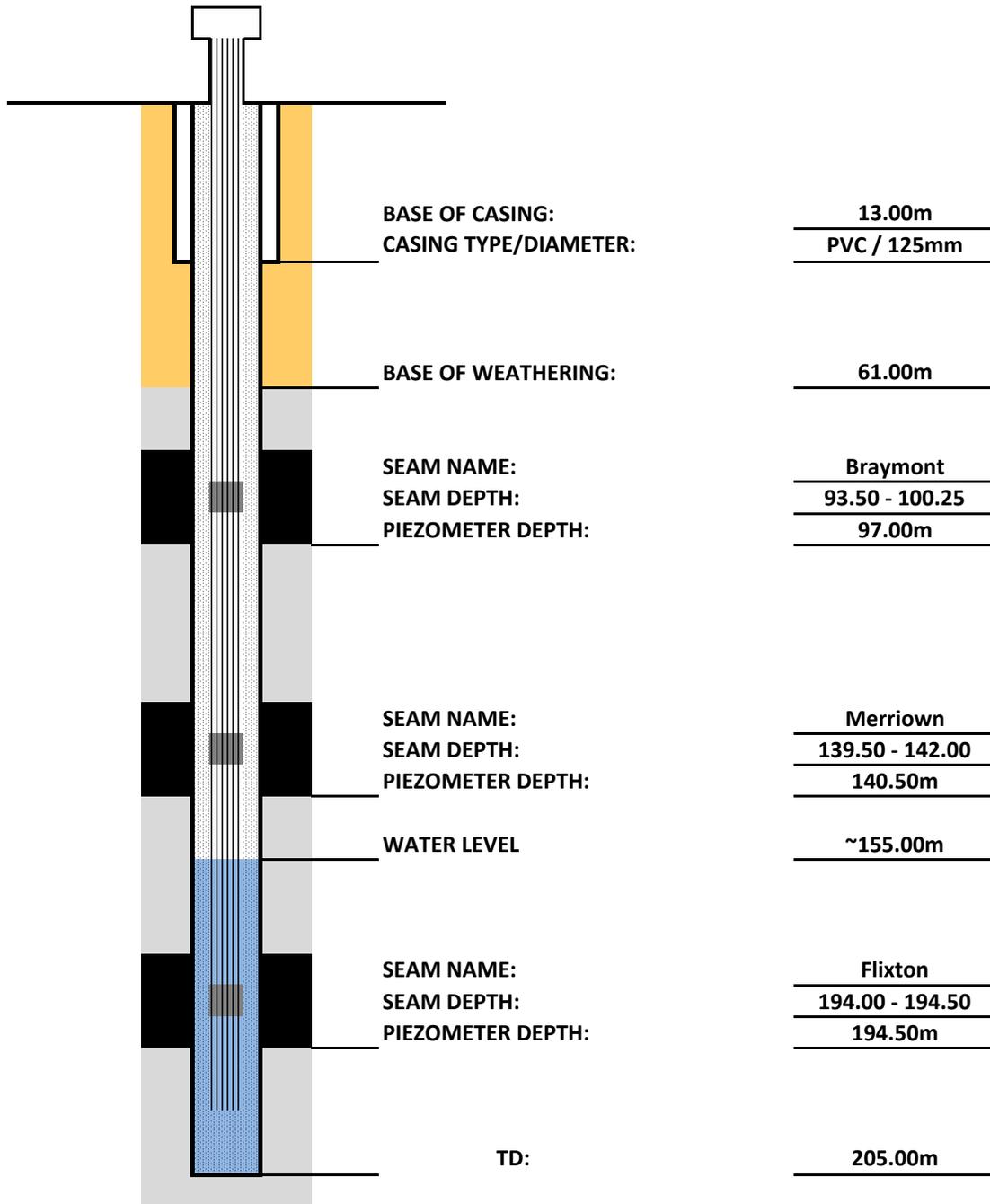
DEPTH OF SLOTTED INTERVAL: 6.75-9.75m

BASE OF STANDPIPE: 9.75m

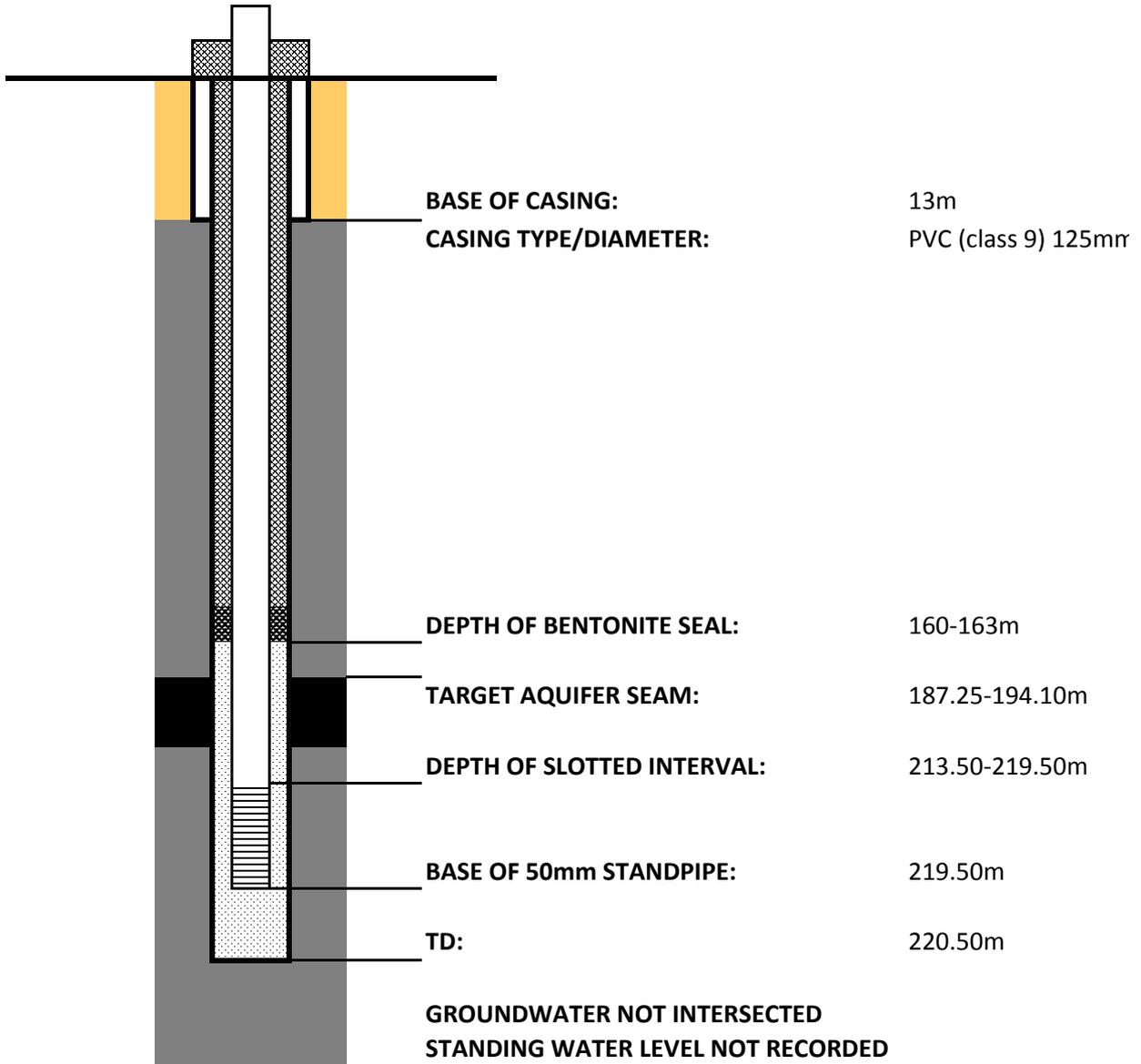
TD: 10.00m

**BASE OF WEATHERING NOT INTERSECTED
GROUNDWATER NOT INTERSECTED
STANDING WATER LEVEL NOT ENCOUNTERED
NO SURFACE CASING INSTALLED**

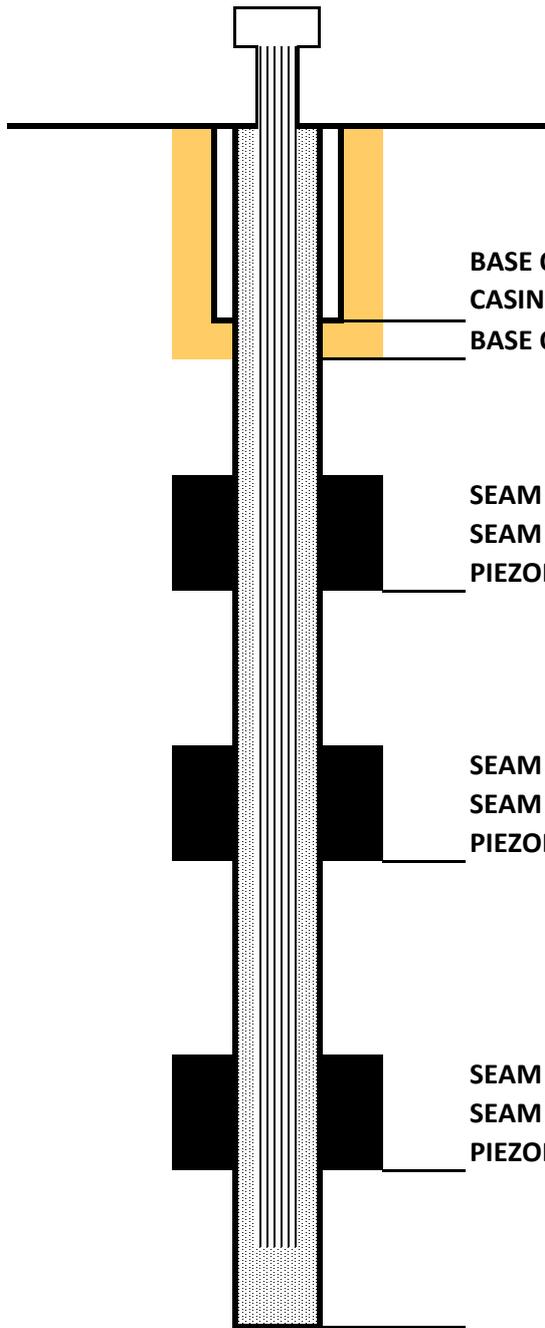
BOREHOLE: RB01



BOREHOLE: RB01A



BOREHOLE: RB02



BASE OF CASING: 6.00m
CASING TYPE/DIAMETER: PVC / 125mm
BASE OF WEATHERING: 19.00m

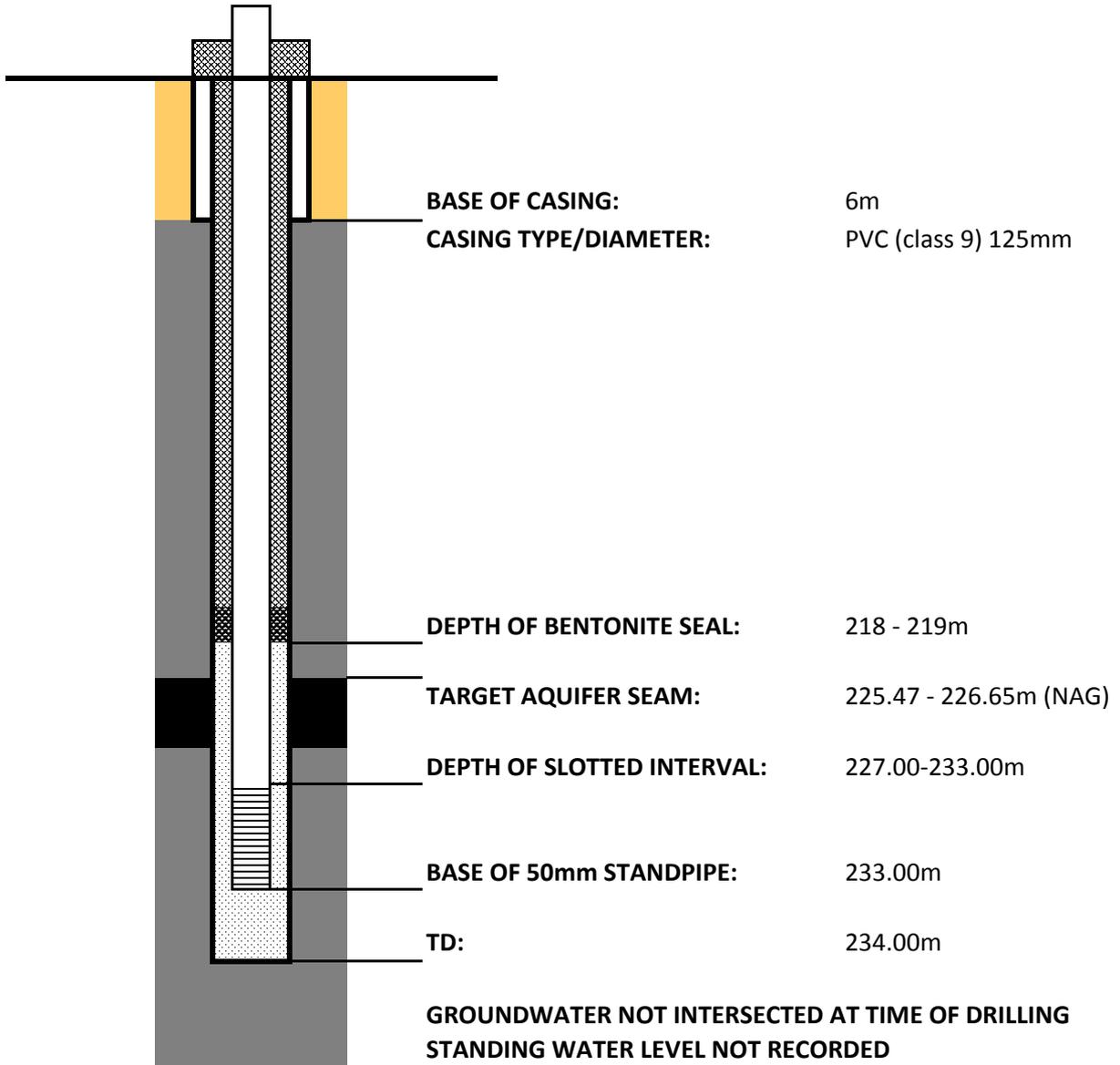
SEAM NAME: Braymont (BRD)
SEAM DEPTH: 106.82 - 114.45m
PIEZOMETER DEPTH: 110m

SEAM NAME: Merriown (MEA)
SEAM DEPTH: 160.37 - 163.23m
PIEZOMETER DEPTH: 162m

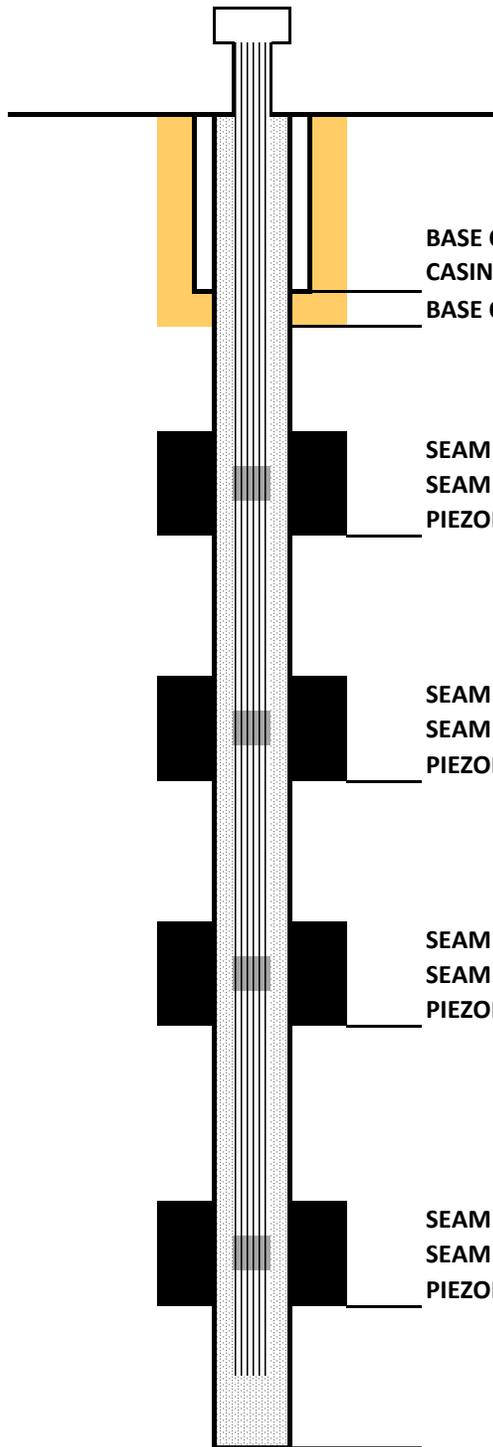
SEAM NAME: Nagero
SEAM DEPTH: 225.47 - 226.65m
PIEZOMETER DEPTH: 225m

TD: 270.00m

BOREHOLE: RB02A



BOREHOLE: RB03



BASE OF CASING: 6.00m
CASING TYPE/DIAMETER: PVC / 125mm
BASE OF WEATHERING: 29.00m

SEAM NAME: Braymont
SEAM DEPTH: 161.90m - 168.50m
PIEZOMETER DEPTH: 164.00m

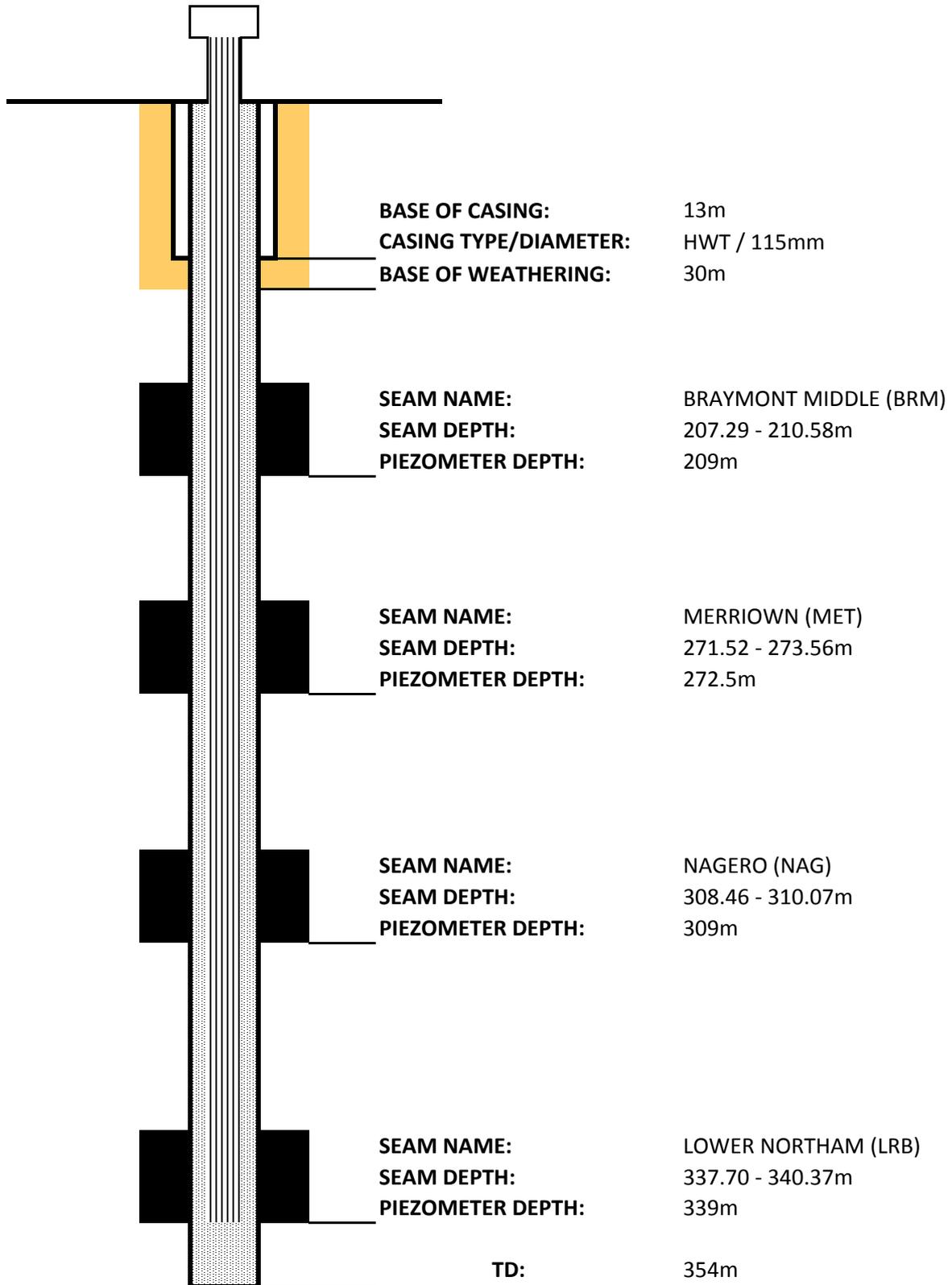
SEAM NAME: Merriown
SEAM DEPTH: 241.00m - 244.20m
PIEZOMETER DEPTH: 242.00m

