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Dunmore Hard Rock Quarry Annual Review

1 July 2022 – 30 June 2023

Document Control Sheet

Document Control				
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Dunmore Hard Rock Quarry Annual Review Title Block

Name of operation	Boral Dunmore Hard Rock Quarry
Name of operator	Boral Resources (NSW) Pty Ltd
Development consent	DA-470-11-2003
Name of holder of development consent	Boral Resources (NSW) Pty Ltd
Water licence number	WAL#25152 Ref# 10AL103610
Name of holder of water licence	Boral Resources (NSW) Pty Ltd
Name of holder of EPL	Boral Resources (NSW) Pty Ltd
Annual Review start date	1 July 2022
Annual Review end date	30 June 2023

I, Glenn Lowerson, certify that this audit is a true and accurate record of the compliance statues of the Dunmore Hard Rock Quarry for the period of the 2023 Financial Year and that I am authorised to make this statement on behalf of Boral Resources (NSW) Pty Ltd.

Note

The annual review is an 'environmental audit' for the purposes of section 122B(2) of the Environmental Planning and Assessment Act 1979. Section 122E provides that a person must not include false or misleading information (or provide information for inclusion in) an audit report produced to the Minister in connection with an environmental audit if the person knows that the information is false or misleading in a material respect. The maximum penalty is, in the case of a corporation, $1 million and for an individual $250,000.

Name of authorised reporting officer	Glenn Lowerson
Title of authorised reporting officer	Quarry Manager
Signature	
Date	29/09/2023

Contents

1. Purpose and Scope 12
1.1. Statement of Compliance 14
1.2. Contacts Relevant to Dunmore Quarry Operations 17
2. Dunmore Quarry Operations 18
2.1. Operations the last 12 months 19
2.2. Operations the next 12 months 19
2.3. Licences and Approvals 19
3. Production, Sales and Transport 20
3.1. Transport Dispatch Data 21
3.1.1. Transport Options Review 21
4. Actions Required from Previous Annual Review 23
5. Environmental Performance 24
5.1. Meteorological Monitoring 24
5.1.1. Meteorological Monitoring Long Term Analysis and Trends 24
5.1.2. Meteorological Monitoring Summaries and Opportunity for Improvement 24
5.2. Air Quality Monitoring 25
5.2.1. Deposited Dust Monitoring Assessment Criteria 25
5.2.2. Deposited Dust Monitoring FY23 Performance Review 27
5.2.3. Particulate Monitoring Assessment Criteria 29
5.2.4. Particulate Monitoring FY23 Performance Review 30
5.2.5. Air Quality Monitoring Long Term Analysis and Assessment 31
5.2.6. Air Quality Monitoring Summary and Opportunities for Improvement 32
5.3. Blast Monitoring 32
5.3.1. Blast Monitoring Impact Assessment Criteria 33
5.3.2. Blast Monitoring FY23 Performance Review 34
5.3.3. Blast Monitoring Long Term Analysis and Trends 35
5.3.4. Blast Monitoring Summary and Opportunities for Improvement 36
5.4. Noise Monitoring 36
5.4.1. Noise Monitoring Impact Assessment Criteria 36
5.4.2. Noise Monitoring FY23 Performance Review 39
5.4.3. Noise Monitoring Long Term Analysis and Trends 40
5.4.4. Noise Monitoring Summary and Opportunities for Improvement 45
5.5. Surface Water Monitoring 45
5.5.1. Surface Water Quality Impact Assessment 46
5.5.2. Surface Water Quality FY23 Performance Review 47
5.5.3. Surface Water Long Term Analysis and Trends 63

5.5.4. Water Balance and Consumption 64
5.5.5. Surface Water Quality Summary and Opportunities for Improvement 66
5.6. Ground Water Monitoring 67
5.6.1. Groundwater Monitoring Impact Assessment Criteria 68
5.6.2. Groundwater Monitoring FY23 Performance Review 68
5.6.3. Groundwater Monitoring Summary and Opportunities for Improvement 69
5.7. Flora and Fauna Management and Rehabilitation 69
5.7.1. Flora and Fauna Impact and Rehabilitation Assessment Criteria 71
5.7.2. Flora and Fauna and Rehabilitation FY23 Performance Review 72
5.7.3. Flora and Fauna and Rehabilitation Summary and Opportunities for Improvement 90
5.8. Heritage Conservation 90
5.9. Waste Minimisation 90
5.9.1. Waste Tracking Register 90
5.9.2. Waste Minimisation Opportunities for Improvement 91
5.10. Incident and Emergency Response 91
5.11. Dangerous and Hazardous Goods Storage 92
6. Community 93
6.1. Environmental Complaints Management 93
6.2. Summary of Regulatory Notifications 94
7. Activities to be completed by the Next Reporting Period 95
8. Conclusion 96
9. Appendix A Meteorological Monitoring Locations Data and Graphs 97
10. Appendix B Air Quality Monitoring Additional Data and Graphs 106
11. Appendix C MAC Noise Monitoring Annual Compliance Report 112
12. Appendix D Blast Monitoring Tables 132
13. Appendix E EMM Ground Water Monitoring Annual Report 133
Appendices 136
1 Introduction 137
1.1 Site operations 138
1.2 Approvals history 138
1.3 Scope of works 138
2 Environmental setting 5
2.1 Site setting 5
2.2 Climate 5
Table 2.1 Average monthly rainfall and evaporation statistics 5
Table 2.1 Average monthly rainfall and evaporation statistics 6

Figure 2.1 Cumulative deviation from long-term monthly mean rainfall 7
2.3 Surface water 8
2.4 Geology 8
2.5 Hydrogeology 9
2.5.1 Overview 9
2.5.2 Conceptual hydrogeological model i Groundwater flows 9
3 Groundwater monitoring program 12
3.1 Monitoring network design 12
3.2 Groundwater quality 13
Table 3.2 Groundwater quality monitoring program 13
3.3 Sampling methodology 13
3.4 Chemical analysis 13
Table 3.3 Water quality suite of analysis 13
3.4.1 Quality assurance and quality control (QA/QC) 14
3.4.2 Laboratory QA/QC 14
3.5 Groundwater levels 14
4 Groundwater levels 15
4.1 Alluvium 15
4.2 Bumbo Latite 15
Figure 4.1 Groundwater levels in the alluvium 16
Figure 4.2 Groundwater levels in the Bumbo Latite 18
5 Groundwater quality 20
5.1 Field parameters 20
Figure 5.1 EC timeseries for all monitoring bores 21
5.2 Major ions 21
5.3 Dissolved metals 22
5.4 Nutrients 23
Figure 5.5 Nitrate concentration time series 24
Figure 5.6 Total phosphorus concentration time series 25
6 Conclusions and recommendations 26
6.1 Recommendations 26
References 26
General Comments 2
Analytical Results 2
Analytical Results 5
CERTIFICATE OF ANALYSIS 1

General Comments 2
Analytical Results 2
Analytical Results 4
14. Appendix F Goodbush Bushland Restoration Annual Report 14
15. Objectives 17
16. Vegetation Assessment Report Outcomes 17
17. Summary of Works for All Zones 18
18. Zone 1 Remnant Conservation Area 19
18.1. Zone 1 Remnant Vegetation Conservation Area Site Description 19
18.2. Summary of Works 20
18.3. Description of Works 21
19. Zone 2 Offset Area Works 21
19.1. Zone 2 Offset Area Site Description 21
19.2. Summary of Works 22
19.3. Work Areas Map 24
19.4. Vegetation Condition Assessment 25
19.5. Zone 2a: Melaleuca armillaris Tall Shrubland 25
19.6. Zone 2b: Illawarra Subtropical Rainforest 26
19.7. Zone 2c: Illawarra Grassy Woodland 27
19.8. Zone 2 Photographs 28
20. Zone 3 Compensatory Habitat Area 35
20.1. Zone 3 Compensatory Habitat Area Site Description 35
20.2. Summary of Works 36
20.3. Work Areas Map 39
20.4. Vegetation Condition Assessment 40
20.5. Zone 3 Photographs 44
21. Gorse Treatment 48
22. Appendix 1 Vegetation Monitoring Field Sheets 51
23. Photo Reference 67

Tables

Table 1 Annual Review Consent Requirements 12
Table 2 Statement of Compliance 14
Table 3 Non-Compliances Risk Assessment 14
Table 4 Contacts Relevant to Dunmore Quarry Operations 17
Table 5 Relevant Licences and Approvals 19
Table 8 FY23 Annual review actions 23