SEAM NAME: Nagero
SEAM DEPTH: 286.50m - 289.60m
PIEZOMETER DEPTH: 289.00m

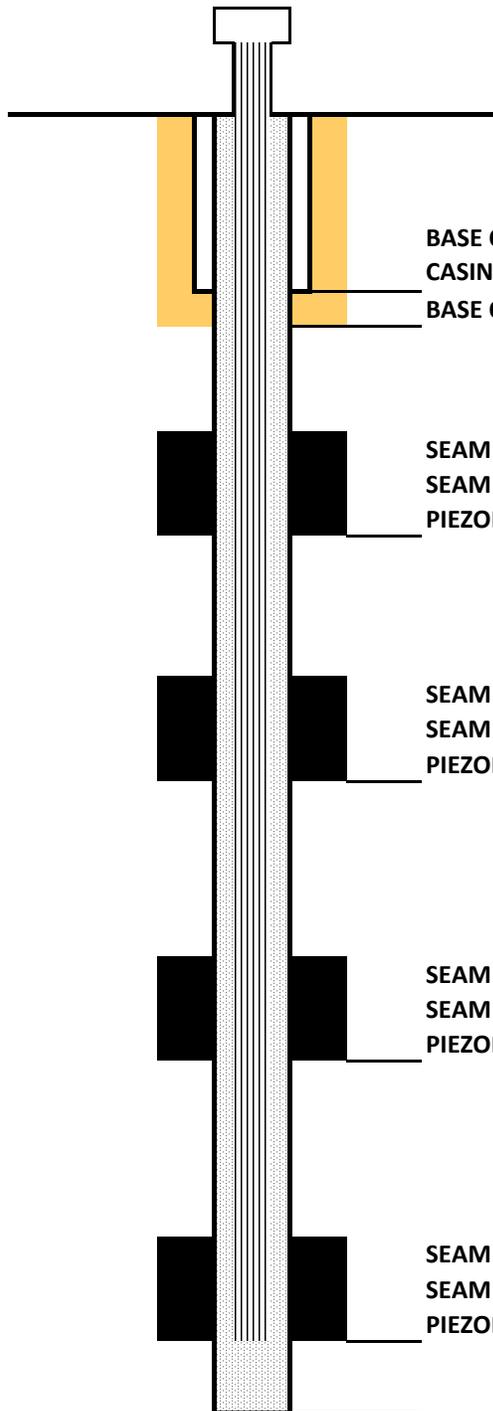
SEAM NAME: Templemore
SEAM DEPTH: 313.50m - 317.50m
PIEZOMETER DEPTH: 317.00m

TD: 324.44m

BOREHOLE: RB04



BOREHOLE: RB05



BASE OF CASING: 48m
CASING TYPE/DIAMETER: PVC / 125mm
BASE OF WEATHERING: 42m

SEAM NAME: BRAYMONT (BRU)
SEAM DEPTH: 105.00 - 108.00
PIEZOMETER DEPTH: 107.00m

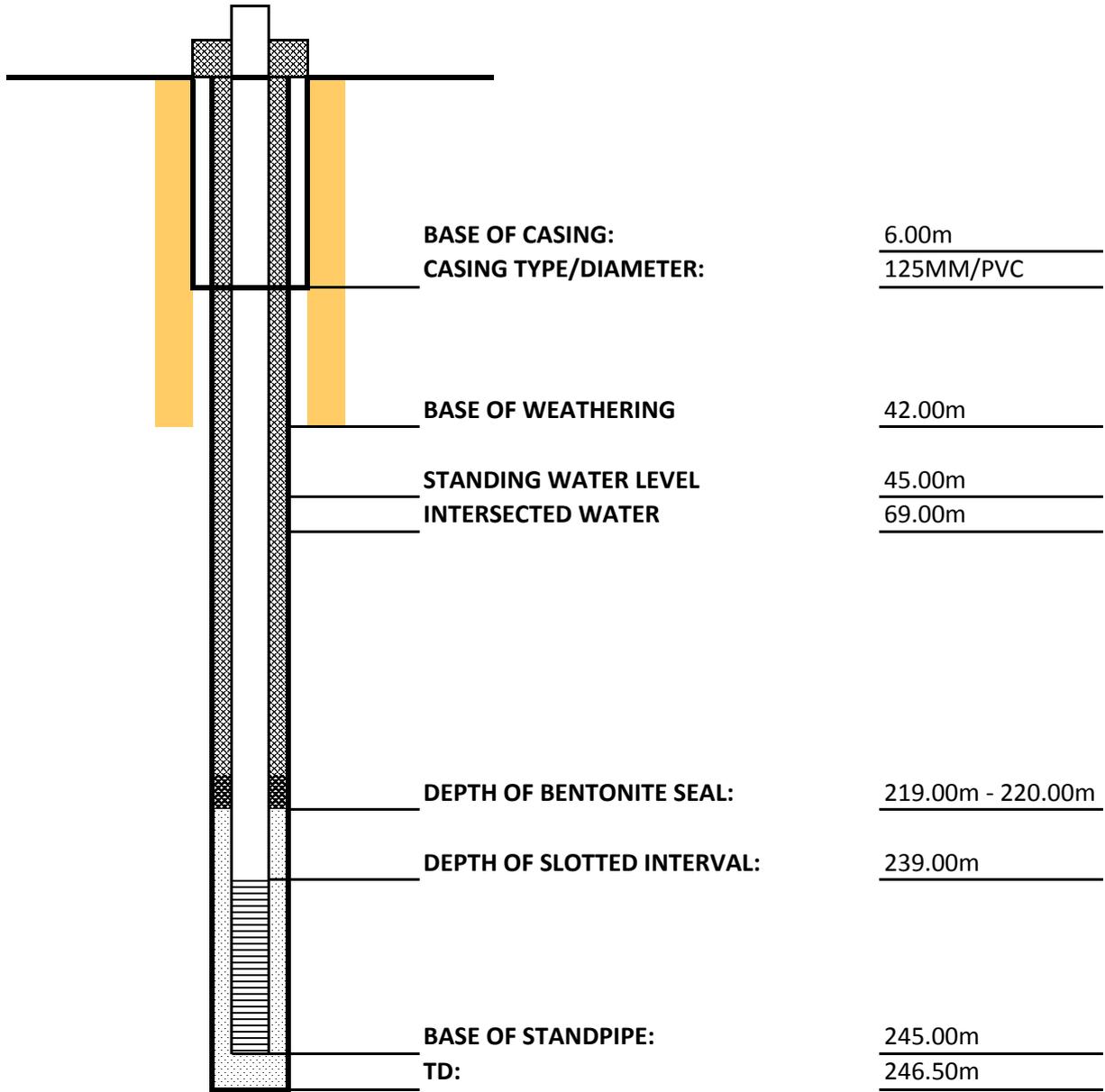
SEAM NAME: JERALONG
SEAM DEPTH: 212.00 - 214.00
PIEZOMETER DEPTH: 213.00m

SEAM NAME: NAGERO (NAG)
SEAM DEPTH: 278.00 - 280.50
PIEZOMETER DEPTH: 280.00m

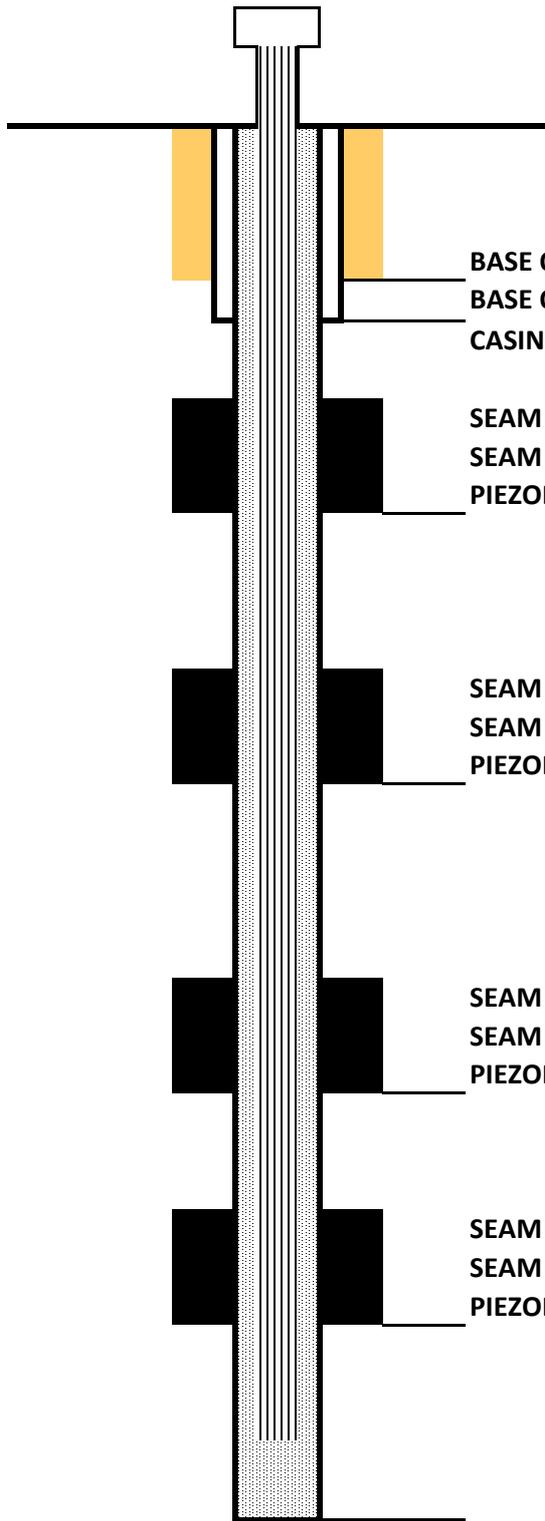
SEAM NAME: TEMPLEMORE (TRD)
SEAM DEPTH: 381.00 - 383.00
PIEZOMETER DEPTH: 382.00m

TD: 391.50m

BOREHOLE: RB05a



BOREHOLE: REG01



BASE OF WEATHERING: 111.75M
BASE OF CASING: 118.38M
CASING TYPE/DIAMETER: HWT / 115mm

SEAM NAME: JERLONG
SEAM DEPTH: 118.4-118.86m
PIEZOMETER DEPTH: 118.7

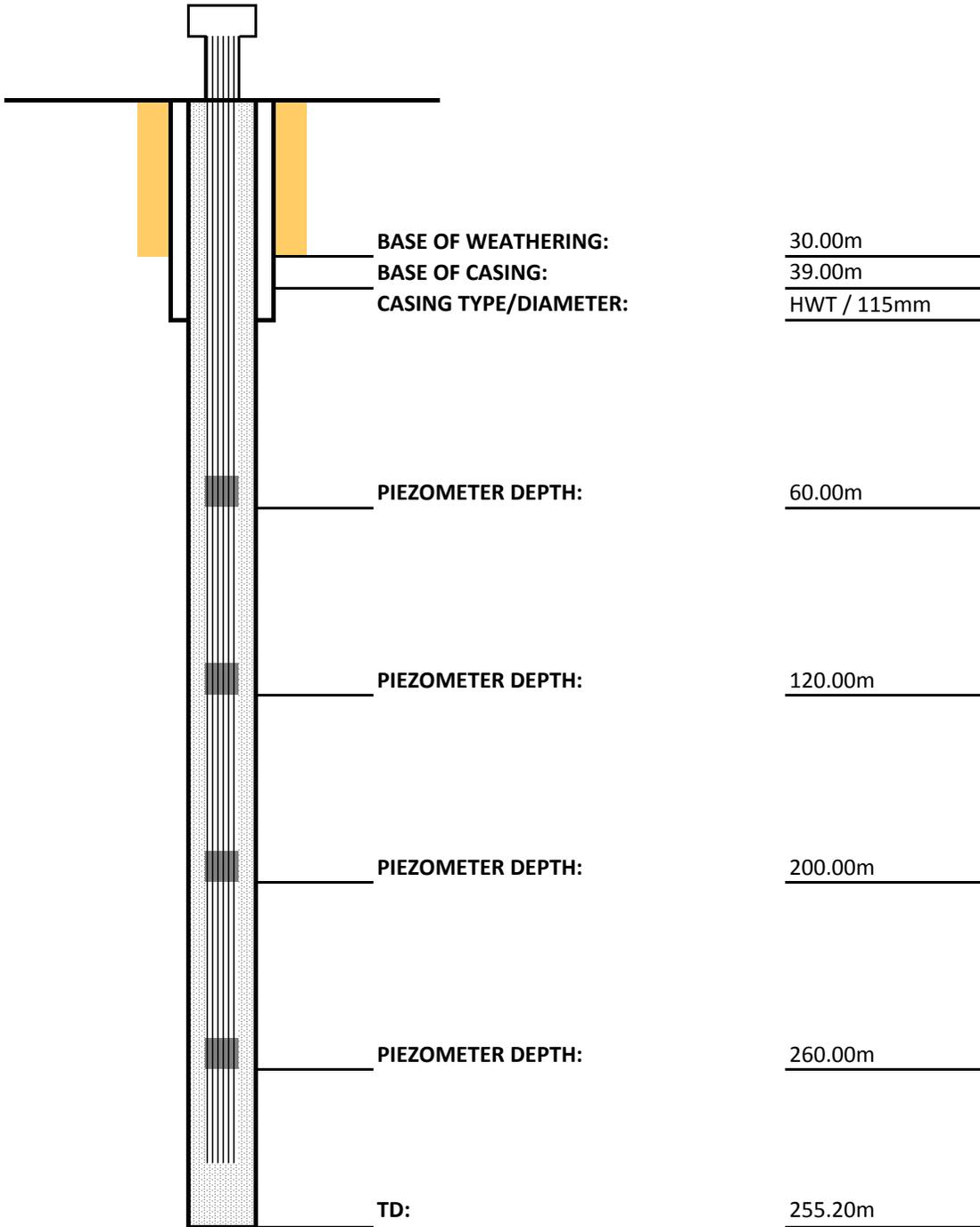
SEAM NAME: MERROWN
SEAM DEPTH: 134.20-134.55m
PIEZOMETER DEPTH: 134.5

SEAM NAME: NAGERO
SEAM DEPTH: 192.29-193.69m
PIEZOMETER DEPTH: 193.5

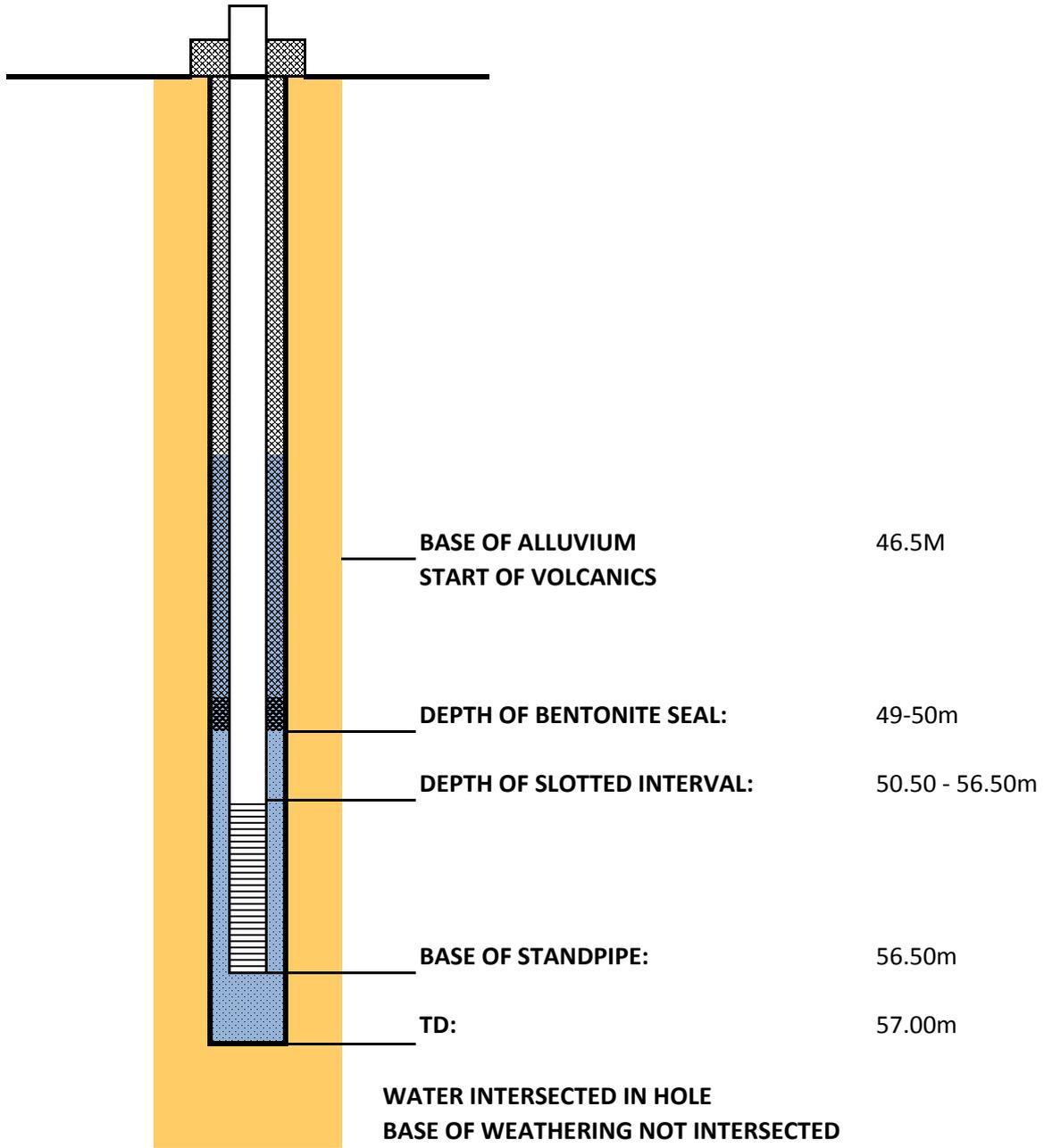
SEAM NAME: THERRIBRI UPPER (TEA)
SEAM DEPTH: 280.65-282.50m
PIEZOMETER DEPTH: 281.5