Table 9 Deposited Dust Impact Assessment Criteria 25
Table 10 Deposited Dust Monitoring Summary 27
Table 11 Particulate Monitoring Impact Assessment Criteria 29
Table 12 Summary of Particulate Monitoring Data 30
Table 13 Blast Monitoring Parameters 33
Table 14 Blast Monitoring Parameters – MacParlands Residence 34
Table 15 Noise Monitoring Impact Assessment Criteria 37
Table 16 Attended noise monitoring results 39
Table 17 Water quality monitoring results at GS-1, GS-4/EPL#8, and GS-2 over the reporting period 48
Table 18 Wet Weather Discharge Monitoring 49
Table 19 Proposed Water Management System Improvements 666
Tables 20-22 Zone 2 Vegetation Condition Summary 73
Tables 23-26 Zone 3 Vegetation Condition Summary 82
Table 27 Waste Tracking Data 90
Table 28 Historical Waste Data 91
Table 29 Activities to be completed by next reporting period 95
Table 30 Rainfall Data 97
Table 31 Historical Rainfall Data 98
Table 32 Historical Deposited Dust Results 106
Table 33 Particulate Monitoring 109
Table 34 Benny Residence FY23 Blast Monitoring Data 132

Figures

Figure 1 Dunmore Site Layout 18
Figure 2 Air Quality Monitoring Locations 25
Figure 3 DQ1 Deposited Dust Results 27
Figure 4 DQ2 Deposited Dust Results 28
Figure 5 DQ3 Deposited Dust Results 28
Figure 6 DQ4 Deposited Dust Results 29
Figure 7 PM_{10} Measurements – FY23 30
Figure 8 Historical Dust Monitoring Data 31
Figure 9 Historical PM_{10} Monitoring Data 32
Figure 10 Blast Monitoring Locations 33
Figure 11 FY23 Overpressure Data 34
Figure 12 FY23 Ground Vibration Data 35
Figure 13 Historical Overpressure Data 35
Figure 14 Historical Ground Vibration Data 36
Figure 15 Noise Monitoring Locations 38
Figure 16 Long term noise monitoring at NM-1 results since 2007 41
Figure 17 NM-1 Noise monitoring results since MOD-9 42
Figure 18 NM-2 Noise monitoring results since MOD-9 42
Figure 19 NM-3 Noise monitoring results since MOD-9 43
Figure 20 NM-4 Noise monitoring results since MOD-9 43
Figure 21 NM-5 Noise monitoring results since MOD-9 44
Figure 22 Surface water monitoring points 46
Figure 23 Lower Dam Annual pH Averages 63
Figure 24 Lower Dam Annual TSS Averages 63
Figure 25 Lower Dam Annual Turbidity Averages 64
Figure 26 Lower Dam Annual Conductivity Averages 64
Figure 27 Water Storage Locations 65

Figure 28 Existing water management system: typical wet year water balance 66
Figure 29 Groundwater Monitoring Bores 68
Figure 30 Hydroseeding cover and trees over Croome West Bund..... 70
Figure 31 Conservation Areas 71
Figure 36 July 2022 Wind Rose..... 99
Figure 48 Dunmore Seasonal Wind Rose Data……100
Figures 49-52 Historical Deposited Dust Trends……102

List of Abbreviations

ACHMP	Aboriginal and Cultural Heritage Management Plan
ANZECC	Australian and New Zealand Environment Conservation Council
AQMP	Air Quality Management Plan
AR	Annual review
AS	Australian Standard
BFMP	Bushfire Management Plan
BMP	Blast Management Plan
BOS	Biodiversity Offset Strategy
CCC	Community Consultative Committee
DA 470-11-2003	The development application for the Dunmore Hard Rock Quarry operated by Boral Resources (NSW) Pty Ltd
DO	Dissolved Oxygen
DPIE	Department of Planning, Industry and Environment
DRG	NSW Division of Resources and Geoscience
EPA	Environmental Protection Authority
EPA&A Act	Environmental Planning and Assessment Act 1979
EPL 77	Environmental Protection Licence 77 for the Dunmore Hard Rock Quarry operated by Boral Resource (NSW) Pty Ltd
FFMP	Flora and Fauna Management Plan
FY21	Financial Year 2021 (1 July 2020 – 30 June 2021)
HVAS	High Volume Air Sampler
IEA	Independent Environmental Audit
LOR	Limit of Reporting
ML	Megalitres
MSDS	Material Safety Data Sheet
NATA	National Association of Testing Authorities
NMP	Noise Management Plan
NRAR	Natural Resource Access Regulator
NTU	Nephelometric Turbidity Units
OEH	Office of Environment and Heritage
PIRMP	Pollution Incident Response Management Plan

PM10	Particulate Matter (10 microns in diameter)
PM2.5	Particulate Matter (2.5 microns in diameter)
POEO Act	*Protection of the Environment Operations Act 1997*
RIC	Rail Infrastructure Corporation
S5.C9	Used to refer to a particular condition in DA-470-11-2003 (in this case Schedule 5, Condition 9).
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
WMP	Water Management Plan
WQO	Water Quality Objectives
µg/m^3	Micrograms per cubic metre

1. Purpose and Scope

In addition to determining compliance of the operation, DA 470-11-2003 Schedule 5 Condition 9 (S5.C9) requires that the AR reports on specific components of the operation.

S5.C9 and all other relevant conditions required to be addressed as part of the AR are outlined in Table 1 with reference to the section of this report where each has been addressed. The timeframe for the annual review is the 2023 Financial Year which is 1 July 2022–30 June 2023.

Table 1 Annual Review Consent Requirements

Condition	Condition Requirements	Location within this report
S4.C29	In each Annual Review, the Applicant must:	
	(a) recalculate the site water balance for the development; and	Section 5.5.4
	(b) provide information on evaporative losses, dust suppression, dam storage levels and implications of obtaining any water supplies from off-site; and	Section 5.5.4
	(c) evaluate water take against licensing requirements	Section 5.5.4
S4.C50	The Applicant must include a progress report on the implementation of the Flora and Fauna Management Plan in the Annual Review.	Section 5.7, Appendix F
S4.C57	The Applicant must include a progress report on the implementation of the Rehabilitation Management Plan in the Annual Review.	Section 5.7, Appendix F
S4.C71	The Applicant must describe what measures have been implemented to minimise the amount of waste generated by the development in the Annual Review	Section 5.9
S4.C77	The Applicant must:	
	a. provide annual production data to the DRG using the standard form for that purpose; and	Section 3
	b. include a copy of this data in the Annual Review.	Section 3

Condition	Condition Requirements	Location within this report
S5.C9	By the end of September each year, or other timing as may be agreed by the Secretary, the Applicant must submit a report to the Department reviewing the environmental performance of the development to the satisfaction of the Secretary. The review must: a) Describe the development (including rehabilitation) that was carried out in the previous financial year, and the development that is proposed to be carried out over the current financial year; b) Include a comprehensive review of the monitoring results and complaints records of the development over the previous financial year, which includes a comparison of these results against the: • Relevant statutory requirements, limits or performance measures/criteria; • Requirements of any plan or program required under this consent; • Monitor results of previous years; and • Relevant predictions in the document listed in condition 2 of schedule 3; c) Identify any non-compliance over the last financial year, and describe what actions were (or are being) taken to ensure compliance; d) Identify any trends in the monitoring data over the life of the development; e) Identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and f) Describe what measures will be implemented over the current financial year to improve the environmental performance of the development. The Applicant must ensure that copies of the Annual Review are submitted to Council and are available to the Community Consultative Committee (see condition 6 of Schedule 5) and any interested person upon request.	Section 5.7, Appendix F Section 5, Section 6.1 Section 1.1 Section 5 Section 5 Section 5

1.1. Statement of Compliance

The statement of compliance for the FY23 reporting period (1 July 2022 – 30 June 2023) is contained in Table 2 below.

Table 2 Statement of Compliance

Were all conditions of the relevant approval(s) complied with?	
DA-470-11-2003	No

The non-compliances identified in the reporting period are detailed in Table 3. Each non-compliance has been risk assessed as per the DPIE Annual Review Guidelines Compliance Status key outlined in Table 3.

Table 3 Non-Compliances Risk Assessment

Condition #	Condition Description	Compliance Status	Comments	Section addressed
DA 470-11-2003 S4.C32	By 18 May 2008, or as otherwise agreed to by the Secretary, the Applicant must: (a) modify the existing dam at the site to create increased capacity offline from Rocklow Creek; (b) construct dams within the site of sufficient capacity to ensure that the water quality criteria in condition 29 can be met for all rainfall events up to and including the 5-day duration 95th percentile rainfall event; (c) ensure the discharge and overflow points of the dams do not cause erosion at the point of discharge/overflow; (d) rehabilitate and stabilise the banks of the dams; and	Non-compliant Administrative	C32 (a) and (b) are still to be undertaken. A number of water improvement works have been implemented at the quarry site including • An increase in storage capacity of the Middle Dam and the improved spillway arrangement; • An upgraded drainage system between the Middle Dam and the Lower Dam; • An upgraded water recycling ability for the quarry; A revised water management plan was submitted to NRAR and DPIE water with comments received in October 2020 regarding	

Condition #	Condition Description	Compliance Status	Comments	Section addressed
	(e) ensure the integrity of the dams would not be compromised by flooding; to the satisfaction of the EPA and the Secretary.		the proposed changes to the operation and management of the dams, specifically in relation to items (a) and (b) of C32. Items (c), (d) and (e) are managed as part of ongoing operations. Modification 13 for Dunmore Quarry has since been submitted to DPE and a review of the Lower dam requirements were undertaken. The water management plan has subsequently been reviewed and will be issued for DPE and NRAR approval. Once approval is granted works as agreed will commence. Water monitoring has continued at the dam overflows and is contained in this annual review.	
S4. C60	Transport Options Review Within three years of the determination of Modification 11, and every five years thereafter (if directed to do so by the Planning Secretary), the Applicant must commission and pay the full costs of a Transport Options		The Transport Option Review was not provided within the 3 year timeframe, due to difficulties with the engaged consultant completing the works. A new consultant has been engaged. The Transport Options review is currently being prepared by EMM and will be provided in this current reporting period.	

Condition #	Condition Description	Compliance Status	Comments	Section addressed
	Review for the development.			

Risk Assessment of Non-Compliances

Risk Level	Colour Code	Description
High	Non-compliant	Non-compliance with potential for significant environmental consequences, regardless of the likelihood of occurrence
Medium	Non-compliant	Non-compliance with: • potential for serious environmental consequences, but is unlikely to occur; • potential for moderate environmental consequences, but is likely to occur
Low	Non-compliant	Non-compliance with: • potential for moderate environmental consequences, but is unlikely to occur; or • potential for low environmental consequences, but is likely to occur
Administrative	Non-compliant	Only to be applied where the non-compliance does not result in any risk of environmental harm (eg submitting a report to government later than required under approval conditions)

Copies of the AR will be submitted to the DPIE and made available to the public at on the Dunmore Quarry website.

https://www.boral.com.au/locations/boral-dunmore-operations

1.2. Contacts Relevant to Dunmore Quarry Operations

Key contacts associated with the management of the Quarry operations, environment, safety and stakeholder relationships are provided in Table 4.

Table 4 Contacts Relevant to Dunmore Quarry Operations

Contact	Position	Contact Details
Glenn Lowerson	Dunmore Quarry Manager	Tel: (02) 4237 2000 Email: glenn.lowerson@boral.com.au
Angus Shedden	Metropolitan Operations Manager NSW/ACT	(02) 4237 8414 Email: angus.shedden@boral.com.au
Matt Bray	Environment and Stakeholder Advisor Dunmore	Tel: (02) 4237 8414 Email: matt.bray@boral.com.au
Kate Woodbridge	Stakeholder Relations Manager	Tel: (02) 4237 8414 Email: kate.woodbridge@boral.com.au

2. Dunmore Quarry Operations

The Dunmore Hard Rock Quarry, owned and operated by Boral Resources (NSW) Pty Ltd, is located at Tabbita Road Dunmore, approximately 12 kilometres north-west of Kiama in the Shellharbour Local Government Area. The Quarry produces hard rock from Bumbo Latite Member, a fine-grained intermediate volcanic rock similar to basalt, which is crushed to produce coarse aggregates, road construction materials and fines.

Development Consent (DA 470-11-2003), issued 19 November 2004 by the Minister for Infrastructure and Planning, allows Boral to produce up to 2.5 million tonnes of quarry product a calendar year (Mtpa), and transport it offsite by road and rail to local and regional markets.

Dunmore Hard Rock Quarry (the site) covers approximately 248 hectares and is surrounded by private property, predominantly agricultural grazing land and tracts of remnant native vegetation, to the south, north and west (The Boral owned and operated Dunmore Lakes Sand Project adjoins the site to the east).

The extraction method involves drilling and blasting to produce broken rock, that is transported to the primary crusher feed bin. The primary-crushed rock is further reduced in size in a series of crushers, before being conveyed to the tertiary screen house where the crushed rock is sized according to product specifications. The sized products are then stockpiled within the various stockpile areas on site, until they are transported to local and regional markets.

During the reporting period extraction has occurred in the area known as the Croome West Pit. Approval of the most recent modification, MOD 12, was granted in September 2021. The site layout is shown below in Figure 1.

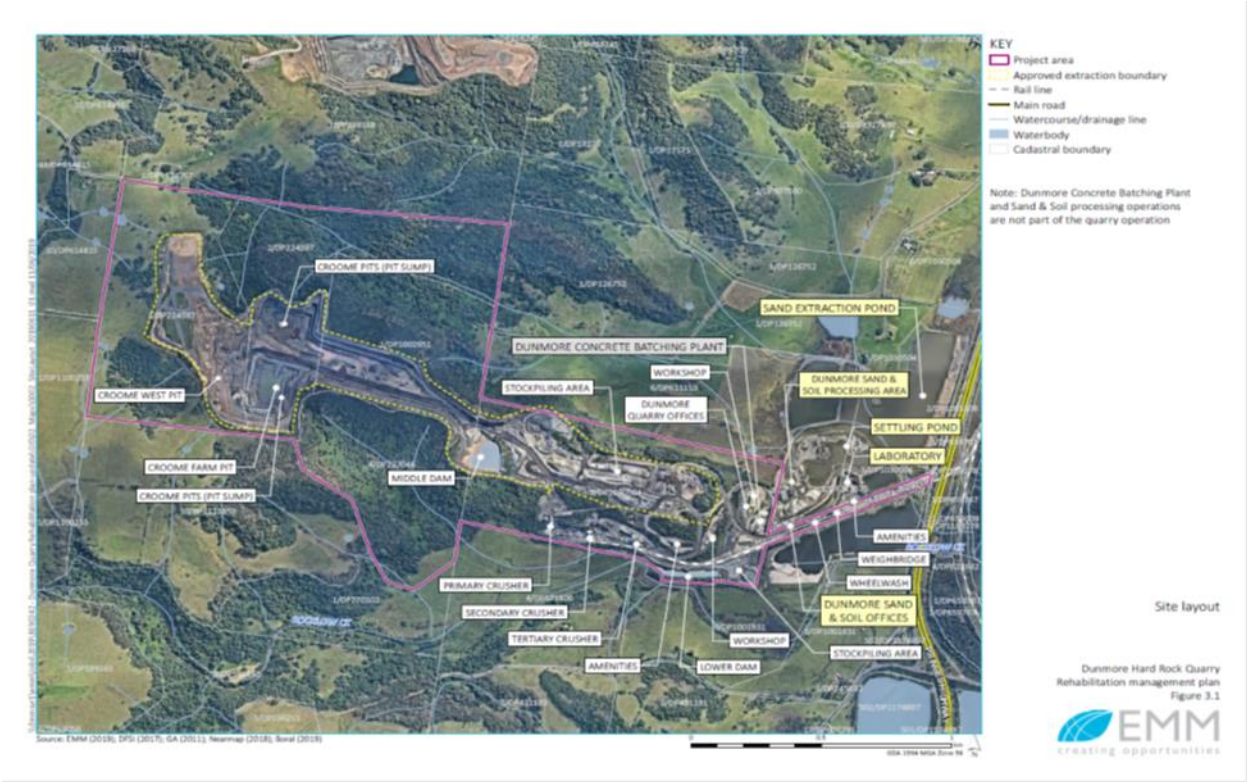


Figure 1 Dunmore Site Layout

2.1. Operations the last 12 months

The last 12 months at Dunmore saw a considerable increase in production above what was forecast, due to a healthy market demand with a number of projects in the greater Sydney region. The aggregate supply to Greater Sydney has been consistent and preparations to supply the Western Sydney International Airport project, has resulted in an increase in production. This has resulted in a direct increase to blasting activities, additional load and haul requirements and further development to the pit operations.

There has been an increase in both external customers and road base sales. Production was out of the RIC, South Croome and West Croome areas of the pit, which posed continued challenges in the removal and placement of inter burden materials.

2.2. Operations the next 12 months

Following Boral's previous acquisition of the Rail Infrastructure Corporation (RIC) slot from Sydney Trains, a modification has since been lodged to allow development and extraction in this area.