TD: 255.20m

BOREHOLE: REG02

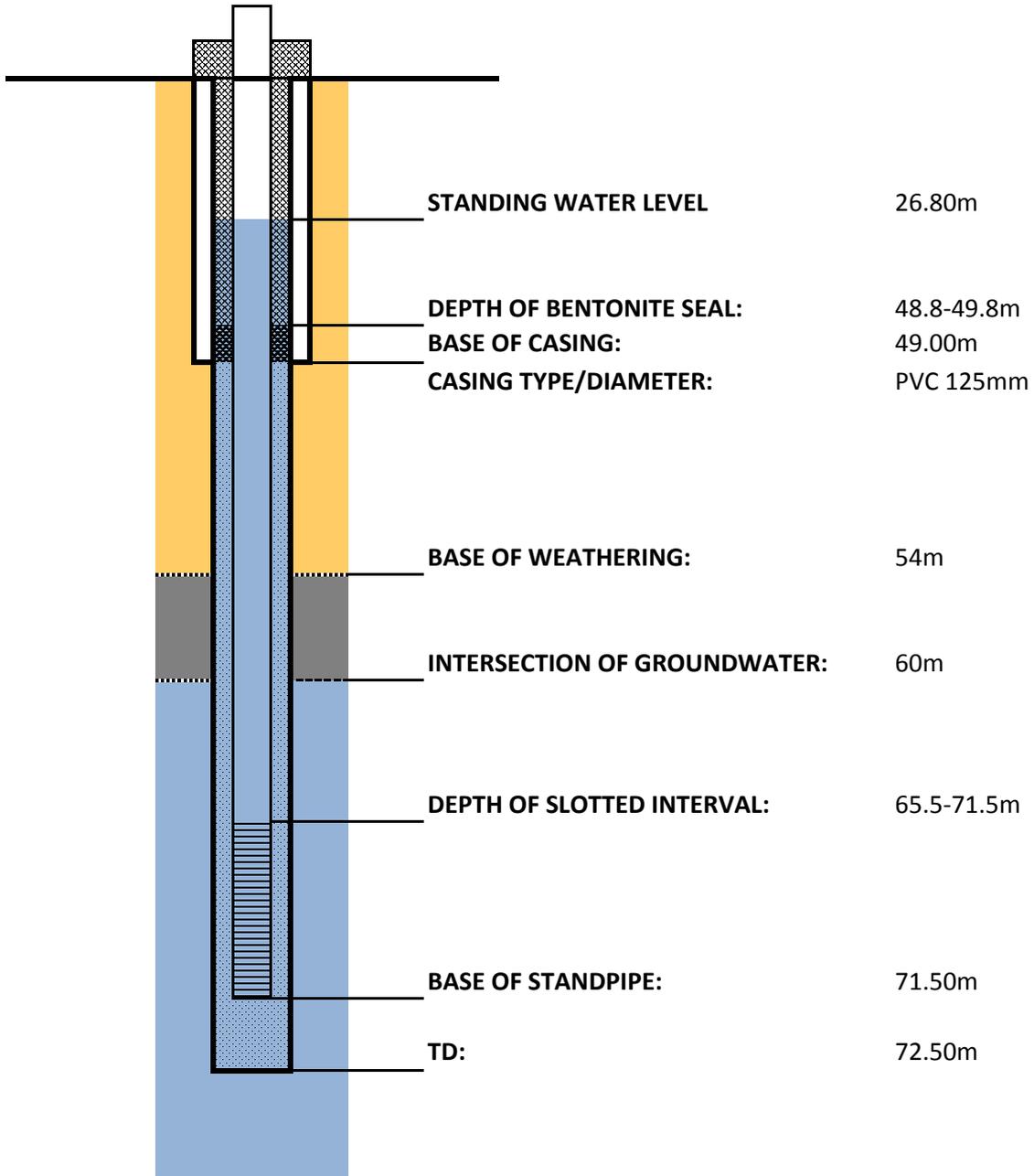


BOREHOLE: REG03

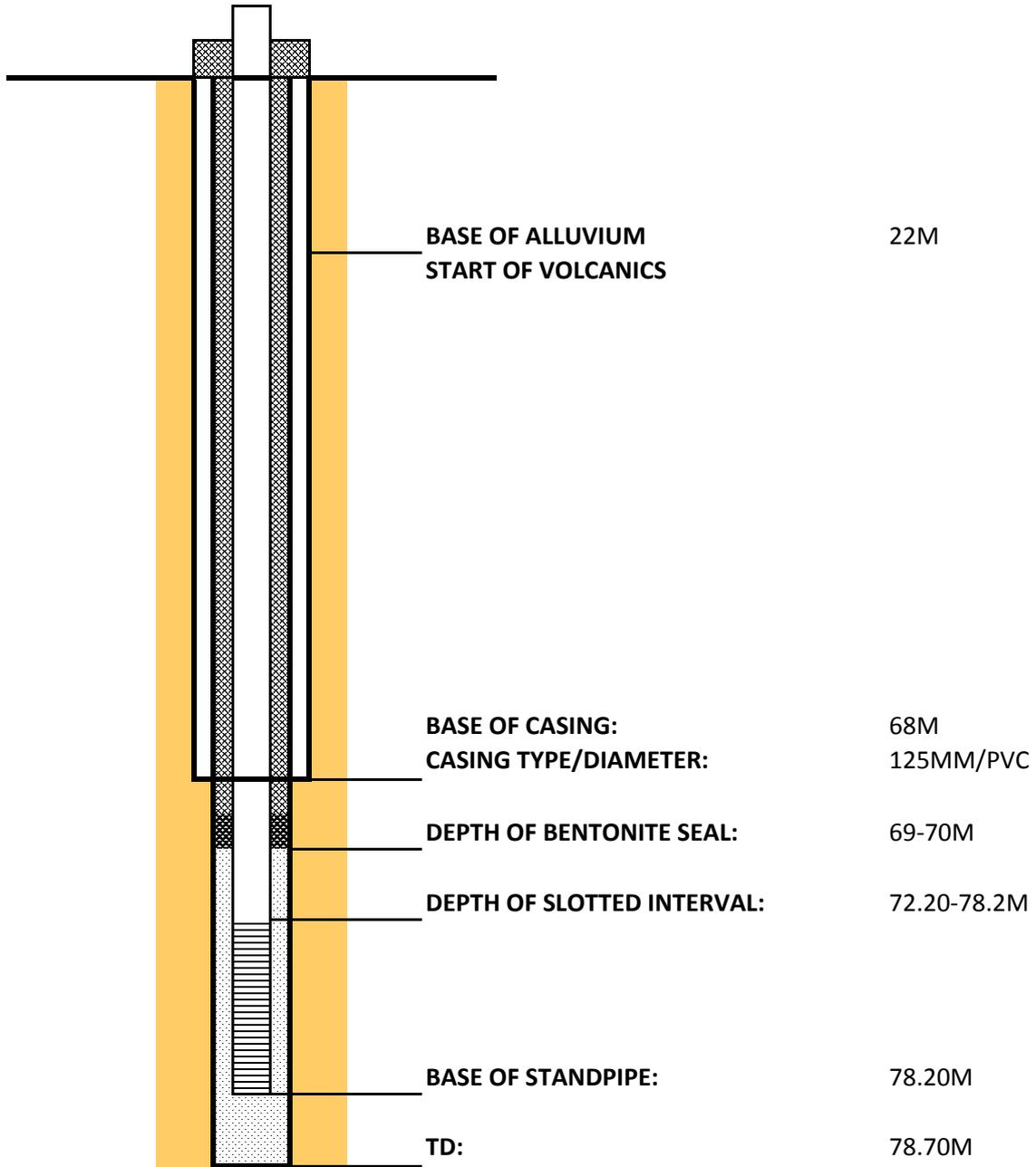


**WATER INTERSECTED IN HOLE
BASE OF WEATHERING NOT INTERSECTED
STANDING WATER LEVEL NOT MEASURED
SURFACE CASING NOT INSTALLED**