Raw rock feed will continue to be balanced between extraction from the Croome West and the RIC slot. It is predicted that the sales market will be reactive upon construction in the Greater Sydney region and production will be able to adjust based on the continued demand. Supply of asphalt aggregates will also commence out of Dunmore Quarry for the Western Sydney International Airport project that is expected to commence late 2023.

Trials of the site blending plant capabilities will continue, and plans are ongoing to expand sales of prepared road base.

Production will be tied to demand which is forecast to be 1.4 to 1.6 Mt for the next reporting period however these estimates are expected to fluctuate depending on the COVID pandemic and government mandates for the construction industry.

Overarching safety management systems and management plans will be continuously reviewed.

2.3. Licences and Approvals

Dunmore Quarry operates under a number of regulatory approvals and licences which are summarised in Table 5 below.

Table 5 Relevant Licences and Approvals

Approval	Detail	Regulatory Authority
DA 470-11-2003 Modification 12	Approved in September 2021, MOD12 removed the multiple hourly dispatch volumes across any given day, replacing these with a single hourly limit. No change is proposed to the overall daily limit of 400 heavy vehicles.	NSW Department of Industry, Planning and Environment
EPL 77	The EPL is issued for the scheduled activity of: Crushing, Grinding, Separation and Extractive activities for tonnages up to 2 million tonnes per annum as defined by the EPA anniversary date 01 July.	NSW Environmental Protection Authority

Water Access Licence WAL#25152 WSW# 10AL103610	Extraction of water from the Lower Dam. This allows for 227 ML per annum to be extracted from Rocklow Creek. Since 2008 the Lower Dam has been taken offline from Rocklow Creek as part of MOD 2	NSW Office of Water

A copy of DA 470-11-2003 and EPL 77 is available on request or can be accessed through the Boral Dunmore website:

https://www.boral.com.au/locations/boral-dunmore-operations

3. Production, Sales and Transport

Production was forecast to be lower than expected but delivered a strong result due to the buoyant Greater Sydney market with a increase in infrastructure works in the both the Sydney and Illawarra.

Table 6 and Table 7 detail the production data in both a monthly breakdown and the format submitted to DRG as required by S4.C77.

Table 6 Production data

Month	Production (t)	Sales (t)	
		Road	Transfers
Jul-2022	83,734	86,999	1,586
Aug-2022	115,703	133,751	2,457
Sep-2022	139,399	115,319	11,870
Oct-2022	121,184	98,206	2,654
Nov-2022	173,839	147,242	11,638
Dec-2022	90,741	117,505	10,791
Jan-2023	96,382	98,123	7,054
Feb-2023	132,544	130,781	2,527
Mar-2023	159,561	129,670	17,550
Apr-2023	97,181	90,202	8,072
May-2023	216,961	121,130	4,435
Jun-2023	144,627	124,753	456
FY 23 Total	1,571,856	1,393,681	81,101
		1,474,782	

Table 7 Sales data for FY23 period

Total Sales/Disposals			
Product	**Type of Material**	**Quantity (Tonnes)**	**$ Value of Sale***
Virgin Materials			
Crushed Coarse Aggregates			
Over 75mm	Latite	55,134	*
Over 30mm to 75mm	Latite	162,591	*
5mm to 30mm	Latite	841,227	*
Under 5mm	Latite	187,271**	*
Natural sand		0	*
Manufactured Sand	Latite	70,515	*
Construction Sand		0	*
Prepared Road Base & Sub Base	Latite	254,351	*
Other Unprocessed Materials	Latite	766	*
Total		1,571,856	*

Note: This data is an approximation of FY23 production data and is subject to change.

*This information is commercially sensitive and has been omitted.

** This product is not part of the total sales

3.1. Transport Dispatch Data

Transport numbers are extracted from the transport monitoring system, which uses a docket tracking system to calculate the dispatch number, which is then automatically migrated over to the transport dispatch monitoring sheet.

No exceedances occurred with respect to the limit of 400 laden trucks from the site per day during the reporting period. The highest number of trucks leaving site on any given day was 267.

3.1.1. Transport Options Review

A transport options review is required within three years of determination of Modification 11 and every five years after as per SC.C60C. The review should have been made available by March 2022.

A tender has been circulated with independent consultants and endorsement by the Planning Secretary of the preferred tenderer has been granted.

The Review will be provided to DPE in the 2024 reporting period and the Transport Management plan reviewed as necessary to incorporate any findings of the review.

4. Actions Required from Previous Annual Review

Table 8 details the actions required from the FY23 Annual review and where each item is discussed.

Table 6 FY23 Annual review actions

Reference	Description of Action	Actions Completed	Section Addressed
AR1	Update Water Management Plan as part of MOD 12 post approval documentation.	Water Management Plan is currently being reviewed and will be submitted to DPE this current reporting period.	Section 5.5
AR2	Update Air Quality Management Plan as part of MOD 12 post approval documentation to denote that DSS is included in the monitoring program	Air Quality management Plan was reviewed following the annual review.	Section 5.2
AR3	Update Rehabilitation Management Plan post calculation of the Rehabilitation Conservation Bond	Rehabilitation and Conservation Bond calculation report is currently with the Department – once this is approved the Rehabilitation Management Plan will be updated.	Section 5.7
AR4	Recalculate and lodge the rehabilitation bond	Completed and waiting for Departmental Approval.	Section 5.7
AR5	Liaise with DPIE to discuss the need to audit the FFMP given that the site undertakes 3 yearly independent audits of the consent which includes the conditions relating to the FFMP.	Correspondence issued to DPE advising audit of the FFMP will be included as part of the independent audit.	Section 5.7
AR6	Complete Transport Options Review	Update of Transport Options Review has been commissioned and is currently underway.	Section 3.1.1
AR7	Update Transport Management Plan as part of MOD 12 post approval documentation to reflect the transport dispatch monitoring undertaken onsite.	Update of Transport Management Plan has been commissioned and is currently underway.	Section 3

Reference	Description of Action	Actions Completed	Section Addressed
AR8	Update Tyre Register after recycling of excess tyres by licenced contractor.	This is now an ongoing process.	Section 5.9.1
AR9	Complete re-fencing of rehabilitation areas to limit intrusion of cattle when the RVCA area is accessible.	Complete	Section 5.7.3

5. Environmental Performance

Dunmore Quarry has comprehensive management and monitoring programs which collect information and data for the assessment of environmental impacts, regulatory compliance and performance against continual improvement objectives. Specific Management Plans define the framework for measuring environmental performance and compliance with statutory requirements for each relevant aspect of environmental performance

5.1. Meteorological Monitoring

An onsite weather station is located at Dunmore, which collects a range on meteorological parameters. This system was upgraded as part of the transition to real time air quality monitoring. The location of the weather station is shown in Appendix A.

There is no prescribed impact assessment criteria and meteorological monitoring is used to provide background information for management of the site. A detailed summary of the FY23 and historical rainfall data can be found in Appendix A.

5.1.1. Meteorological Monitoring Long Term Analysis and Trends

The FY23 period was wetter than average with 1,715 mm falling over the reporting period. There were five notable rain events during the reporting period, all of which exceeded the design capacity of the lower dam (90.7 mm over 5 days):

- 2-5 July 2022: 477 mm.
- 6-9 October 2022: 99 mm.
- 21-25 October 2022: 124 mm.
- 8-11 February 2023: 188 mm.
- 13-15 March 2023: 64 mm.

Typically winds during the reporting period originated from the west and west-south-west for the majority of the year. In Summer, prevailing winds were also from the north-east. These results are mostly consistent with historic trends and generally had a greater concentration of winds from the west and north-east.

5.1.2. Meteorological Monitoring Summaries and Opportunity for Improvement

The weather station is capable of providing real time data via download which is an upgrade from the previous station. The next reporting period will focus on continuing the processes established during the current reporting period.

5.2. Air Quality Monitoring

Two methods of monitoring air quality are used at Dunmore Quarry. Deposited dust gauges are used to measure deposited dust every 30 days (+/- 2 days). A High Volume Air Sampler (HVAS) is used to measure the fine particulate matter under 10 microns (PM_{10}) every 6 days.

A real time monitoring system has been installed which is used to guide day to day management and response to air quality monitoring. This system is currently in a transitional phase. Under the currently approved AQMP, the real-time monitoring network is proposed to eventually replace the deposited dust and HVAS monitoring once the transitional phase is complete. During the transition phase, the existing HVAS monitor would continue to be operated and be used to validate real-time monitoring network and assess the compliance of the project. An alert system is to be trialled in the next reporting period, as part of the transitional phase. A determination on the use of both the HVAS monitoring network and real time monitors will be made in the FY24 reporting period.

The location of air quality monitoring equipment is shown below in Figure 2.

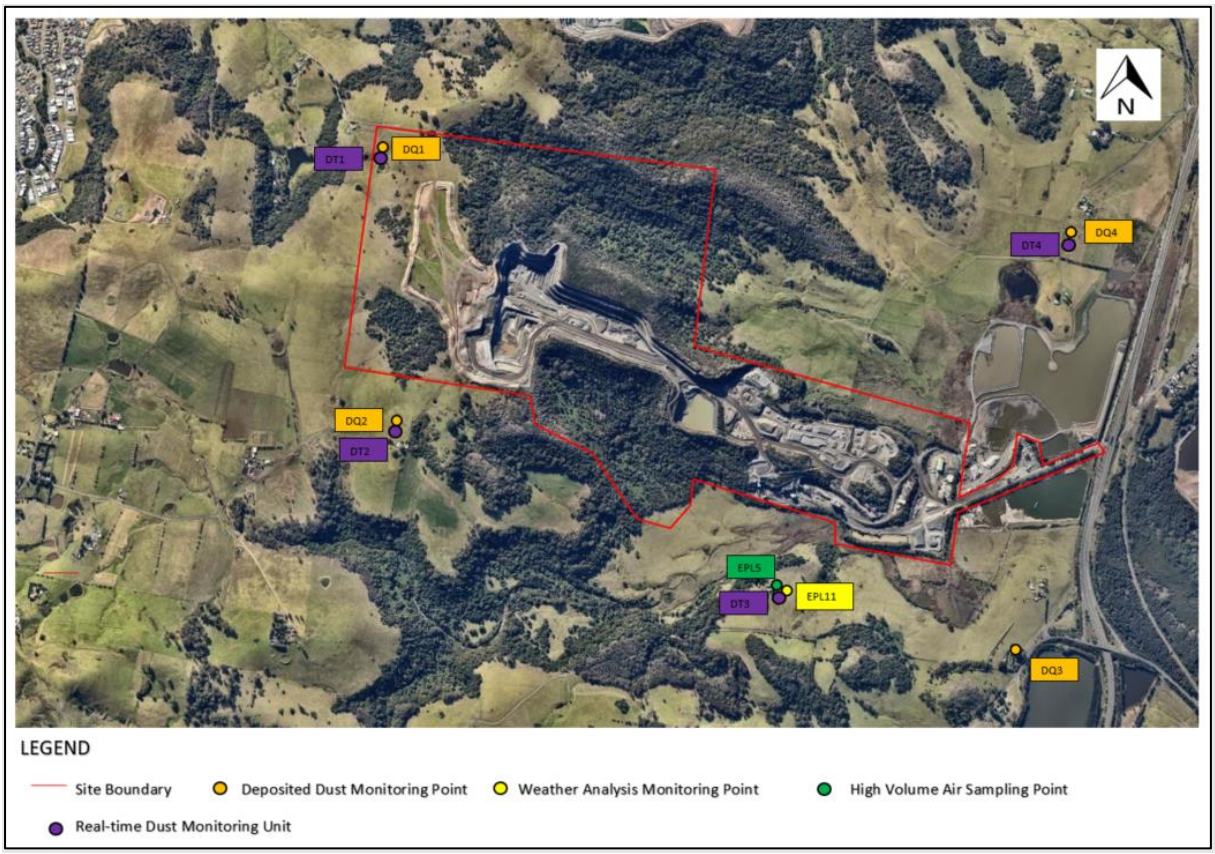


Figure 2 Air Quality Monitoring Locations

5.2.1. Deposited Dust Monitoring Assessment Criteria

The relevant deposited dust impact assessment criteria apply to a residence on privately owned land. Monitoring points 1, 2 and 4 are not located in direct vicinity of residences. It is important to note that the assessment criteria refer to an annual averaging period (i.e. a monthly average over the last 12 months). Impact assessment criteria is shown in Table 9 below.

Table 7 Deposited Dust Impact Assessment Criteria

Pollutant	Averaging Period	Criterion	
Deposited dust[c]	Annual	2g/m2/month[b]	4g/m^2/month[a,d]

[a] Cumulative impacts (ie increases in concentration due to development plus all other sources)

[b] Incremental impact (ie increases in concentration alone, with zero allowable exceedances of criteria over the life of the development.

[c] Deposited dust is defined as insoluble solids

[d] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents or any other activity as agreed by the Secretary.

5.2.2. Deposited Dust Monitoring FY23 Performance Review

All monitoring points were below the required assessment criteria of rolling annual average of 4g/m^2/month for dust measured as insoluble solids during the reporting period.

All sites also were below 4g/m^2/month for ash fraction which excludes the organic (combustible) component of the sample such as vegetation, bird droppings and insects. These organic contaminants within the sample are typically representative of the surrounding wetlands and farmland which the monitors are located within.

A summary of results for each monitoring location is shown in Table 10 below. A monthly breakdown of each site and summary graphs is located in Figures 3 to 6.

Table 8 Deposited Dust Monitoring Summary

	Site 1 grams/m^2/month		Site 2 grams/m^2/month		Site 3 grams/m^2/month		Site 4 grams/m^2/month	
	Insoluble Solids	Ash	Insoluble Solids	Ash	Insoluble Solids	Ash	Insoluble Solids	As4h
FY23 Average	2.26	1.20	1.32	0.69	2.21	1.39	1.32	0.91
Criterion	4	-	4	-	4	-	4	-