BOREHOLE: REG04

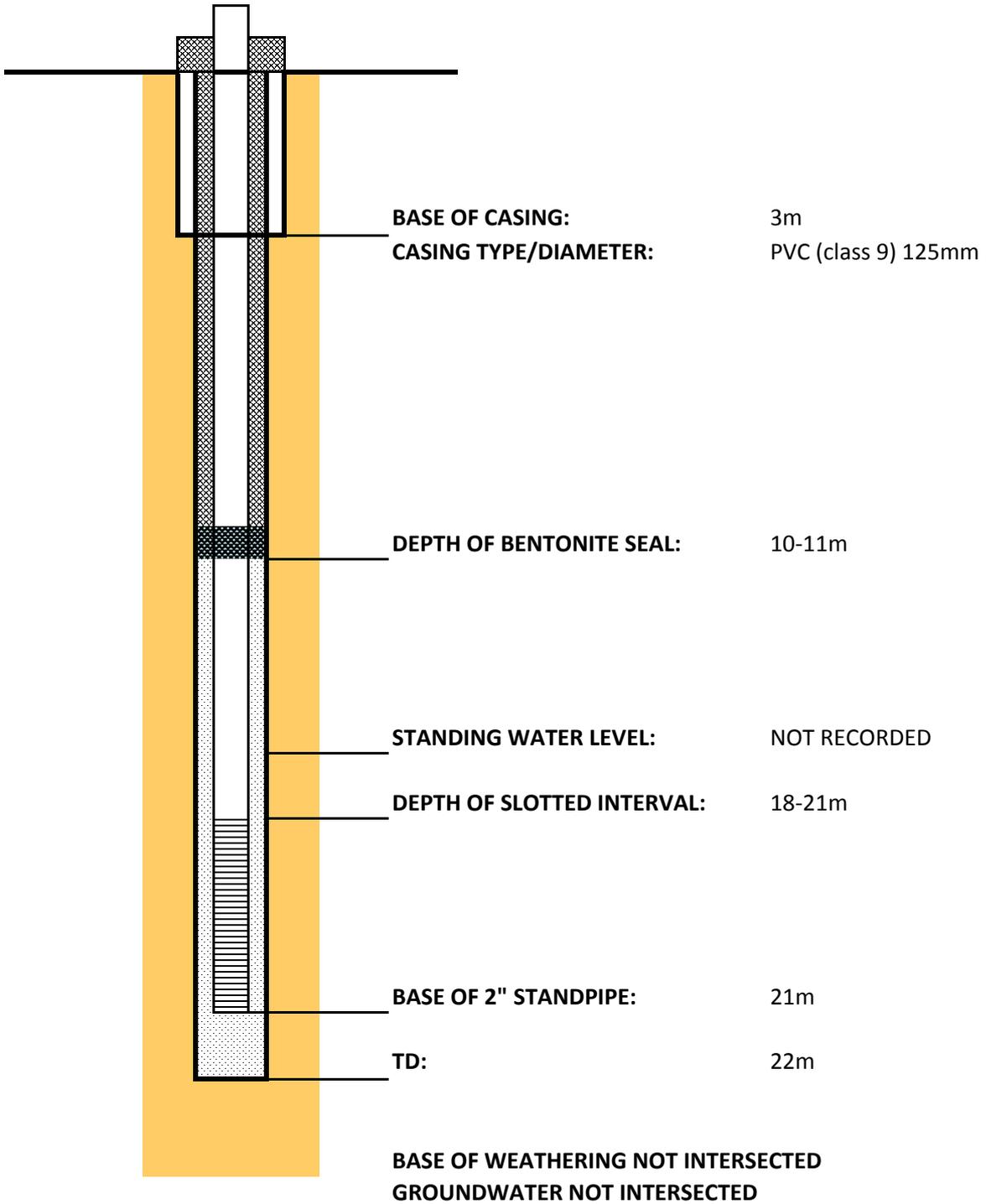


BOREHOLE: REG05

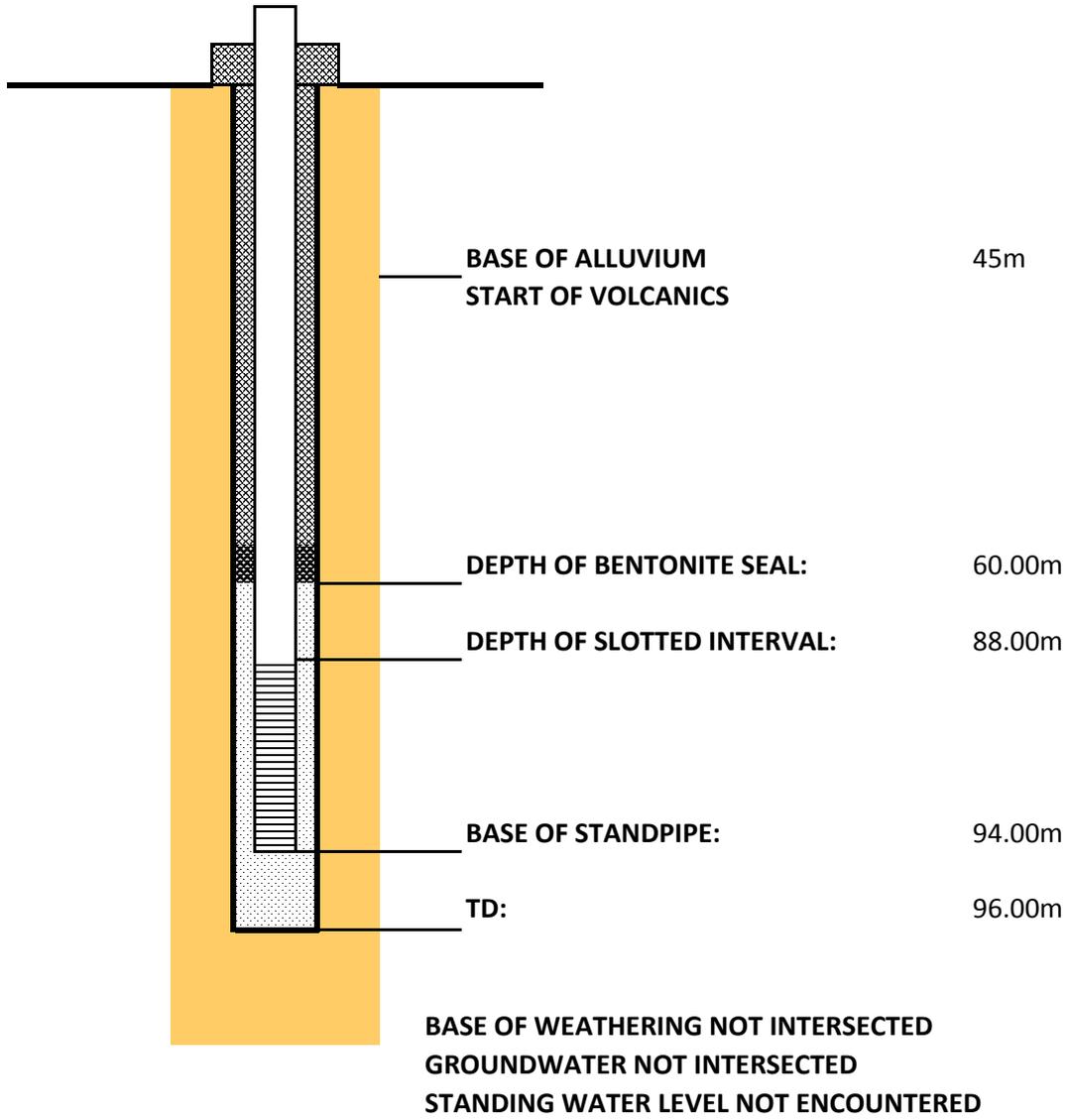


**BASE OF WEATHERING NOT INTERSECTED
GROUNDWATER NOT INTERSECTED
STANDING WATER LEVEL NOT ENCOUNTERED**

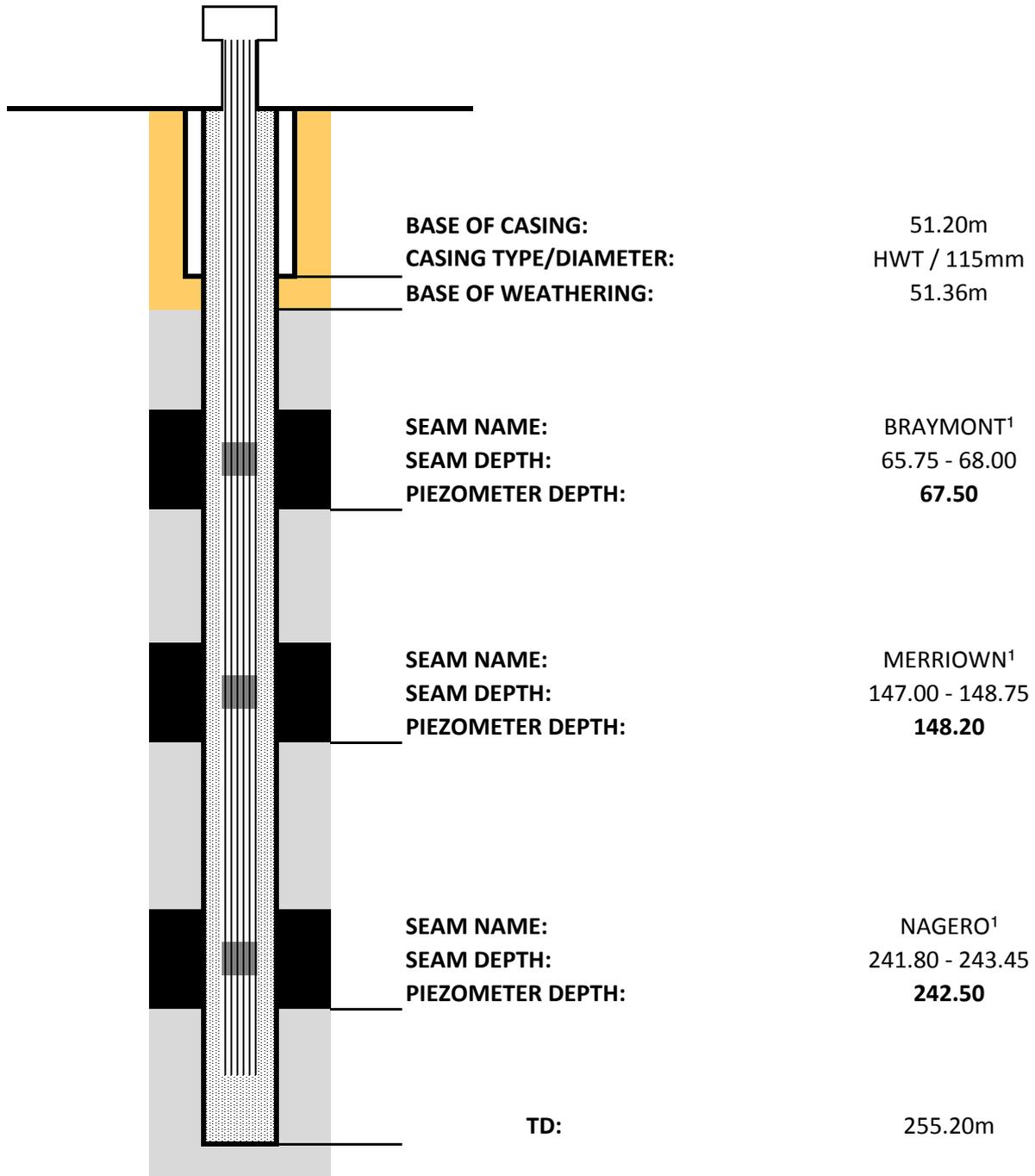
BOREHOLE: REG05A



BOREHOLE: REG06

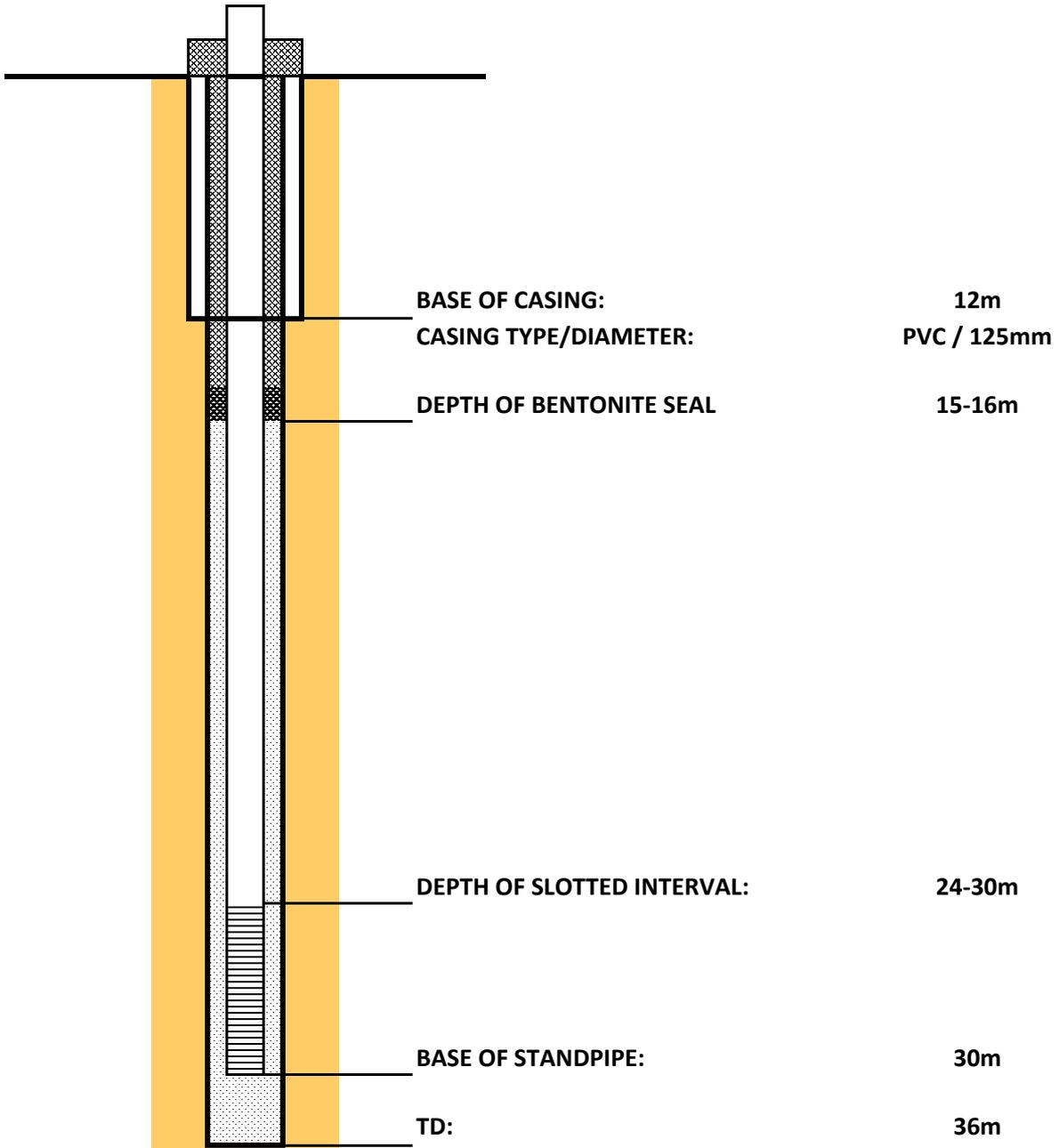


BOREHOLE: REG07



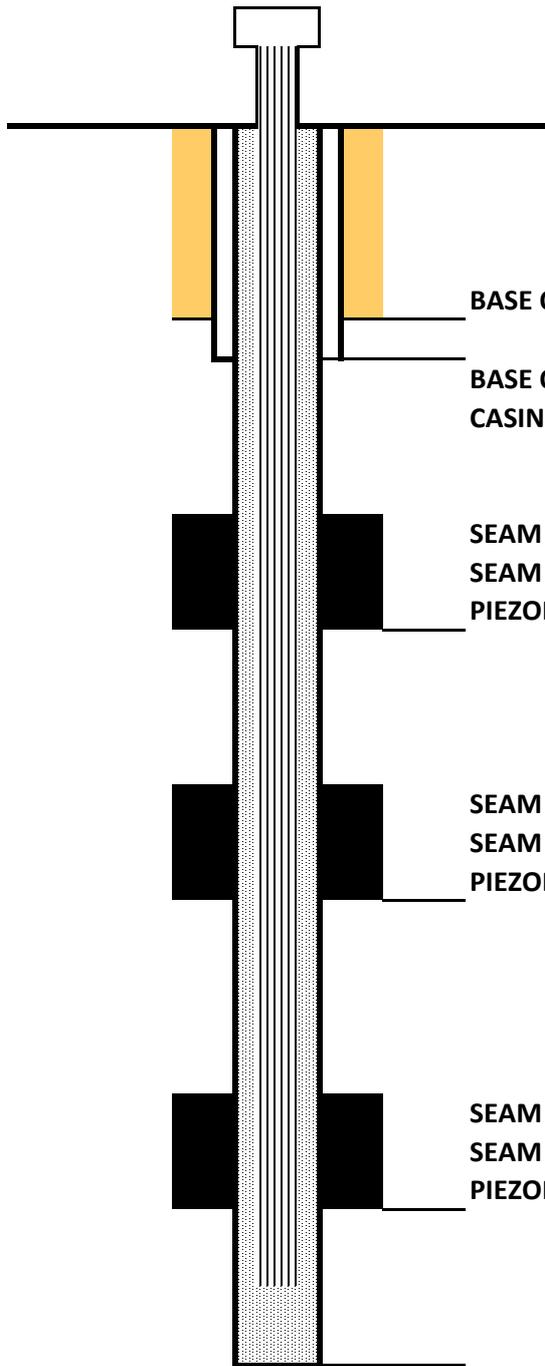
¹ Seam yet to be correlated in geological model

BOREHOLE: REG07A



**BASE OF WEATHERING NOT INTERSECTED
GROUNDWATER NOT INTERSECTED
STANDING WATER LEVEL NOT ENCOUNTERED**

BOREHOLE: REG08



BASE OF WEATHERING: 35m

BASE OF CASING: 36.00m
CASING TYPE/DIAMETER: PVC / 125mm

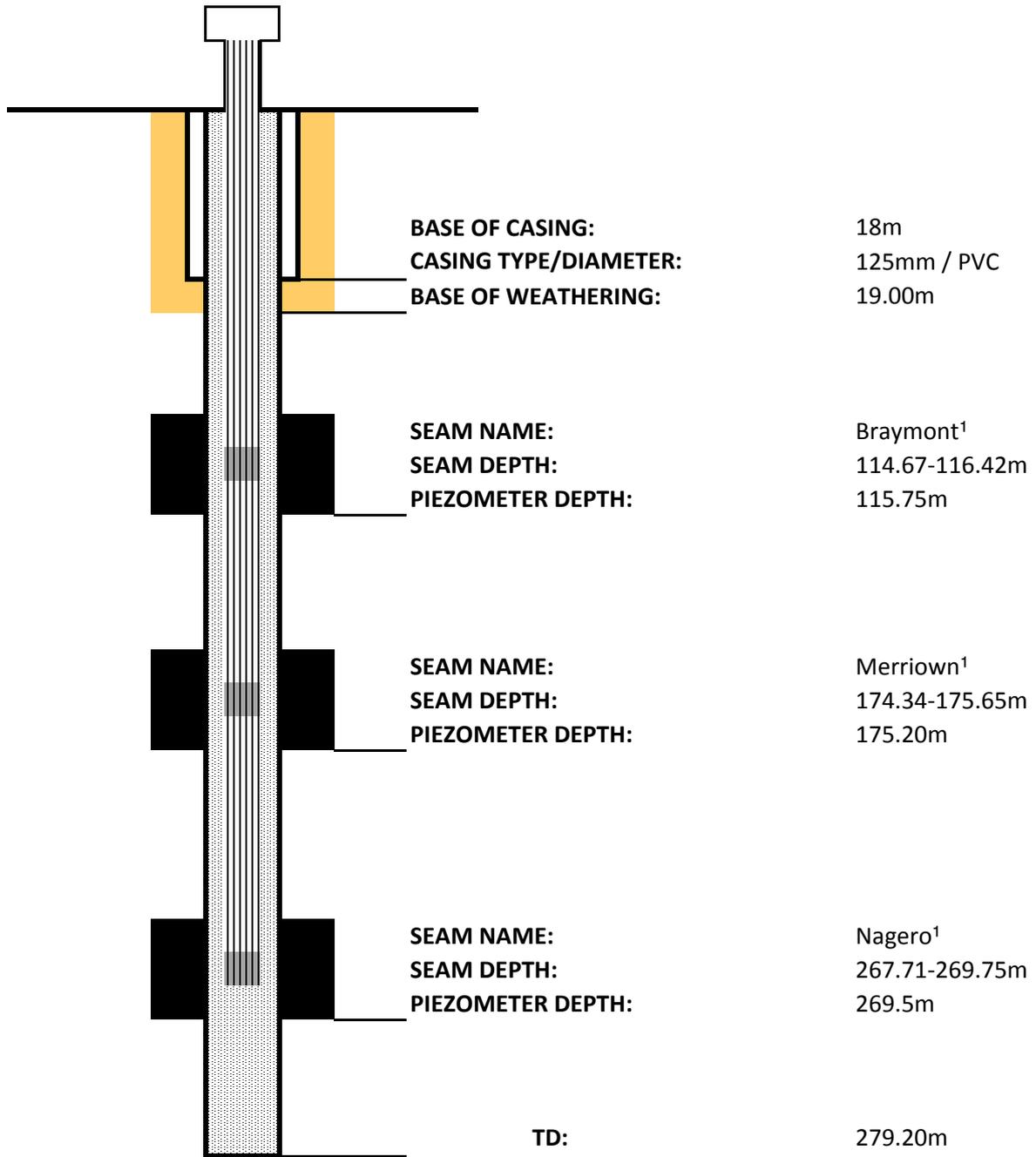
SEAM NAME: Braymont Middle (B)
SEAM DEPTH: 90.29 - 92.99m
PIEZOMETER DEPTH: 91.50m