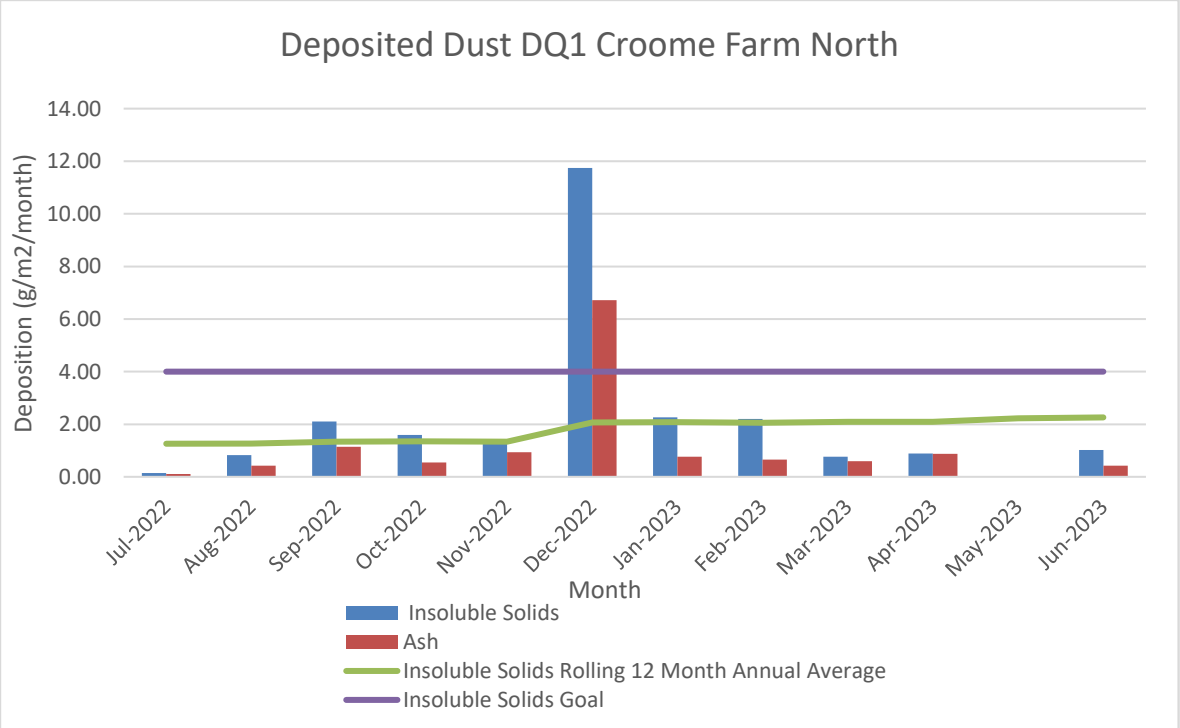


Figure 3 DQ1 Deposited Dust Results

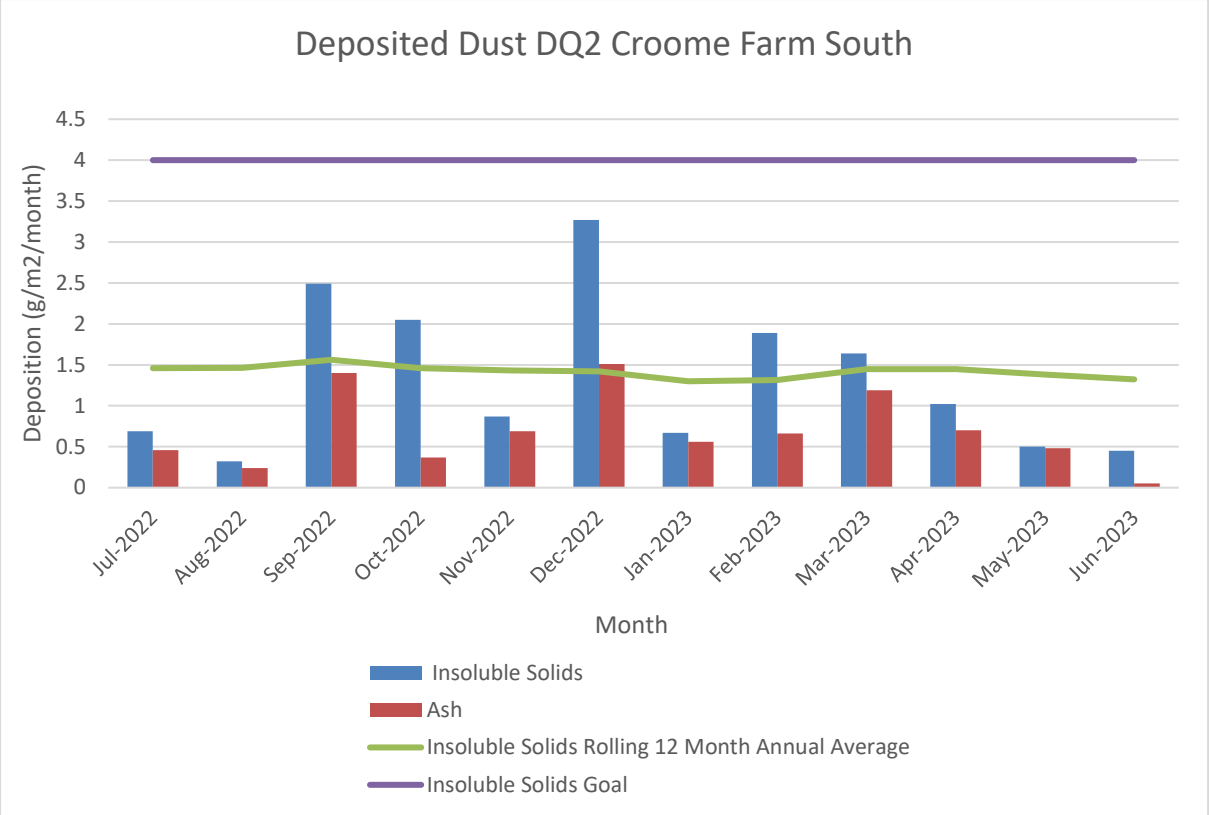


Figure 4 DQ2 Deposited Dust Results

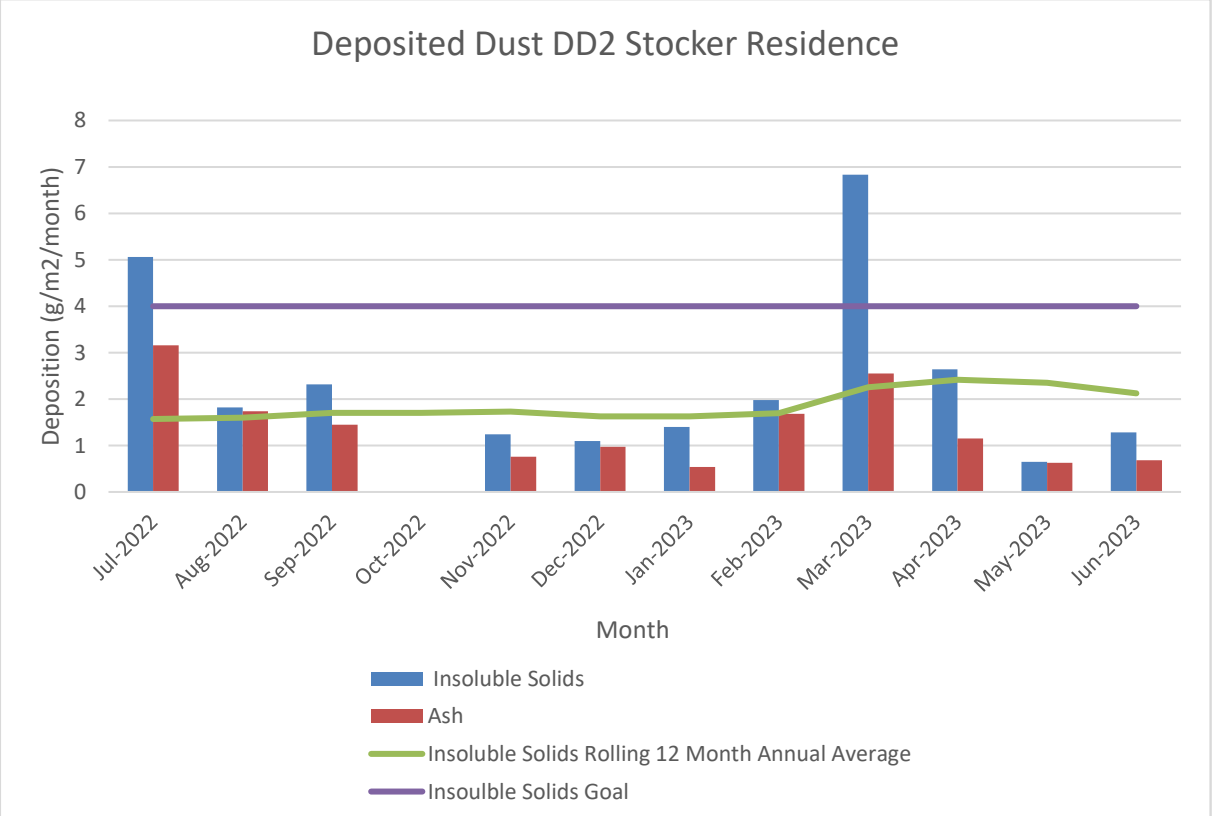


Figure 5 DQ3 Deposited Dust Results

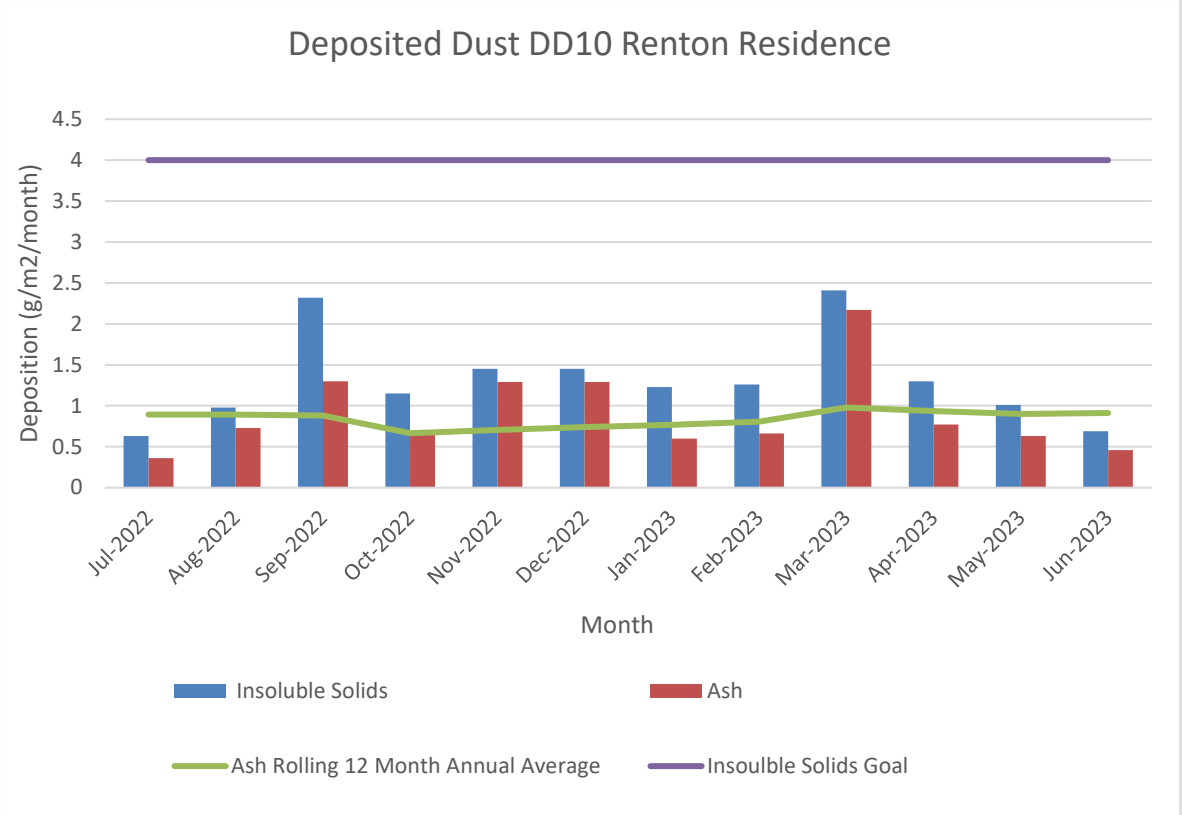


Figure 6 DQ4 Deposited Dust Results

5.2.3. Particulate Monitoring Assessment Criteria

The impact assessment criteria for Particulate Monitoring is provided below in Table 11.