SEAM NAME: Merriown A (MEA)
SEAM DEPTH: 220.66 - 221.58m
PIEZOMETER DEPTH: 221.00m

SEAM NAME: Nagero (NAG)
SEAM DEPTH: 272.70 - 274.52m
PIEZOMETER DEPTH: 274m

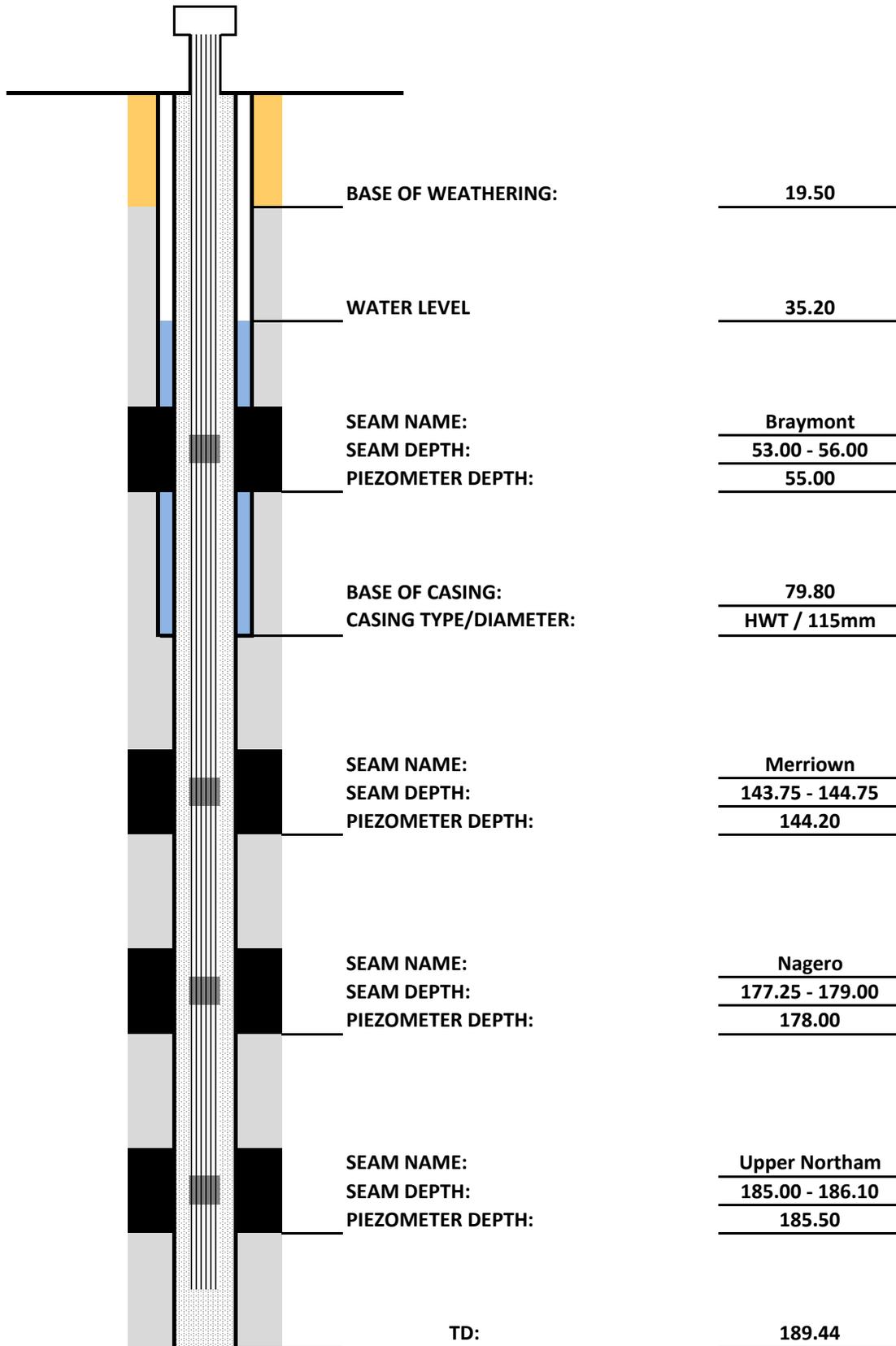
TD: 342m

BOREHOLE: REG09

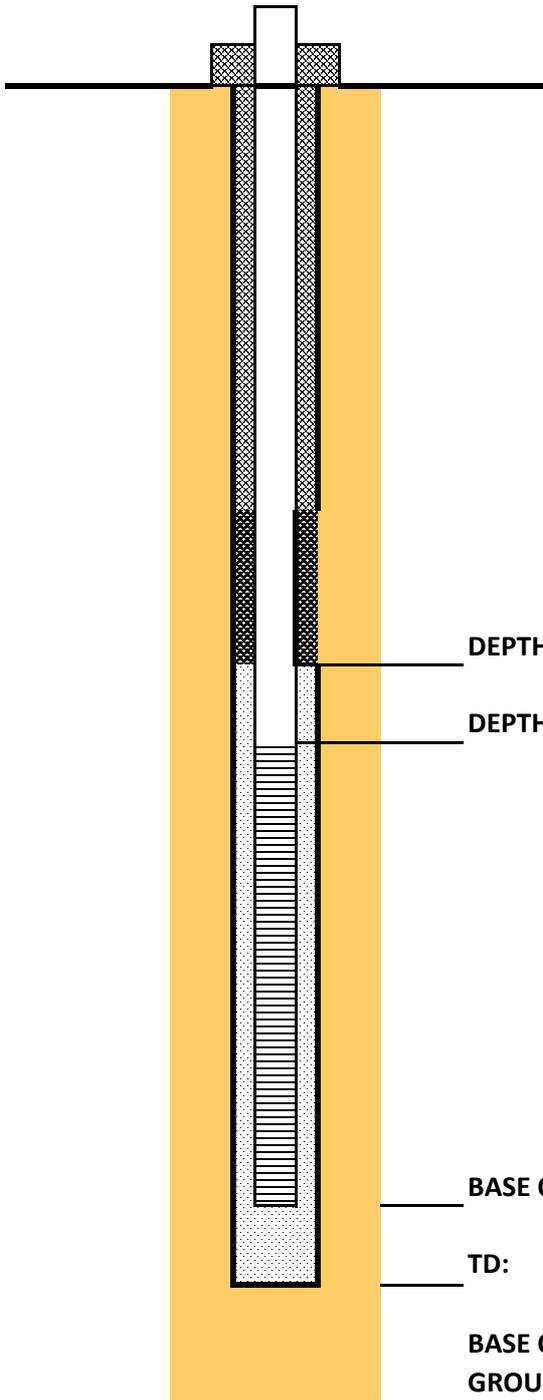


¹ Seam yet to be correlated in geological model

BOREHOLE: REG10



BOREHOLE: REG10A



DEPTH OF BENTONITE SEAL: 5.5-6.5m

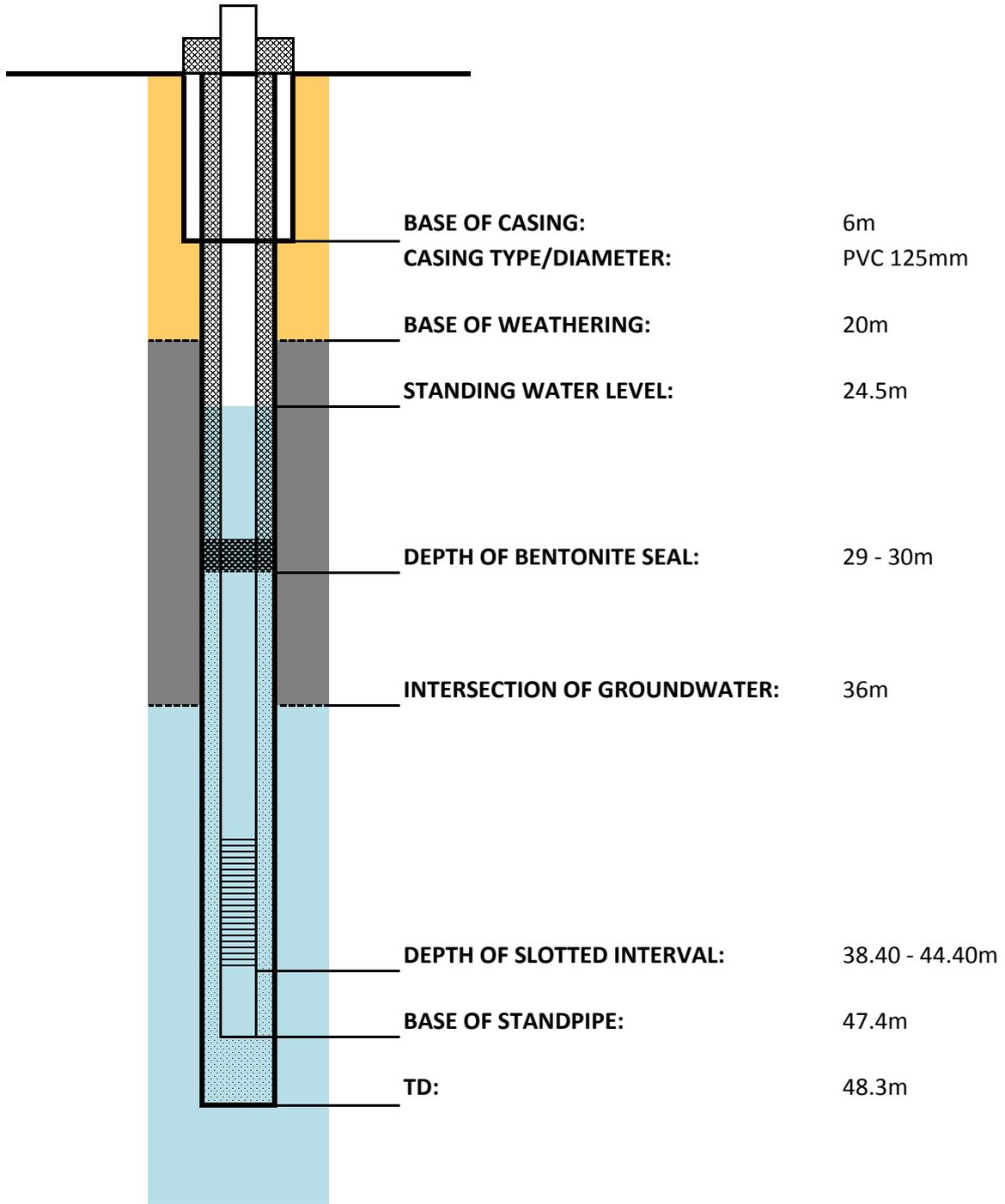
DEPTH OF SLOTTED INTERVAL: 6.75-9.75m

BASE OF STANDPIPE: 9.75m

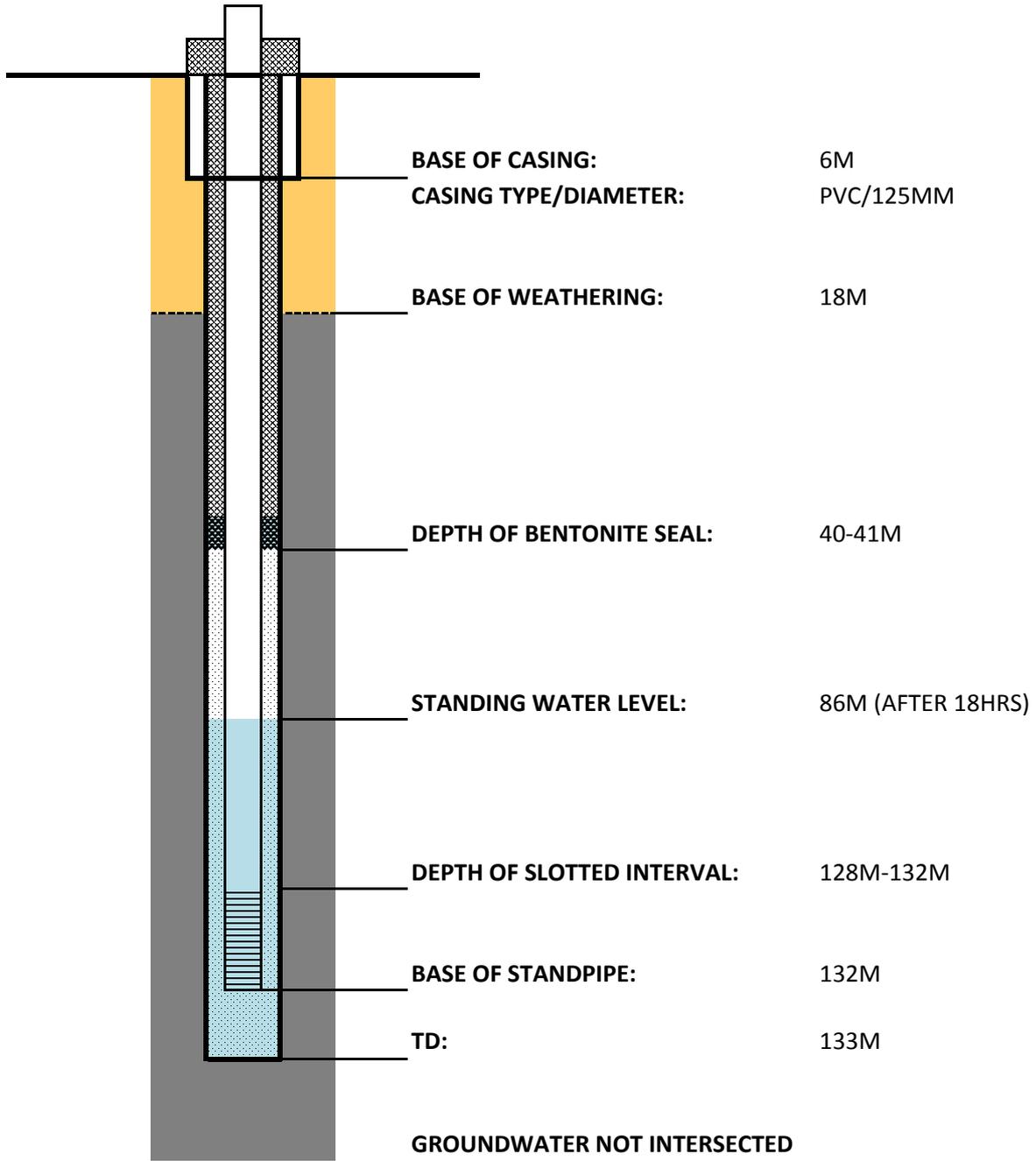
TD: 10.00m

**BASE OF WEATHERING NOT INTERSECTED
GROUNDWATER NOT INTERSECTED
STANDING WATER LEVEL NOT ENCOUNTERED
NO SURFACE CASING INSTALLED**

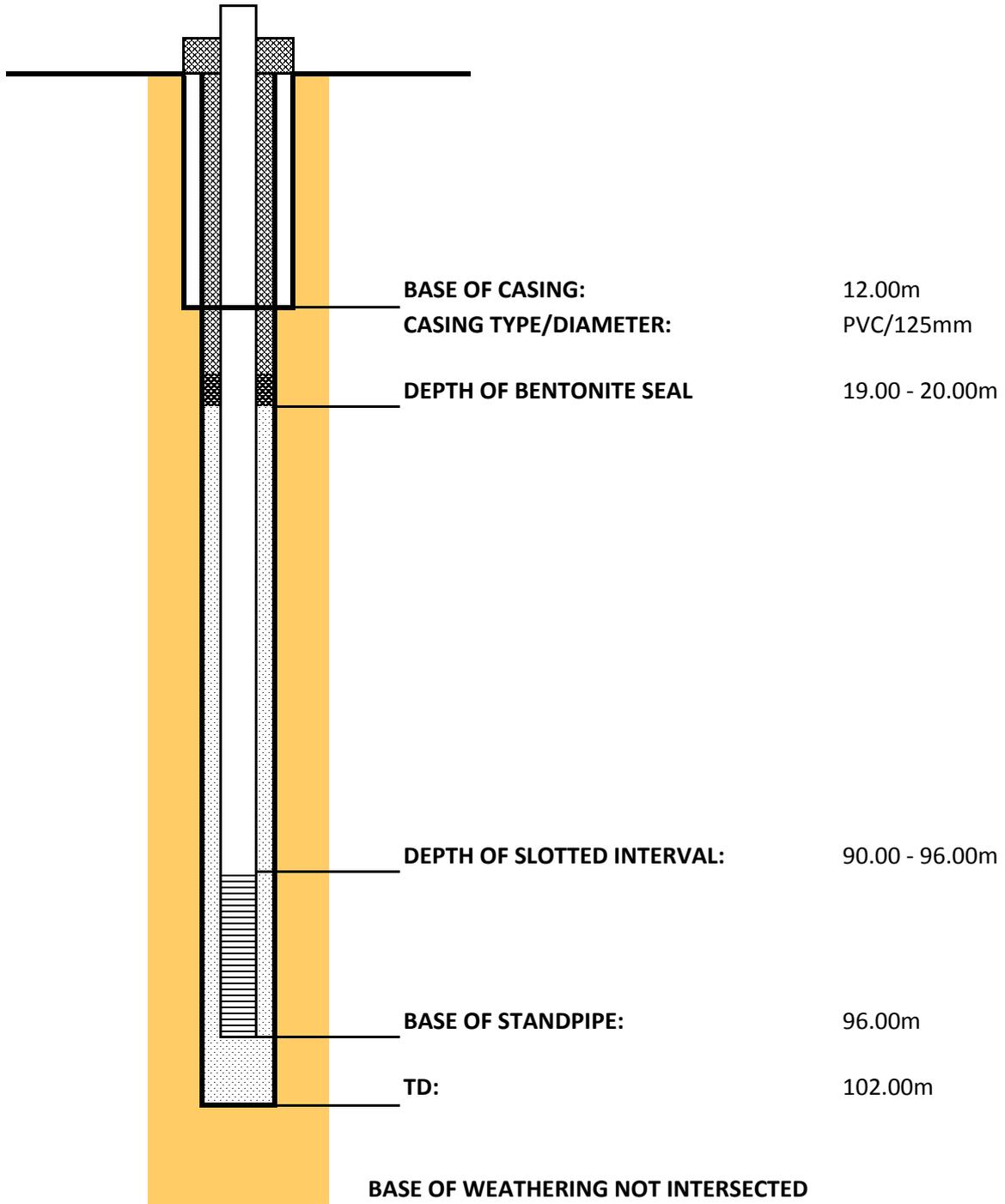
BOREHOLE: REG12



BOREHOLE: REG13



BOREHOLE: REG14



**BASE OF WEATHERING NOT INTERSECTED
GROUNDWATER NOT INTERSECTED
STANDING WATER LEVEL NOT ENCOUNTERED**

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APPENDIX D

GROUNDWATER QUALITY RESULTS



MAULES CREEK

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Table E 1 Groundwater Quality Results

Sample	Date Sampled	Order #	Field pH	Lab pH	Field EC	EC @ 25°C	Total Dissolved Solids @180°C	Sulfate as SO4	Aluminium (fll.)	Barium (fll.)	Boron (fll.)	Cadmium (fll.)	Iron (fll.)	Lead (fll.)	Lithium (fll.)	Manganese (fll.)	Molybdenum (fll.)	Nickel (fll.)
			pH Unit	pH Unit	µS/cm	µS/cm	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 Guideline Level	Drinking Water (Health & Aesthetic)		6.5-8.5	6.5-8.5	1500'	1500'	-	-	0.2 (A)	0.7	0.3	0.002	0.3 (A)	0.01	-	0.5 (H) 0.1 (A)	0.05	0.02
	ANZECC Livestock Drinking Water		-	-	7500 - 15000	7500 - 15000	5000 - 10000	1000 - 2000	5	-	5	0.01	-	0.1	-	-	0.15	1
	Long-Term Irrigation Water		-	-	9000'	9000'	-	-	5	-	0.5	0.01	0.2	2	2.5	0.2	0.01	0.2
	Limit or Reporting		0.01	0.01	f	f	f	f	0.01	0.001	0.05	0.0001	0.05	0.001	0.001	0.001	0.001	0.001
1218	27/07/2010	ES1014535002	6.68	6.75	848	960	552	19	-	-	-	-	-	-	-	-	-	-
1218	20/09/2010	ES1018923009	12.15	11.9	535	2790	2260	392	-	-	-	-	-	-	-	-	-	-
1219	25/10/2010	ES1021484008	12.23	12.1	1370	3820	1390	94	-	-	-	-	-	-	-	-	-	-
1218	18/11/2010	ES1023537002	12.3	-	452	-	1690	5	-	-	-	-	-	-	-	-	-	-
1218	22/12/2010	ES1026590001	10.5	-	321	-	248	40	0.55	0.052	0.05	0.0001	<0.05	<0.001	0.015	0.004	0.001	0.004
1218	10/01/2011	ES1100464007	9.82	-	306	-	510	31	0.43	0.077	<0.05	<0.0001	0.1	0.001	0.021	0.016	<0.001	0.006
1218	24/02/2011	ES1100411001	11.1	-	341	-	372	25	0.18	0.053	0.09	<0.0001	0.06	0.001	0.016	0.006	<0.001	0.009
1218	28/03/2011	ES1106517004	9.8	-	340	-	328	26	0.12	0.053	0.08	0.0001	0.07	<0.001	0.023	0.004	0.001	0.005
1218	2/05/2011	ES1109205007	9.29	-	321	-	338	24	0.17	0.037	<0.05	<0.0001	0.13	<0.001	0.015	0.005	<0.001	0.003
1218	16/05/2011	ES1110179006	7	-	837	-	530	21	0.08	0.264	<0.05	<0.0001	0.13	0.008	0.068	0.074	0.001	0.004
1218	2/06/2011	ES1111766001	10.4	-	290	-	238	27	0.14	0.064	<0.05	<0.0001	<0.05	<0.001	0.013	0.003	<0.001	0.003
1218	1/07/2011	ES1114250008	9.6	-	338	-	276	20	0.12	0.07	<0.05	<0.0001	<0.05	0.001	0.026	0.009	<0.001	0.002
1218	12/07/2011	ES1114891008	10.2	-	281	-	282	29	0.09	0.058	<0.05	<0.0001	<0.05	<0.001	0.02	0.002	0.001	0.004
1218	25/07/2011	ES1115923007	10.2	-	312	-	292	26	0.13	0.038	<0.05	<0.0001	<0.05	<0.001	0.016	0.003	<0.001	0.003
1218	9/08/2011	ES1117221007	11.3	-	549	-	364	26	0.28	0.061	<0.05	<0.0001	<0.05	<0.001	0.02	0.001	0.002	0.006
1218	24/08/2011	ES1118476008	10.3	-	278	-	294	26	0.11	0.051	<0.05	<0.0001	<0.05	<0.001	0.017	0.002	0.001	0.006
1218	5/09/2011	ES1119286008	11.4	-	486	-	264	23	0.3	0.054	<0.05	0.0001	<0.05	<0.001	0.022	0.006	0.002	0.005
1218	22/09/2011	ES1120774008	10.3	-	284	-	314	23	0.2	0.044	<0.05	<0.0001	<0.05	<0.001	0.015	0.003	0.001	0.003
1218	4/10/2011	ES1121559008	10.6	-	273	-	316	28	0.17	0.035	<0.05	<0.0001	<0.05	<0.001	0.015	0.002	0.001	0.004
1218	24/10/2011	ES1123180008	11.8	-	699	-	416	27	1.03	0.073	<0.05	<0.0001	<0.05	<0.001	0.081	0.002	0.013	0.005
1218	8/11/2011	ES1124426008	10.5	-	287	-	368	32	0.17	0.054	<0.05	<0.0001	0.08	<0.001	0.018	0.003	0.001	0.005
1218	21/11/2011	ES1125388008	10.7	-	283	-	268	22	0.2	0.075	0.06	<0.0001	<0.05	<0.001	0.02	0.007	0.002	0.005
1218	22/12/2011	ES1128450007	11.5	-	510	-	360	46	0.28	0.062	<0.05	<0.0001	<0.05	<0.001	0.017	0.006	0.002	0.016
1218	29/03/2012	ES1207655 005	10.8	-	395	-	310	46	0.04	0.015	<0.05	<0.0001	<0.05	<0.001	0.07	<0.001	0.003	0.005
1218	23/04/2012	ES1209789007	9.1	-	444	-	334	49	0.53	0.056	<0.05	<0.0001	0.36	0.011	0.023	0.012	0.004	0.008
1218	29/05/2012	ES1213289001	11.12	11.7	1282	1320	25	0.96	0.131	<0.05	<0.0001	<0.05	<0.001	0.026	<0.001	<0.001	0.01	
1218	26/06/2012	ES1216274001	12.34	12	2190	1990	19	2.08	0.195	<0.05	<0.0001	<0.05	<0.001	0.038	<0.001	<0.001	0.01	
1218	26/07/2012	ES1218635001	11.11	12.7	1721	511	31	0.75	0.07	<0.05	<0.0001	<0.05	<0.001	0.028	<0.001	<0.001	0.012	
1219	27/07/2010	ES1014935003	6.67	6.65	558	545	308	12	-	-	-	-	-	-	-	-	-	-
1219	20/09/2010	ES1018923008	7.13	7.08	945	893	730	43	-	-	-	-	-	-	-	-	-	-
1219	25/10/2010	ES1021484007	7.47	7.59	802	885	494	30	-	-	-	-	-	-	-	-	-	-
1219	18/11/2010	ES1023537003	8.01	-	805	-	400	22	-	-	-	-	-	-	-	-	-	-
1219	22/12/2010	ES1026590002	7.31	-	604	-	580	28	0.03	0.193	0.08	0.0003	<0.05	<0.001	0.09	0.008	0.002	0.003
1219	10/01/2011	ES1100464008	7.75	-	868	-	620	30	0.13	0.182	0.09	<0.0001	<0.05	<0.001	0.098	0.004	0.002	0.002
1219	24/02/2011	ES1100411002	9.99	-	1	-	670	25	0.05	0.191	0.22	<0.0001	<0.05	<0.001	0.109	0.011	0.002	0.007
1219	28/03/2011	ES1106517005	7.86	-	1030	-	610	25	0.03	0.233	0.44	0.0005	0.06	0.001	0.083	0.051	0.002	0.041
1219	2/05/2011	ES1109205006	7.35	-	956	-	798	22	0.05	0.289	0.08	0.0001	0.07	<0.001	0.061	0.101	<0.001	0.002
1219	16/05/2011	ES1110179005	7.7	-	850	-	494	21	0.2	0.432	<0.05	<0.0001	0.05	0.035	0.11	0.04	0.003	0.01
1219	2/06/2011	ES1111766002	6.8	-	760	-	504	24	0.03	0.366	0.1	<0.0001	<0.05	<0.001	0.058	0.066	<0.001	0.002
1219	1/07/2011	ES1114250007	6.7	-	720	-	588	15	0.02	0.233	<0.05	<0.0001	0.44	0.005	0.04	0.097	<0.001	<0.001
1219	12/07/2011	ES1114891007	7.1	-	744	-	482	22	0.04	0.291	<0.05	<0.0001	<0.05	0.009	0.067	0.052	<0.001	0.004
1219	25/07/2011	ES1115923008	7.1	-	737	-	558	20	0.03	0.243	0.05	<0.0001	<0.05	<0.001	0.053	0.058	<0.001	<0.001
1219	9/08/2011	ES1117221008	7	-	734	-	558	20	0.04	0.246	0.06	<0.0001	0.06	<0.001	0.065	0.054	<0.001	0.004
1219	24/08/2011	ES1118476007	6.9	-	698	-	528	20	0.03	0.283	0.05	<0.0001	<0.05	<0.001	0.039	0.092	<0.001	0.014
1219	5/09/2011	ES1119286007	7	-	692	-	416	20	0.1	0.238	0.06	<0.0001	0.35	<0.001	0.044	0.082	0.001	0.002
1219	22/09/2011	ES1120774007	6.8	-	682	-	546	19	0.03	0.246	0.06	<0.0001	0.23	<0.001	0.042	0.088	<0.001	<0.001
1219	4/10/2011	ES1121559007	7.4	-	694	-	538	25	0.01	0.295	0.07	<0.0001	0.18	<0.001	0.039	0.09	<0.001	0.002
1219	24/10/2011	ES1123180007	6.6	-	696	-	494	19	<0.01	0.268	<0.05	<0.0001	<0.05	<0.001	0.044	0.127	<0.001	0.003
1219	8/11/2011	ES1124426007	6.7	-	683	-	576	22	<0.01	0.218	0.06	<0.0001	0.21	<0.001	0.041	0.097	<0.001	0.003
1219	21/11/2011	ES1125388007	6.8	-	682	-	474	16	0.07	0.312	0.1	0.0004	0.77	<0.001	0.064	0.092	0.005	0.005
1219	22/12/2011	ES1128450006	6.9	-	717	-	532	24	0.01	0.296	0.09	<0.0001	0.63	<0.001	0.036	0.137	<0.001	0.051
1219	29/03/2012	ES1207655006	7.3	-	795	-	576	22	<0.01	0.238	0.05	<0.0001	<0.05	<0.001	0.147	0.031	<0.001	0.002
1219	23/04/2012	ES1209789006	7.2	-	776	-	490	22	0.16	0.218	0.05	<0.0001	1.72	0.008	0.116	0.059	<0.001	0.003
1219	29/05/2012	ES1213289002	7.54	7.16	941													