Table 9 Particulate Monitoring Impact Assessment Criteria

Pollutant	Averaging Period	Criterion
PM_{10}	Annual	[a,d] 25 µg/m³
PM_{10}	24 hour	[b]50 µg/m³
TSP	Annual	[a,d] 90 µg/m³
$PM_{2.5}$*	Annual	[a,d] 8 µg/m³

[a] Cumulative impacts (i.e increases in concentration due to development plus all other sources)

[b] Incremental impact (i.e increases in concentration alone, with zero allowable exceedances of criteria over the life of the development.

[d] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents or any other activity as agreed by the Secretary.

5.2.4. Particulate Monitoring FY23 Performance Review

The PM_{10} readings from FY23 can be seen below in Figure 7.

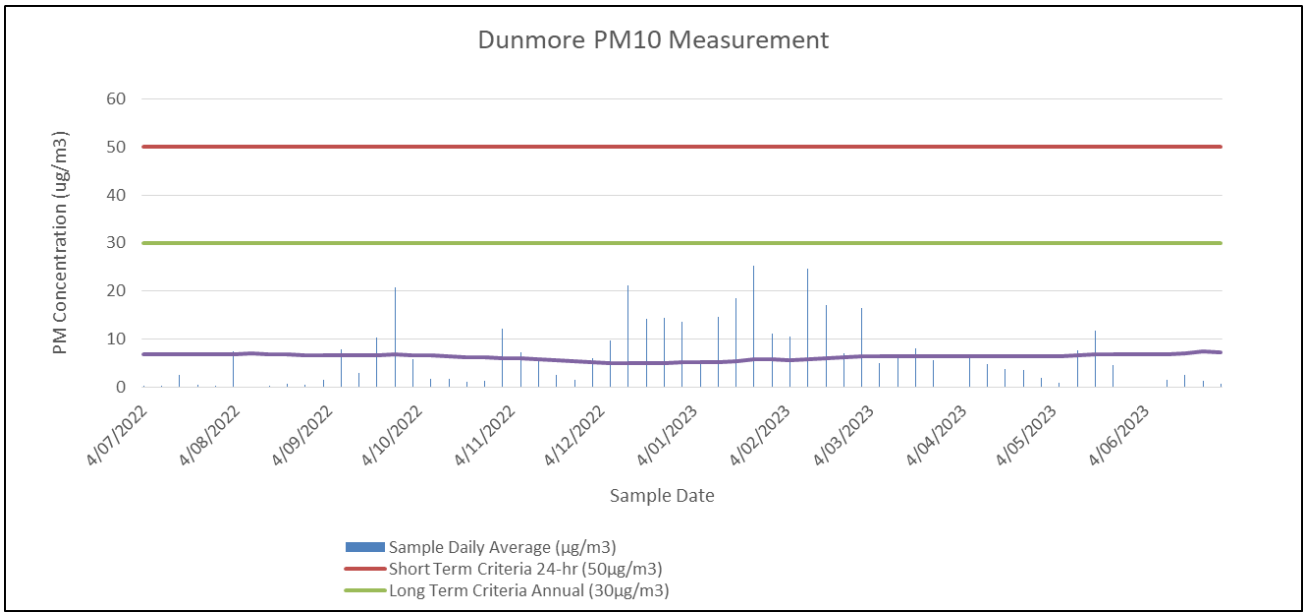


Figure 7 PM_{10} Measurements – FY23

The annual average PM_{10} measurement for the reporting period was below the impact assessment criteria of 30 µg/m³ for PM_{10} and 90 µg/m³ for TSP. The PM_{10} measurements were also similar to the Albion Park South air quality monitoring station's annual averages.

There were no readings recorded as occurring above the long-term criteria for PM_{10} of 50µg/m³ during the reporting period.

TSP concentrations are not measured in the vicinity of the quarry, however annual average TSP concentrations can be derived based on typical ratios of PM_{10}: TSP. Rural areas (such as DQ), typically experience a PM_{10}:TSP ratio of 0.4. This ratio has been applied to the annual average PM_{10} concentrations to derive a representative TSP background concentration in µg/m³. This methodology is in-line with the method used by Ramboll in the MOD 9 Environmental Assessment for the Dunmore Quarry.

Table 10 Summary of Particulate Monitoring Data

Pollutant	Dunmore Quarry FY23 Average (µg/m³)	Albion Park FY23 Average(µg/m³)	Dunmore Quarry Long Term Average (µg/m³)
Measured PM10	7.06	10.9	12.29
Derived TSP	17.65	27.25	30.275
Real time monitor TSP	15.52	-	-
Real time monitor PM10	6.21	-	-
Real time monitor PM2.5	0.40	-	-

5.2.5. Air Quality Monitoring Long Term Analysis and Assessment

The DQ site has been collecting deposited dust data since 2002. A graph of long-term trends can be found in Figure 8 below and shows that deposited dust has typically decreased over time.

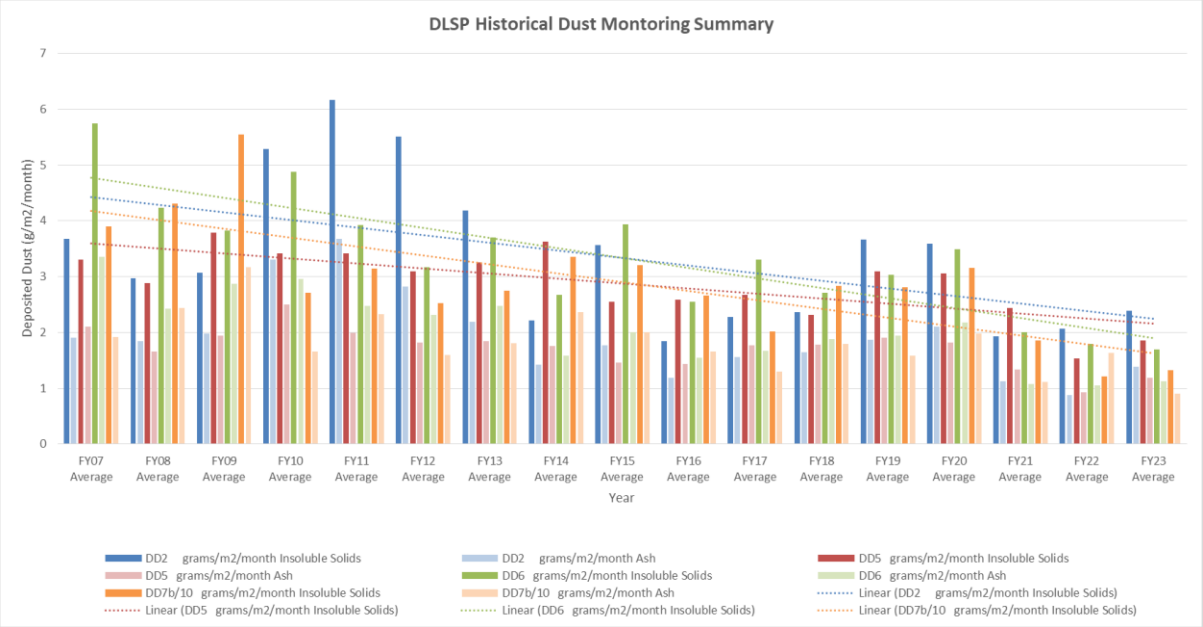


Figure 8 Historical Dust Monitoring Data

A general trend that has been observed is that measured deposited dust is typically higher in dry summer months than winter months, which is to be expected. This trend is also confirmed with the PM_{10} measurements and is generally reflective of regional conditions as a whole.