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WHC_PLN_MC_WATER MANAGEMENT PLAN

Sample	Date Sampled	Order #	Field pH	Lab pH	Field EC	EC @ 25°C	Total Dissolved Solids @180°C	Sulfate as SO4	Aluminium (filit.)	Barium (filit.)	Boron (filit.)	Cadmium (filit.)	Iron (filit.)	Lead (filit.)	Lithium (filit.)	Manganese (filit.)	Molybdenum (filit.)	Nickel (filit.)
			pH Unit	pH Unit	µS/cm	µS/cm	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 Guideline Level	Drinking Water (Health & Aesthetic)		6.5 - 8.5	6.5 - 8.5	1500 ¹	1500 ¹	-	-	0.2 (A)	0.7	0.3	0.002	0.3 (A)	0.01	-	0.5 (H) 0.1 (A)	0.05	0.02
	ANZECC Liveatook Drinking Water		-	-	7500 - 15000	7500 - 15000	5000 - 10000	1000 - 2000	5	-	5	0.01	-	0.1	-	-	0.15	1
	Long-Term Irrigation Water		-	-	9000 ²	9000 ²	-	-	5	-	0.5	0.01	0.2	2	2.5	0.2	0.01	0.2
	Limit or Reporting		0.01	0.01	1	1	1	1	0.01	0.001	0.05	0.0001	0.05	0.001	0.001	0.001	0.001	0.001
1259	27/07/2010	-	6.99	-	1707	-	-	62	-	-	-	-	-	-	-	-	-	-
1259	20/09/2010	-	10.1	-	1351	-	-	63	-	-	-	-	-	-	-	-	-	-
1259	25/10/2010	-	7.12	-	1512	-	-	71	-	-	-	-	-	-	-	-	-	-
1259	22/12/2010	-	7.38	-	1440	-	-	68	-	-	-	-	-	-	-	-	-	-
1259	2/02/2011	-	7.23	-	1600	-	-	58	-	-	-	-	-	-	-	-	-	-
1259	24/02/2011	-	8.29	-	1650	-	-	60	-	-	-	-	-	-	-	-	-	-
1259	28/03/2011	-	8.01	-	1630	-	-	63	-	-	-	-	-	-	-	-	-	-
1259	15/04/2011	-	7.68	-	650	-	-	30	-	-	-	-	-	-	-	-	-	-
1259	2/05/2011	-	7.91	-	970	-	-	37	-	-	-	-	-	-	-	-	-	-
1259	26/05/2011	-	6.7	-	385	-	-	22	-	-	-	-	-	-	-	-	-	-
1259	2/06/2011	-	6.5	-	647	-	-	42	-	-	-	-	-	-	-	-	-	-
1259	1/07/2011	-	7.6	-	898	-	-	47	-	-	-	-	-	-	-	-	-	-
1259	12/07/2011	-	7.4	-	1000	-	-	72	-	-	-	-	-	-	-	-	-	-
1259	25/07/2011	-	7.4	-	1040	-	-	76	-	-	-	-	-	-	-	-	-	-
1259	9/08/2011	-	7.8	-	1120	-	-	72	-	-	-	-	-	-	-	-	-	-
1259	24/08/2011	-	7.1	-	1010	-	-	59	-	-	-	-	-	-	-	-	-	-
1259	5/09/2011	-	7.7	-	1240	-	-	82	-	-	-	-	-	-	-	-	-	-
1259	22/09/2011	-	7.6	-	502	-	-	22	-	-	-	-	-	-	-	-	-	-
1259	4/10/2011	-	7.9	-	541	-	-	18	-	-	-	-	-	-	-	-	-	-
1259	24/10/2011	-	7.1	-	691	-	-	29	-	-	-	-	-	-	-	-	-	-
1259	8/11/2011	-	7	-	775	-	-	37	-	-	-	-	-	-	-	-	-	-
1261	27/07/2010	ES1014935009	6.69	6.71	1162	1130	726	86	-	-	-	-	-	-	-	-	-	-
1261	17/09/2010	ES1018923002	12.14	11.9	20.9	3350	2550	312	-	-	-	-	-	-	-	-	-	-
1261	25/10/2010	ES1021484002	11.73	11.7	1539	969	534	124	-	-	-	-	-	-	-	-	-	-
1261	18/11/2010	ES1023537004	12.4	-	483	-	1470	19	-	-	-	-	-	-	-	-	-	-
1261	22/12/2010	ES1026590004	12.3	-	325	-	1190	66	1	0.451	<0.05	<0.0001	0.05	0.003	0.158	<0.001	0.006	0.004
1261	10/01/2011	ES1100464001	11.9	-	289	-	924	84	0.62	0.38	<0.05	<0.0001	<0.05	<0.001	0.156	<0.001	0.005	<0.001
1261	2/02/2011	ES1102297002	12.1	-	368	-	1080	70	0.37	0.437	0.11	<0.0001	<0.05	0.006	0.158	<0.001	0.005	0.002
1261	24/02/2011	ES1104111004	12.4	-	4	-	1190	69	0.39	0.461	0.1	<0.0001	<0.05	0.004	0.173	<0.001	0.005	0.002
1261	28/03/2011	ES1106517001	11.8	-	4460	-	1220	70	0.33	0.511	0.08	<0.0001	<0.50	0.005	0.159	<0.001	0.006	<0.005
1261	15/04/2011	ES1108240001	10.8	-	4530	-	1110	97	0.24	0.527	<0.05	<0.0001	<0.05	0.001	0.188	<0.001	0.006	<0.001
1261	2/05/2011	ES1109205001	10.3	-	4310	-	1300	84	0.32	0.488	0.12	<0.0001	<0.05	0.003	0.161	0.006	0.005	0.002
1261	16/05/2011	ES1110179001	12.6	-	3920	-	1130	63	0.36	0.5	<0.05	<0.0001	<0.50	0.003	0.141	<0.001	0.005	<0.001
1261	26/05/2011	ES1111133001	12.4	-	3950	-	960	80	0.52	0.622	<0.05	<0.0001	<0.05	0.003	0.15	<0.001	0.005	0.002
1261	1/06/2011	ES1111766004	12.3	-	4030	-	1150	96	0.24	0.454	0.06	<0.0001	<0.05	0.002	0.138	<0.001	0.004	0.002
1261	1/07/2011	ES1114250001	12.4	-	3660	-	1040	54	0.4	0.551	<0.05	<0.0001	<0.05	0.004	0.14	<0.001	0.004	0.003
1261	12/07/2011	ES1114891001	12.6	-	3450	-	1220	72	0.46	0.568	<0.05	<0.0001	0.06	0.003	0.168	<0.001	0.005	0.003
1261	25/07/2011	ES1115923001	12.4	-	3590	-	1000	45	0.32	0.507	<0.05	<0.0001	0.11	0.002	0.143	<0.001	0.004	<0.001
1261	9/08/2011	ES1117221001	12.3	-	3430	-	1000	80	0.28	0.558	<0.05	<0.0001	<0.05	0.001	0.162	<0.001	0.004	0.003
1261	24/08/2011	ES1118478001	12.9	-	3210	-	992	65	0.19	0.541	<0.05	<0.0001	<0.50	0.003	0.143	<0.001	0.004	<0.005
1261	5/09/2011	ES1119286001	12.5	-	2640	-	802	73	0.22	0.403	<0.05	<0.0001	<0.05	<0.001	0.107	<0.001	0.004	0.002
1261	22/09/2011	ES1120774001	12.6	-	2570	-	856	48	0.26	0.413	0.06	<0.0001	<0.05	<0.001	0.113	<0.001	0.004	0.003
1261	4/10/2011	ES1121559001	12.4	-	2340	-	796	92	0.22	0.335	<0.05	<0.0001	<0.05	<0.001	0.084	<0.001	0.003	0.001
1261	24/10/2011	ES1123160001	12.7	-	1920	-	682	85	0.21	0.304	<0.05	<0.0001	0.07	<0.001	0.076	<0.001	0.003	0.003
1261	8/11/2011	ES1124426001	12.7	-	1750	-	618	93	0.14	0.252	0.08	<0.0001	0.29	<0.001	0.076	0.001	0.002	0.003
1261	21/11/2011	ES1125588001	12.8	-	1680	-	608	61	0.46	0.258	0.06	<0.0001	<0.05	<0.001	0.071	0.004	0.003	0.001
1261	22/12/2011	ES1128450001	12.1	-	1500	-	532	80	0.32	0.191	<0.05	<0.0001	<0.05	<0.001	0.069	0.001	0.002	0.001
1261	29/03/2012	ES1207655001	10.6	-	2180	-	732	57	0.1	0.327	<0.05	<0.0001	<0.05	0.001	0.084	<0.001	0.004	0.002
1261	23/04/2012	ES1209789001	9.7	-	2230	-	732	72	0.24	0.313	<0.05	<0.0001	0.17	0.005	0.084	0.007	0.004	0.004
1261	29/05/2012	ES1213289004	11.8	12	2820	2680	44	0.06	0.365	<0.05	<0.0001	<0.05	0.002	0.077	<0.001	-	-	0.001
1261	26/06/2012	ES1216274004	12.9	12.1	2800	2680	64	0.06	0.382	<0.05	<0.0001	<0.05	<0.001	0.084	<0.001	-	-	0.001
1261	26/07/2012	ES1218635004	11.99	12.2	2960	2070	67	0.04	0.356	<0.05	<0.0001	<0.05	<0.001	0.076	<0.001	-	-	<0.001
1279	27/07/2010	ES1014935009	7.04	6.72	2930	2780	1780	140	-	-	-	-	-	-	-	-	-	-
1279	17/09/2010	ES1018923002	10.12	10.3	248	3000	1720	458	-	-	-	-	-	-	-	-	-	-
1279	25/10/2010	ES1021484002	8.54	8.57	2005	2160	1290	282	-	-	-	-	-	-	-	-	-	-
1279	17/11/2010	ES1023420001	8.86	-	1940	-	1320	188	-	-	-	-	-	-	-	-	-	-
1279	22/12/2010	ES1026590005	8.89	-	1930	-	1210	180	0.1	0.101	0.1	<0.0001	<0.05	<0.001	0.112	0.001	0.009	0.002
1279	10/01/2011	ES1100464004	9.59	-	1800	-	1190	176	0.12	0.083	0.08	<0.0001	<0.05	0.001	0.123	<0.001	0.009	0.001
1279	2/02/2011	ES1102297003	9.18	-	1990	-	1210	147	0.07	0.066	0.1	<0.0001	<0.05	<0.001	0.113	0.002	0.009	0.002
1279	25/02/2011	ES1104293001	9.3	-	2000	-	1260	168	0.06	0.07	0.13	0.0003	<0.05	<0.001	0			



MAULES CREEK

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WHC_PLN_MC_WATER MANAGEMENT PLAN

Sample	Date Sampled	Order #	Field pH	Lab pH	Field EC	EC @ 25°C	Total Dissolved Solids @180°C	Sulfate as SO4	Aluminium (filit.)	Barium (filit.)	Boron (filit.)	Cadmium (filit.)	Iron (filit.)	Lead (filit.)	Lithium (filit.)	Manganese (filit.)	Molybdenum (filit.)	Nickel (filit.)
			pH Unit	pH Unit	µS/cm	µS/cm	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 Guideline Level	Drinking Water (Health & Aesthetic)		6.5 - 8.5	6.5 - 8.5	1500 ^f	1500 ^f	-	-	0.2 (A)	0.7	0.3	0.002	0.3 (A)	0.01	-	0.5 (H) 0.1 (A)	0.05	0.02
	ANZECC Livestock Drinking Water		-	-	7500 - 15000	7500 - 15000	5000 - 10000	1000 - 2000	5	-	5	0.01	-	0.1	-	-	0.15	1
	Long-Term Irrigation Water		-	-	9000 ^f	9000 ^f	-	-	5	-	0.5	0.01	0.2	2	2.5	0.2	0.01	0.2
	Limit or Reporting		0.01	0.01	1	1	1	1	0.01	0.001	0.05	0.0001	0.05	0.001	0.001	0.001	0.001	0.001
1280	27/07/2010	ES1014935010	7.67	7.31	0	2150	1310	52	-	-	-	-	-	-	-	-	-	-
1280	17/09/2010	ES1018923004	12	11.9	341	4450	1380	14	-	-	-	-	-	-	-	-	-	-
1280	25/10/2010	ES1021484004	12.58	12.4	1427	6290	2050	<1	-	-	-	-	-	-	-	-	-	-
1280	22/12/2010	ES1026590006	12.6	-	716	-	2870	3	0.22	1.35	<0.05	<0.0001	<0.50	0.005	0.264	<0.001	0.006	0.048
1280	10/01/2011	ES1100046000	12.2	-	669	-	2390	3	0.3	1.25	<0.05	<0.0001	<0.50	0.007	0.25	<0.001	0.005	0.027
1280	2/02/2011	ES1102297004	12.3	-	811	-	2400	4	0.28	1.17	<0.05	<0.0001	<0.50	0.011	0.246	<0.001	0.008	0.028
1280	25/02/2011	ES1104293002	12	-	8190	-	4190	5	0.06	1.17	<0.05	<0.0001	<0.50	0.006	0.242	<0.001	0.007	0.028
1280	28/03/2011	ES1106517002	11.9	-	8540	-	2300	<1	0.26	1.18	<0.05	<0.0001	<0.50	0.008	0.218	<0.001	0.007	0.028
1280	15/04/2011	ES1108240002	11	-	8490	-	2200	<1	0.26	1.3	<0.05	<0.0001	<0.50	0.003	0.304	<0.001	0.006	0.027
1280	2/05/2011	ES1109205003	10.8	-	8270	-	1960	3	0.43	1.07	<0.05	0.0002	<0.50	0.013	0.234	0.009	0.007	0.025
1280	16/05/2011	ES1110179004	12.6	-	7360	-	1960	4	0.28	0.886	<0.05	<0.0001	<0.50	0.066	0.218	0.003	0.007	0.022
1280	26/05/2011	ES1111133002	12.6	-	7330	-	1960	<1	0.35	1.13	<0.05	<0.0001	<0.50	0.006	0.205	0.001	0.007	0.024
1280	1/06/2011	ES1111768006	12.6	-	7310	-	2210	6	0.25	0.954	<0.05	<0.0001	<0.50	0.008	0.203	<0.001	0.007	0.022
1280	1/07/2011	ES1114250003	12.6	-	6820	-	2500	1	0.32	1.08	<0.05	<0.0001	<0.50	0.008	0.219	0.002	0.005	0.027
1280	12/07/2011	ES1114891003	12.1	-	6540	-	1910	2	0.39	0.964	<0.05	<0.0001	0.29	0.019	0.216	<0.001	0.008	0.026
1280	25/07/2011	ES1115923003	12.8	-	6630	-	2120	3	0.34	0.994	<0.05	0.0008	0.32	0.005	0.212	<0.001	0.005	0.007
1280	9/08/2011	ES1117221003	12.5	-	6720	-	2200	<1	0.34	0.954	<0.05	<0.0001	0.07	0.003	0.206	0.001	0.006	0.023
1280	24/08/2011	ES1118476003	12.9	-	6180	-	2140	2	0.38	0.967	<0.05	<0.0001	<0.50	0.002	0.194	<0.001	0.006	0.02
1280	5/09/2011	ES1119286003	12.9	-	6420	-	1920	2	0.28	0.88	<0.05	<0.0001	0.12	0.003	0.166	0.009	0.006	0.02
1280	22/09/2011	ES1120774003	13	-	6430	-	1840	2	0.11	0.977	<0.05	<0.0001	<0.50	0.001	0.203	<0.001	0.007	0.017
1280	4/10/2011	ES1121559003	13.3	-	6410	-	1990	<1	0.32	0.942	<0.05	<0.0001	<0.50	0.003	0.193	<0.001	0.006	0.023
1280	24/10/2011	ES1123160003	12.7	-	6530	-	2040	3	0.21	1.08	<0.05	<0.0001	<0.50	0.003	0.238	<0.001	0.006	0.028
1280	8/11/2011	ES1124428003	13.1	-	6470	-	2330	2	0.38	1.08	<0.05	<0.0001	1.52	0.004	0.239	0.001	0.004	0.038
1280	21/11/2011	ES1125589003	13.2	-	6430	-	2200	3	0.45	1.09	<0.05	<0.0001	<0.50	0.002	0.225	<0.001	0.006	0.03
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1280	29/03/2012	ES1207655003	10.8	-	6540	-	2230	<1	0.08	1.07	<0.05	<0.0001	<0.50	0.003	0.245	<0.001	0.006	0.026
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1280	29/05/2012	ES1213289003	12.5	12.4	8060	8160	<10	0.2	1.1	<0.05	<0.0001	<0.50	0.002	0.234	<0.001	0.002	0.023	
1280	26/06/2012	ES1216274006	12.93	12.5	8380	8470	2	0.12	1.16	<0.05	<0.0001	<0.50	0.002	0.283	<0.001	0.002	0.032	
1280	26/07/2012	ES1218635007	12.7	12.7	7630	-	<1	0.09	1.07	<0.05	<0.0001	<0.50	<0.001	0.265	<0.001	0.002	0.032	
1283	27/07/2010	ES1014935005	6.85	6.77	969	1510	1070	51	-	-	-	-	-	-	-	-	-	-
1283	20/09/2010	ES1018923005	14.8	11.9	489	4240	1390	24	-	-	-	-	-	-	-	-	-	-
1283	25/10/2010	ES1021484005	11.71	11.6	1390	945	492	82	-	-	-	-	-	-	-	-	-	-
1283	18/11/2010	ES1023537001	11.1	-	565	-	496	86	-	-	-	-	-	-	-	-	-	-
1283	22/12/2010	ES1026590007	10.2	-	746	-	460	83	0.76	0.034	0.14	<0.0001	<0.05	<0.001	0.045	<0.001	0.02	0.009
1283	10/01/2011	ES1100046006	11	-	850	-	496	80	0.17	0.038	0.07	0.0001	<0.05	<0.001	0.071	<0.001	0.013	0.003
1283	2/02/2011	ES1102297005	11.2	-	986	-	494	69	0.02	0.167	0.12	0.0002	<0.05	0.003	0.064	0.014	<0.001	0.003
1283	24/02/2011	ES1104111005	11.6	-	1	-	442	70	0.33	0.044	0.11	0.0001	<0.05	<0.001	0.07	<0.001	0.011	0.01
1283	28/03/2011	ES1106517007	7.91	-	1620	-	1020	65	<0.01	0.098	0.09	<0.0001	<0.05	<0.001	0.047	0.022	<0.001	0.005
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1283	2/05/2011	ES1109205005	10.2	-	1200	-	554	78	0.8	0.058	0.06	<0.0001	0.17	0.001	0.081	0.008	0.012	0.007
1283	24/05/2011	ES1110874002	11.6	11.5	1141	1120	598	83	0.95	0.056	0.06	<0.0001	0.09	<0.001	0.078	0.004	0.012	0.005
1283	1/06/2011	ES1111768007	11.5	-	1100	-	458	94	0.79	0.074	0.06	<0.0001	<0.05	<0.001	0.075	0.002	0.012	0.004
1283	1/07/2011	ES1114250005	11.6	-	1110	-	472	60	0.95	0.041	<0.05	<0.0001	<0.05	<0.001	0.087	0.002	0.012	0.004
1283	12/07/2011	ES1114891006	11.8	-	1070	-	470	81	0.91	0.039	<0.05	<0.0001	<0.05	0.001	0.09	0.003	0.013	0.005
1283	25/07/2011	ES1115923005	11.6	-	1100	-	474	82	1.02	0.047	<0.05	<0.0001	<0.05	<0.001	0.095	<0.001	0.013	0.005
1283	9/08/2011	ES1117221005	11.7	-	1110	-	482	84	1.15	0.046	<0.05	<0.0001	<0.05	<0.001	0.09	<0.001	0.013	0.005
1283	24/08/2011	ES1118476006	12.1	-	1030	-	470	80	0.88	0.123	0.05	<0.0001	<0.05	<0.001	0.088	<0.001	0.013	0.004
1283	5/09/2011	ES1119286006	11.8	-	1020	-	416	82	0.94	0.05	<0.05	0.0004	<0.05	<0.001	0.088	<0.001	0.014	0.004
1283	23/09/2011	ES1120774006	12.1	-	1070	-	526	86	1.05	0.038	<0.05	<0.0001	<0.05	<0.001	0.08	<0.001	0.014	0.005
1283	4/10/2011	ES1121559006	12.2	-	992	-	506	90	0.92	0.046	<0.05	<0.0001	<0.05	<0.001	0.081	<0.001	0.013	0.005
1283	24/10/2011	ES1123160006	12	-	978	-	474	91	1.12	0.031	<0.05	<0.0001	<0.05	<0.001	0.086	<0.001	0.013	0.005
1283	8/11/2011	ES1124428007	11.9	-	975	-	580	86	0.82	0.055	0.1</							

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		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
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APPENDIX E

GROUNDWATER TRIGGER LEVELS



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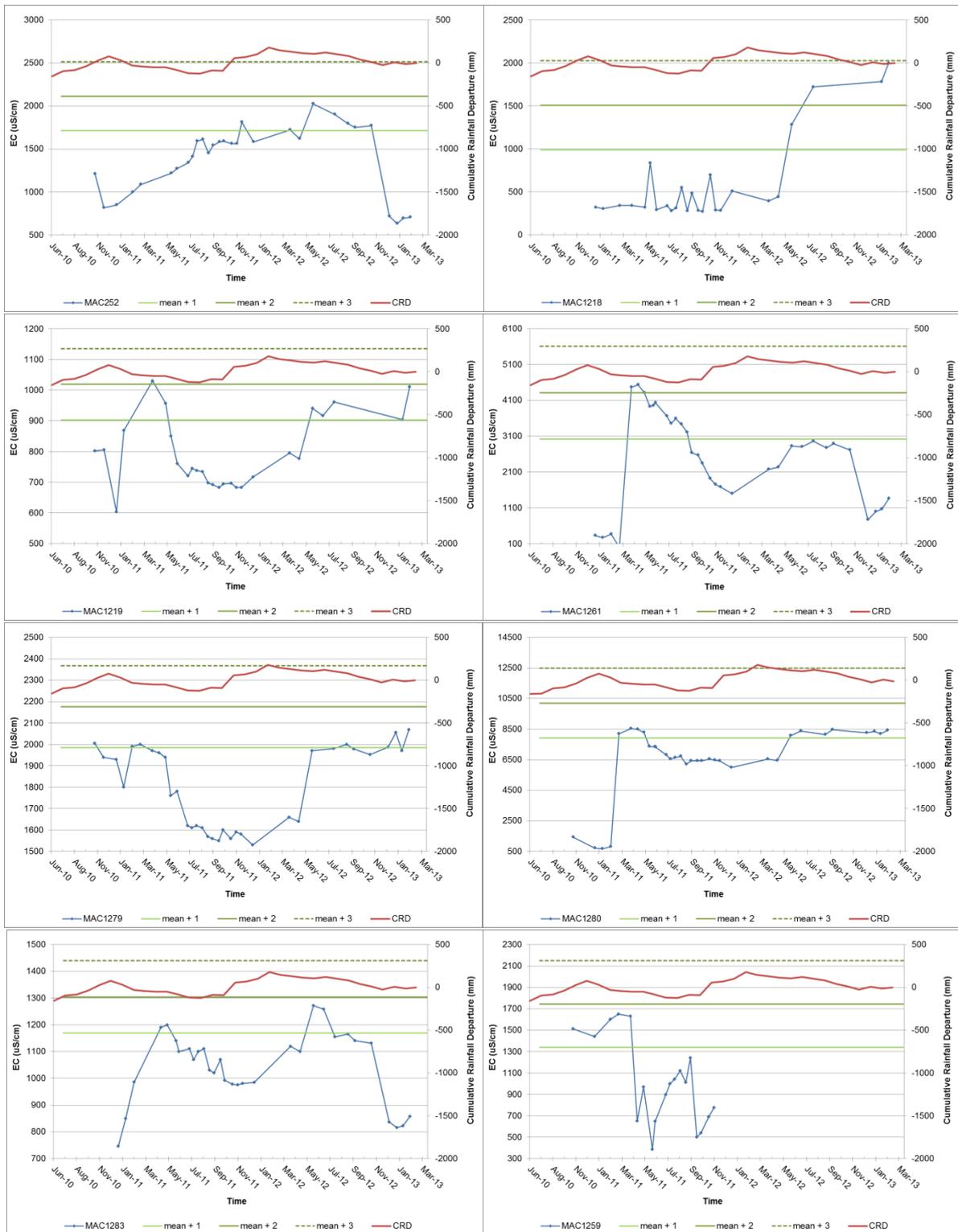


Figure E1 EC Trigger Level – Control Charts



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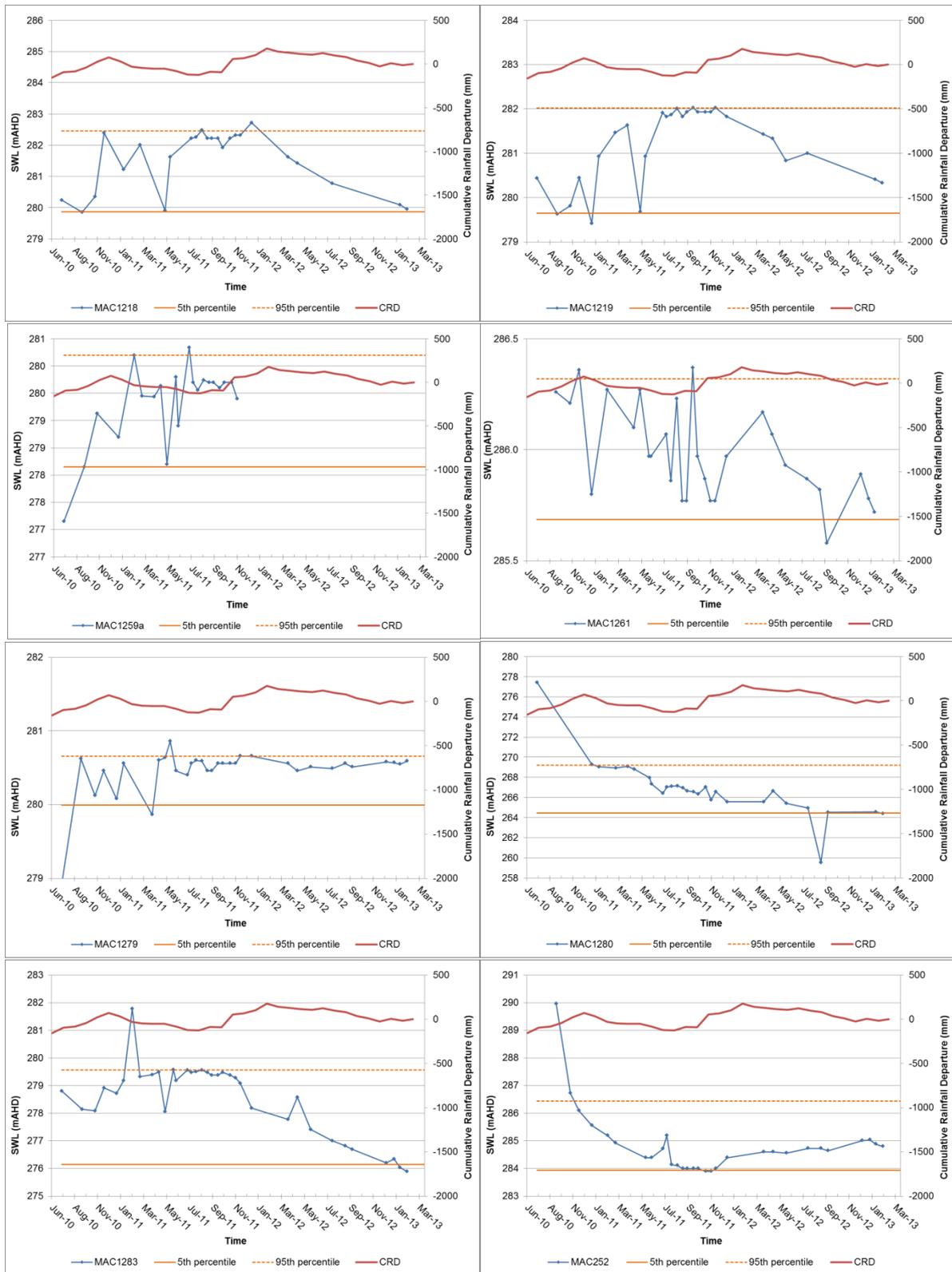


Figure E2 SWL Trigger Level – Control Charts

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		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
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APPENDIX F

LETTER OF ADVICE TO SEWPAC



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Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

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12 March 2013

Mr Dean Knudsen
First Assistant Secretary
Department of Sustainability, Environment, Water, Population and Communities
GPO Box 787
Canberra ACT 2601

Dear Dean

Addressing cumulative groundwater drawdown impacts associated with operation of the BTM Complex

This response has been prepared to address matters relating to the management of the anticipated cumulative groundwater drawdown impacts caused by the concurrent operation of the Boggabri, Tarrawonga and Maules Creek Coal projects (hereby referred to as the BTM Complex). Specifically, the advice provided herein refers to Condition 22 of the Maules Creek Coal Mine Project (EPBC 2010/5566) approval, granted on 11 February 2013.

Condition 22 of the approval requires the proponents to provide written advice to the Minister demonstrating how surface and groundwater management plans are addressing the cumulative impact of groundwater drawdown as a result of mining and how this may impact on the consequent health of the remnant native vegetation in the Leard State Forest, the Leard State Conservation Area and surrounding areas. In particular the condition requires provision of advice on the following matters:

- a. The maximum amount of allowable drawdown in the alluvial aquifer
- b. Drawdown in hard rock
- c. Trigger levels pertaining to drawdown in the alluvial aquifer when corrective actions will be required to be undertaken
- d. Identify the depth of root zone of the native vegetation
- e. Monitoring to assess the ongoing quality and quantity of both surface and groundwater to identify impacts on the native vegetation

Surface Water and Groundwater Management Plans have been developed for the Maules Creek Coal project. The following sections outline how each matter is addressed. **Figure 1:** illustrates how these relate to overarching water management plans and strategy documentation as applied to the broader BTM Complex.



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Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
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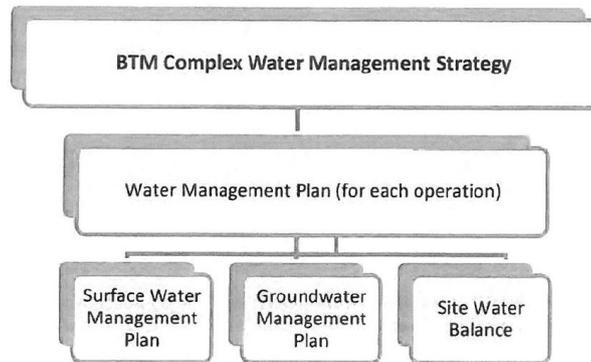


Figure 1: Operation water management and strategy hierarchy

1. Maximum amount of allowable drawdown in the alluvial aquifer

Cumulative groundwater modelling for the BTM Complex (Heritage Computing, 2012) has been undertaken to inform the BTM Complex Water Management Strategy (Idemitsu Australia Resources and Whitehaven Coal Pty Ltd, 2013). Predicted drawdown extents determined during this exercise have been shown to extend into alluvium located to the south of the BTM Complex (Figure 2).

In response to this, the proponents of the BTM complex set out in their respective groundwater management plans, intent to establish a series of monitoring bores adjacent to the edge of the predicted one-metre water table drawdown zone in the alluvium (Figure 2). Water level information collected at these locations will be used to establish baseline conditions and refine numerical groundwater modelling predictions of maximum groundwater drawdown.

Groundwater trigger levels relating to drawdown in the alluvial aquifer as a result of the BTM Complex have been developed and are discussed further in section 4.

2. Drawdown in hard rock

Management of groundwater drawdown in hard rock anticipated as a result of the BTM Complex is set out in the respective groundwater management plans for each operation. These plans incorporate



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

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recommendations made by Heritage Computing (2012) following modelling of cumulative groundwater impacts.

Predicted drawdown derived from cumulative groundwater modelling (Heritage Computing, 2012), as a result of operation of the BTM Complex, is shown to extend into the hard rock formations; the Maules Creek Formation and the Boggabri Volcanics (Figure 2).

Groundwater monitoring bores currently installed within the Maules Creek Formation and Boggabri Volcanics (Figure 2) are directly impacted by dewatering operations at the BTM Complex, and as such cannot be used to set meaningful groundwater trigger levels. In response to this, the proponents of the BTM complex have set out in their respective groundwater management plans, intent to establish a series of monitoring bores outside the predicted one-metre drawdown zone in the Maules Creek Formation and Boggabri Volcanics (Figure 2). Information obtained from these monitoring locations will be used as a basis to determine trigger water levels to detect potential regional drawdown impacts within the hard rock aquifer.

These triggers will incorporate monitoring of impacts resulting from the cumulative effect of the BTM Complex. Trigger levels will be determined and assigned based on departure of measured groundwater heads and vertical head difference from model predictions at specific and identified monitoring bores.

Furthermore, these triggers will consider results from the proposed hydrocensus and groundwater dependent ecosystem (GDE) survey and be developed in consultation with land owners, NOW and the Aquifer Interference Policy (DPI, 2012).



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
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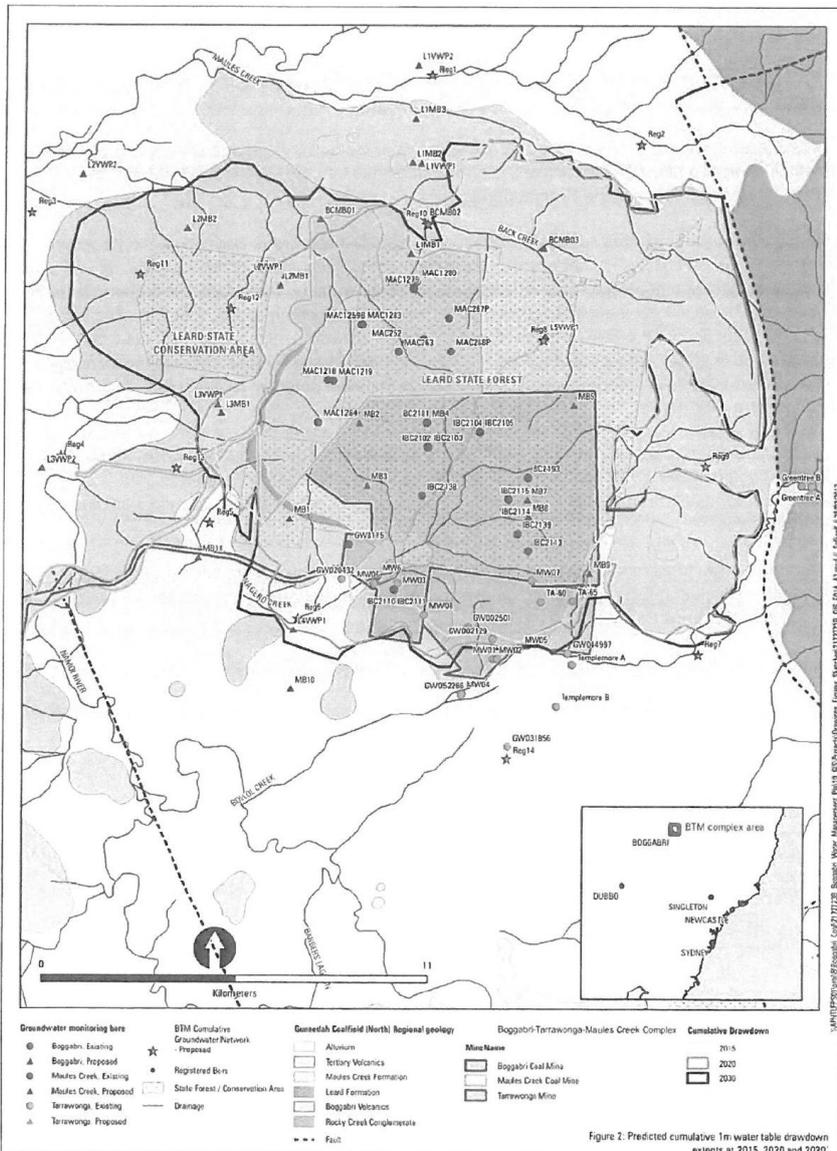


Figure 2: Predicted cumulative 1m water table drawdown extents at 2015, 2020 and 2030

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Page 4



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

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3. Trigger levels pertaining to drawdown in the alluvial aquifer

Groundwater trigger levels relating to drawdown in the alluvial aquifer as a result of the BTM Complex have been developed on the basis of cumulative groundwater modelling conducted by Heritage Computing (2012). These trigger levels are set out in the respective groundwater management plans for each operation.

Groundwater trigger levels will be set for the proposed alluvial monitoring bores Reg 1, Reg 2, Reg3, Reg5, Reg 6, Reg 7, Reg 11 and Reg 13 (with control sites at Reg 4 and Reg 14) (Figure 2), once baseline data is available. These trigger levels will be devised on the basis of a 7-day moving average in each monitoring bore. Where the 7 day average exceeds the historical 5th percentile value, established from the preceding 24 months, a triggering event occurs. These triggers assume dataloggers are installed at all monitoring sites, with a six-hourly sample frequency, and monthly downloads (Heritage Computing, 2012).

Site specific groundwater trigger levels for the alluvial aquifer are set out in the respective groundwater management plans for each operation.

In the event that trigger levels are exceeded, preventative actions will be identified, communicated and agreed on with proponents of the BTM complex. Actions will likely occur in the following sequence:

1. Compare water levels to control site to determine if the cause cannot be directly attributed to natural seasonal variations
2. Engage the services of a groundwater specialist to ascertain cause for the decline in water level
3. If deemed that activities of the BTM complex are contributing to the decline in water level, potential impacts on groundwater dependent ecosystems are to be assessed in accordance with the BTM Complex biodiversity strategy, and appropriate groundwater management responses developed in consultation with NOW
4. An action plan to reduce the impact will be developed in consultation with NOW, with additional monitoring implemented as necessary
5. Reporting of incidents and responses will form part of the Annual Environmental Management Report.



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Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

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4. Identify the depth of root zone of the native vegetation

An ecology impact assessment conducted to inform the Maules Creek Coal Project Environmental Assessment identified *Melaleuca* sp. along the alignment of Back Creek. These species are likely to have a root zone extending up to 2 to 3 m below the land surface. Ongoing management of potential cumulative impacts to native vegetation is outlined in section 5.

Beyond the presence of *Melaleuca* sp. a recent desktop review of the depth of root zone of native vegetation proximal to the BTM complex noted the majority of vegetation communities occur on slopes and ridges associated with well drained soils characterised by shallow skeletal conglomerate on the steeper upper slopes and drainage lines and deep basaltic derived fertile soils on the lower slopes, disconnected from localised groundwater systems. Roots are unable to grow far into soil horizons that are of high bulk density (i.e. excessively stony soils). Consequently, rooting depth in areas of shallow bedrock is limited. These vegetation types do not require a supply of groundwater within the root zone and groundwater is not within the rooting depth of the vegetation. As such, they are excluded from groundwater dependency given their location in the landscape. These vegetation types utilise rainfall to support growth and photosynthesis. This includes vegetation that occurs adjacent to ephemeral streams.

Riparian forests such as the River Red Gum open forest on the banks of the Namoi River are considered to be stream fed ecosystems which rely upon lateral movement of surface water with some contribution from shallow groundwater. The loose, deep and well-drained alluvial soils with large pore spaces promote greater root depths as they are well aerated and provide less resistance to root penetration (rooting is not limited by underlying rock).

Ironbark and Box eucalypts, such as those that dominate the lower slopes of the study area, are shallow rooted and allocate substantial biomass to above-ground parts at the expense of an expansive root system (Fensham & Fairfax, 2007).

While loamy soils allow considerable root development, the remnant vegetation communities (Pilliga Box – Popular Box – White Cypress Pine Grassy Open Woodland and Plains Grassland) that are restricted to the lower lying plain areas are associated with shallow perched water tables over impermeable clay lenses rather than groundwater fed by subsurface aquifers. This vegetation is likely to send roots to the perched water table but not through the impermeable clay lens. This also applies to Derived Native Grassland and Exotic Grassland vegetation types.

Broad ecosystem scale studies have shown that sclerophyllous shrubland and forest (such as that in the study area) have a mean rooting depth of 5.2 ± 0.8 m (Canadell et al. 1996). Average rooting depth for temperate grassland has been shown to be 2.6 ± 0.2 m (Canadell et al. 1996).

As part of the proposed management of the BTM Complex impact on GDEs, the respective operational water management plans set out the following mitigation and monitoring measures;



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

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- A localised tree root depth study using replicate samples within each of the broad vegetation types in the study area. This study will provide site specific local data on the potential root depths and validate or otherwise the literature assessment of the like root depths of local vegetation
- A GDE monitoring network including floristic and vegetative heath assessments for replicate sites in watch of the potential GDE vegetation types, *Melaleuca sp.* and River Red Gum communities. These floristic monitoring sites will be paired with shallow groundwater monitoring bores to identify potential correlations between the health and depth to water

5. Monitoring to assess the ongoing quality and quantity of both surface and groundwater to identify impacts on the native vegetation

An ecology impact assessment conducted to inform the Maules Creek Coal Project Environmental Assessment identified *Melaleuca sp.* along the alignment of Back Creek. As outlined in section 4, these species are likely to have a root zone extending up to 2 to 3 m below the land surface. Cumulative groundwater modelling (Heritage Computing, 2012) predicts groundwater levels to potentially be within 2 m of the land surface in some zones along Back Creek.

In response to this, Maules Creek Coal have set out in their water management plan (Whitehaven Coal Pty Ltd, 2013), intent to install additional groundwater monitoring bores in the vicinity of Back Creek to determine if the vegetation is likely to be groundwater dependent and monitor for ongoing quality and quantity to identify potential impacts.

Beyond vegetation associated with Back Creek, vegetation in the project area is not expected to be groundwater dependent (Idemitsu Australia Resources & Whitehaven Coal Pty Ltd, January 2013). If GDEs are identified during proposed GDE surveys, and are assessed to be potentially impacted, the respective operational groundwater and surface water management plans will be revised accordingly. Additionally, an annual GDE monitoring network will be undertaken, including floristic and vegetative heath assessments for replicate sites in the potential GDE vegetation types, *Melaleuca sp.* and River Red Gum communities. These floristic monitoring sites will be paired with piezometers locations to identify potential correlations between the vegetation health and water depths.

Surface water quantity and quality monitoring results from the preceding year will serve as an input to the annual assessment.

If through the annual monitoring program the vegetation condition and/or general health is found to deteriorate through the likely association with localised draw down impacts to the ground water. A restoration plan will be developed to further mitigate the potential impacts.

If you require any further information, please do not hesitate to contact Dan Martin on (02) 6749 7804.



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Yours sincerely

Brian Cole
Executive General Manager – Project Delivery
Whitehaven Coal

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	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

APPENDIX G

RESPONSE TO MATTERS RAISED BY SEWPAC 17 MAY, 2013.

	<h1>MAULES CREEK</h1>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

G1. PURPOSE & BACKGROUND

SEWPaC has reviewed the Water Management Plan presented in a number of drafts since early March, 2013 and requested modifications to the plan to address some concerns related to ongoing matters of national environmental significance. In particular the concerns were in relation to the proposed monitoring regime so that SEWPaC could be satisfied that any groundwater was being monitored in a way that could verify analyses made in the Environmental Assessment that there would be no significant impacts upon matters of national environmental significance, including the critically endangered Box Gum Woodland and Derived Native Grassland, and other forest and woodland that support habitats for Swift Parrot, Regent Honeyeater and Greater Long-eared Bat.

The purpose of this Appendix is to provide an overview of groundwater regime within the Project Boundary and the surrounding areas containing vegetation and explain how changes in the groundwater regime will be monitored with respect to matters of national environmental significance.

G2. OVERVIEW OF GROUNDWATER WITHIN THE PROJECT ENVIRONS

The groundwater regime in the environs of the future Maules Creek Mine has been extensively studied since investigations first began in the 1980s and so is well understood. The hydrogeological regime in the locality surrounding the mine consists of the following hydro stratigraphic units:

- Quaternary alluvium associated with river and creek systems that forms a productive aquifer system - this alluvium is not present in the mining area and is relatively distant at between 3 km and 9 km from the mine pit ;
- Weathered bedrock (regolith) that is generally unsaturated but acts as a temporary water store during sustained wet periods;
- Permian sandstone/siltstone interburden that is typically an aquitard, and therefore retards the flow of groundwater; and
- Permian coal seams of the Maules Creek Formation that form a low yielding poor quality aquifer.

The bedrock underlying the alluvial aquifers outcrops as distinctive, sometimes rugged hills surrounded by the generally flat to gently sloping plains of the Namoi Valley alluvial aquifer. The shallow bedrock aquifer is comprised of superficial soils and weathered rock. It averages about 25 m in thickness and is up to 60 m thick within the Project Boundary. As the groundwater table is several tens of metres below ground level the shallow bedrock aquifer is generally dry in the elevated areas of the Leard State Forest which corresponds with the mine footprint.. It does however, for limited periods of time, act as a temporary groundwater store during periods of significant and continuous rain events. The vegetation in these areas has clearly adapted to these climatic and subsurface conditions.

The Permian strata can be categorised into the following hydrogeological units:

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

The Permian sedimentary deposits occur as a regular layered easterly to north-easterly dipping sedimentary sequence that are underlain by the Boggabri Volcanics. The basal Boggabri Volcanics outcrop in the western area of the Project.

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

Investigation bores drilled in the mine environs indicate that the static water level is generally some 50 to 70 metres below ground level. Hydraulic packer testing was carried out at four core holes within the Project area. The investigation found that the hydraulic conductivity of the coal seams varies between 0.01 m/day and 0.1 m/day. Low yields within the coal seams, of less than 1 L/s, were also documented.

Numerical modelling of groundwater flow regime was undertaken by using a recognised computer model which adopted conservative parameters to represent the fractured rock and alluvial systems. Even so, the modelling indicates that the depressurised zone may have a one metre drawdown at the end of mining in year 21, extending between 5km and 7km from the proposed open cut mine footprint. The zone of influence is forecast to remain largely within the Permian outcrop zone. These modelling outcomes have been confirmed by other independent hydrogeological models and therefore can be considered to be highly reliable and predictable. The conclusion that can be drawn from these analyses is that the groundwater effects due to mining activity as a result of the hydrogeological properties of the stratigraphy in and around the Project area are minimal and all likelihood will be well within normal seasonal variations.

As the mine develops slowly in areal extent, in all likelihood, it will be at least ten years into the mine life before groundwater effects in terms of significant depressurisation are even detectable.

Investigation bores drilled in the mine environs indicate that pre mining, the static water level is generally some fifty to seventy metres below ground level which accords with the stratigraphic descriptions indicated above. That is, that the bedrock that outcrops in the project area is generally dry and unsaturated.

The Box Gum Woodland, and other forest and woodland vegetation in the Project Boundary generally occur on dry soil landscapes that are not supported by groundwater. Research indicates that roots zones for forest and woodland vegetation in the Project Boundary is likely to be concentrated in a zone from two to four metres below ground level, and that such vegetation generally occurs on soil landscapes where groundwater is well below root depth. No groundwater dependent ecosystems have been detected within the Project Boundary because the groundwater table is demonstrably well below the root zone of any vegetation in that area (below 10 plus metres). However, outside the Project Boundary, along the alignment of Back Creek, *Melaleuca bracteantha* occurs to a limited extent. This shrub species is likely to have a relatively shallow root zone concentrated at 1 to 2 metres depth below the land surface. The groundwater model has predicted groundwater levels are potentially within 5 m to 10 m of the land surface in some zones along Back Creek and potentially within the vicinity of the root zones of the *Melaleuca* although likely to be of limited influence.

The mine pit will be located in an elevated area where the depth to the saturated zone is significant (i.e., several tens of metres), and can be over 100 m at topographic high points. The topography falls from the elevated areas around the planned mine to the lower lying land along the Back Creek drainage alignment. Along Back Creek the water table is potentially in closer proximity to the land surface, and it is only within these areas where it is considered there is potential for vegetation to have roots extending close the water table. Even then it could be several metres away.

G3. BASELINE GROUNDWATER DATA

Maules Creek Coal proposed that in addition to the monitoring boreholes installed during the initial site investigation phase, additional bores would be established as part of the implementation of the WMP It was intended that the location of these bores would be finalised following consultation with NOW. That consultation has now occurred and as a result the bore locations have now been finalised. The finalised bore locations are shown on Figure G1.

The location of the new monitoring network:

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

- aligns with the cumulative approach set down for the three operating mines.
- radiates out from the mining zone, and allows the project to monitor the zone of influence throughout life of the project.
- will provide ongoing data to validate and update the conservative groundwater models that have been produced.
- provides for a rigorous monitoring regime to be implemented during operations to monitor any relationship between the coal measures and alluvial zones.
- targets areas of where water tables may be closer to ground surface level which will enable connectivity (if any) between the native vegetation and coal measures to be understood and monitored.

Figure G2 below indicates the vegetation communities, the zones where the groundwater model indicates the water table is potentially within 5 m to 10 m of the land surface and the monitoring network agreed with NOW. This figure also indicates existing and proposed monitoring points relative to vegetation types e.g. to Leard State Forest, the Leard State Conservation Area and patches of native vegetation in the local vicinity surrounding the mining precinct (including the proposed offsets where relevant providing linkages and connectivity to larger patches of vegetation in the landscape).

As shown in Figure G2, Maules Creek Coal will install further groundwater bores in the vicinity of Back Creek to determine if the *Melaleuca* dominated vegetation along Back Creek is groundwater dependent and monitor for potential impacts. In these boreholes both water level and quality will be measured. With respect to vegetation management the network of bores will:

- a) be located in the vicinity of any shallow alluvium along Back Creek and will identify the maximum drawdown - if it exceeds estimated drawdown to the extent that vegetation may be effected then ameliorative actions will be initiated;
- b) be located in coal measures where the groundwater table is several tens of metres below the root zone of the vegetation will enable the hydraulic gradient to be monitored well in advance of any impact on vegetation;
- c) allow the trigger levels developed from modelling and baseline data to be applied and corrective actions implemented if necessary to maintain the health of native vegetation; and
- d) allow monitoring of water quality of groundwater to identify impacts on native vegetation for the life of the project.



MAULES CREEK

Document Owner:	Env. Manager
Revision Period:	2 years
Issue:	2
Last Revision Date:	March 2019
Date Printed:	

WHC_PLN_MC_WATER MANAGEMENT PLAN

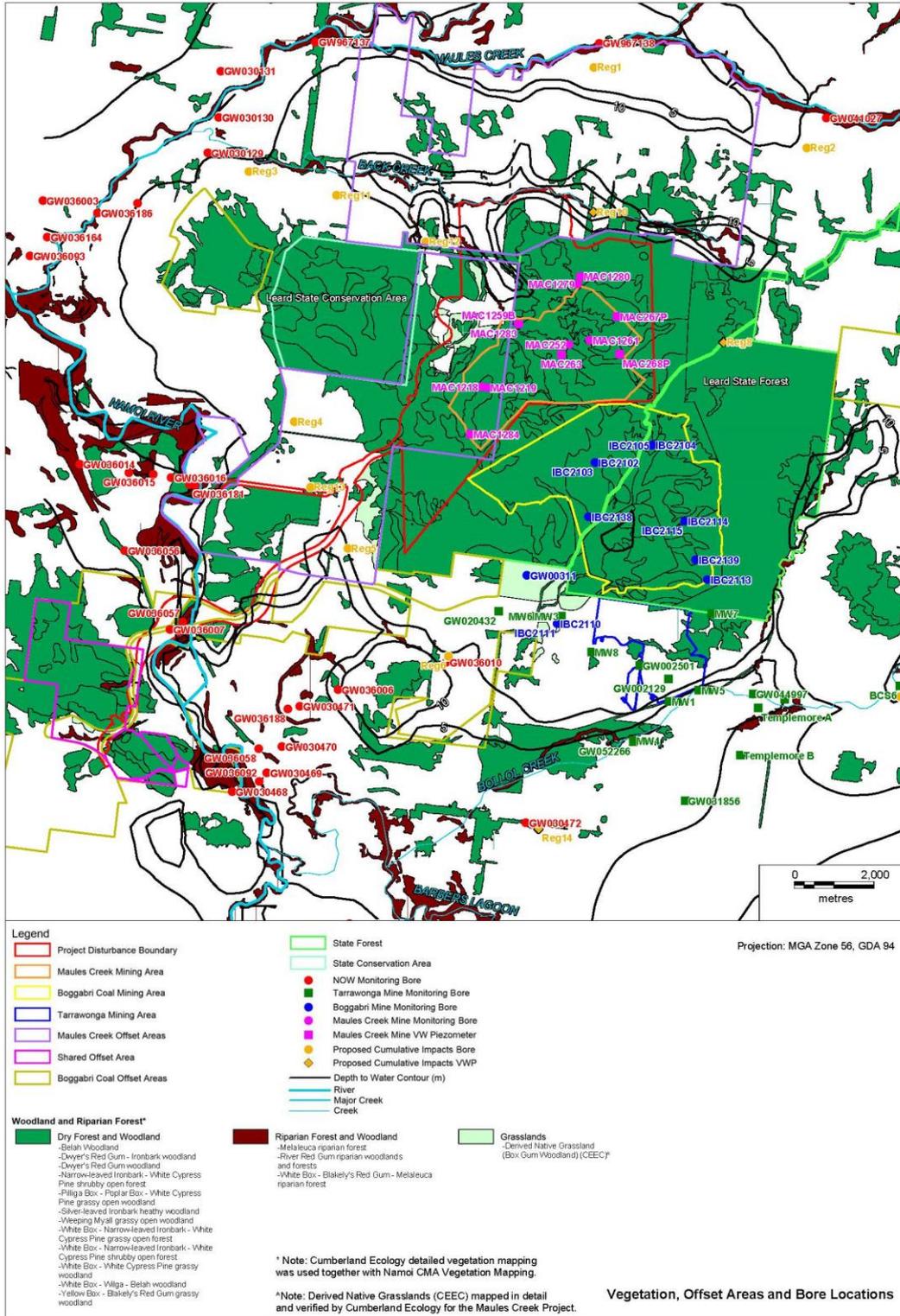


Figure G2: Vegetation, Offsets Areas and Monitoring bore locations

	<h2>MAULES CREEK</h2>	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

G4. MONITORING IMPACTS ON MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE AND TAKING CORRECTIVE ACTION.

Based on a conservative numerical model of groundwater effects, the risks to matters of national environmental significance due to mining-induced groundwater changes are extremely low and confined to a few areas on the margins of the Project Boundary (particularly the *Melaleuca bracteantha* riparian shrub land). Notwithstanding that, the modelled impacts of groundwater changes will be verified by a comprehensive monitoring regime.

The outcomes of the modelling that will be monitored include:-

- Average groundwater seepage rates of around 550 ML/year (~1.5 ML/day) with a peak of up to 1,064 ML/year (4 ML/day in year 14);
- Average reduction in recharge to the neighbouring alluvial aquifers of around 50 ML/year with a peak of up to 128 ML/year (0.35 ML/day at end of mining);
- Change in groundwater levels within the alluvial aquifers (beyond the natural rates of fluctuation) as a result of the Maules Creek Coal Mine;
- Change in groundwater levels within the coal seam Permian coal measures limited to the vicinity of the mining operations as mining progresses; and
- Any effect on water quality of the Permian coal seam aquifer due to mining activities.

Groundwater levels will be compared to the 5th and 95th percentile values for the available dataset . The use of a 5th percentile rule will mean that groundwater elevations can be expected to be below this threshold for five percent of measurements, if future climatic conditions match what has occurred during the baseline monitoring period.

To counteract spurious measurements, which could occur for example during maintenance of a sensor or downloading or water sampling, a 7-day average will be calculated. In addition, to ensure the "breach" of a trigger is sustained and is therefore significant, a 1-month exceedance duration will be adopted to allow water levels to stabilise. This would "trigger" an investigation in the first instance, not an immediately reportable incident.

Research indicates that roots zones for vegetation in the Project Boundary is likely to be concentrated in a zone from two to four metres below ground level. To verify actual root zone depths of different tree species Maules Creek will investigate the depths through excavations of selected trees and will investigate the application of soil moisture meters to measure soil moisture profiles.

Data management and annual reporting will include:

- Review of depressurisation of coal measures and drawdown within alluvial aquifers;
- Monitoring of impacts on GDEs;
- Comparison of observed depressurisation with model predictions;
- Review of data and comparison to the defined trigger levels;
- Actions and responses taken if trigger levels are exceeded; and
- Review of trigger levels and baseline data.

In addition Maules Creek Coal will liaise closely with NOW to share knowledge and experience.

	MAULES CREEK	Document Owner:	Env. Manager
		Revision Period:	2 years
		Issue:	2
		Last Revision Date:	March 2019
		Date Printed:	
WHC_PLN_MC_WATER MANAGEMENT PLAN			

In the event that monitoring indicates that groundwater changes are occurring at a scale that could result in a significant deleterious impact on matters of national environmental significance, the Groundwater Management Protocol will be activated as shown in the table below:

Groundwater Management Protocol

Stage	Procedure
1	Review the unforeseen impact, including consideration of: <ul style="list-style-type: none"> ▫ Any relevant monitoring data; and ▫ Current mine activities and land management practices in the relevant catchment;
2	Commission an investigation into the unforeseen impact by an appropriate specialist selected in consultation with appropriate regulatory authorities;
3	Develop appropriate ameliorative measures based on the results of the above investigations, in consultation with the relevant authorities; these ameliorative measures could include changes to the sequence of mining operations, investigation into aquifer recharge opportunities, review of the ground water models and drawing on experience at other mine sites with similar groundwater issues.
4	Implement additional monitoring where relevant to measure the effectiveness of the ameliorative measures.

G5. CONSISTENCY WITH THE NATIONAL WATER QUALITY MANAGEMENT STRATEGY (NWQMS)

Following discussions with the SEWPaC Water Policy Section it was agreed that the issue raised regarding consistency with NWQMS could be addressed to SEWPaC's satisfaction by adopting water quality target values from the Murray Darling Basin Authority's Basin Plan for the Namoi Basin. Maules Creek Coal has agreed to doing that.

The discussions with the Water Policy Section provided an opportunity to advise the Section that Maules Creek Coal has undertaken a detailed impact assessment of the Project on receiving water quality and quantity under the full range of historical climatic conditions, as documented in the surface water assessment report (Appendix L of the Environmental Assessment). The proposed water management strategy for the Project is based on containing any poor quality water generated on the site within the site water management system to be recycled for on-site use. Hence, the project will not adversely affect receiving water quality.