Figure 9 shows a 90 day average in black, which illustrates a seasonal fluctuation of measured PM_{10} values. A trend can be observed that PM_{10} values are typically higher during summer dry periods and are lower during the winter periods.

This fluctuation is mirrored in the Office of Environment and Heritage's (OEH) Albion Park PM_{10} measurements available on the OEH website (https://www.dpie.nsw.gov.au/air-quality/air-quality-data-services/data-download-facility)

These trends indicate the measured PM_{10} and deposited dust values are typically influenced by ambient local conditions rather than development operations at DLSP.

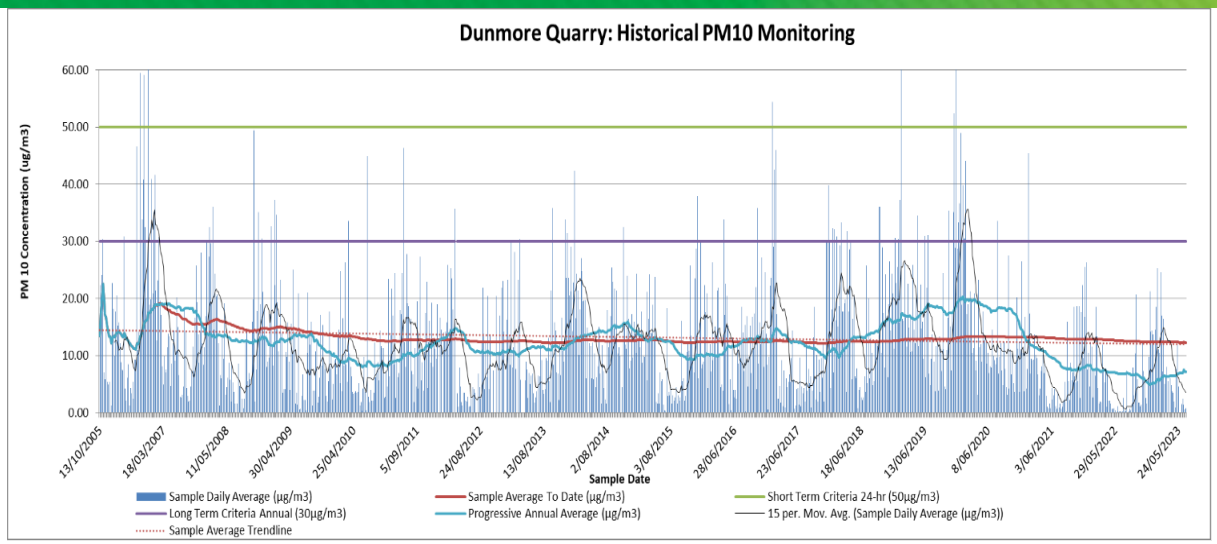


Figure 9 Historical PM_{10} Monitoring Data

5.2.6. Air Quality Monitoring Summary and Opportunities for Improvement

The site is still in the transitional period with TARP and alerting systems being finalised. The alerting system has been redesigned to a web based format to allow greater access to data for operational staff. The next reporting period will focus on fine tuning alerting systems along with continuing the operation of the real time monitoring units.

5.3. Blast Monitoring

S4C16 and S4.C17 outline the blast monitoring parameters which are assessed at the nearest receiver, the Benny Residence. Monitoring at the Benny residence indicated compliance with all relevant blast parameters during the reporting period. Monitoring Points are shown in Figure 10.

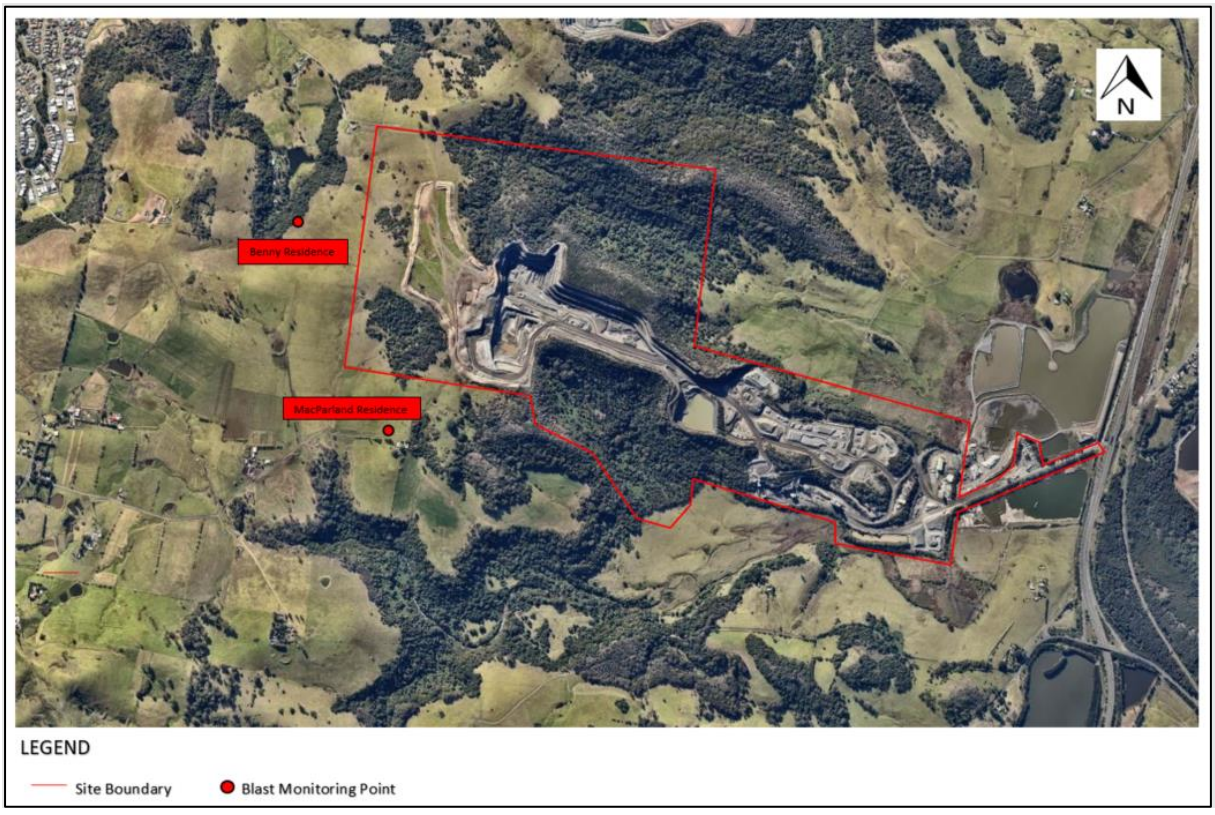


Figure 10 Blast Monitoring Locations

5.3.1. Blast Monitoring Impact Assessment Criteria

S4C16 and S4.C17 outline the blast monitoring parameters which are assessed at the nearest receiver at the Benny Residence. These parameters are reproduced below in Table 13.

Table 11 Blast Monitoring Parameters

Airblast Overpressure	Allowable exceedances
120 ((dB(Lin Peak))	0 (absolute limit)
115 ((dB(Lin Peak))	5% of the total number of blasts over a period of 12 months
Ground Vibration	**Allowable exceedances**
10mm/s	0 (absolute limit)
5mm/s	5% of the total number of blasts over a period of 12 months

In total there were twenty six (26) blasts undertaken during the reporting period, and therefore no more than one (1) blast is allowable over the 95th percentile limits of 115 (dB (Lin Peak)) and 5 mm/s for airblast overpressure and ground vibration respectively at the Benny Residence to ensure compliance with the criteria.

In addition, the approved Blast Management Plan outlines monitoring which will be undertaken to preserve the heritage value of the old flour mill at the MacParlands residence. The following blast parameters were adopted.

Table 12 Blast Monitoring Parameters – MacParlands Residence

Airblast Overpressure	Allowable exceedances
130 ((dB(Lin Peak))	5% of the total number of blasts over a period of 12 months
Ground Vibration	**Allowable exceedances**
30mm/s	5% of the total number of blasts over a period of 12 months

A dilapidation report was commissioned, detailing the condition of the MacParland Residence. Specifically, the condition of the structures of heritage value such as the flour mill, butter mill, hay shed and the primary residence. Baseline monitoring was conducted in FY20. Monitoring during the FY23 period indicated no change to any of the observed structures on the property.

5.3.2. Blast Monitoring FY23 Performance Review

Figure 11 and Figure 12 details a visual representation of the blast monitoring in FY23. A number of blasts did not trigger, and therefore aren't represented in the figures below. The data table associated with these can be found in Appendix D.

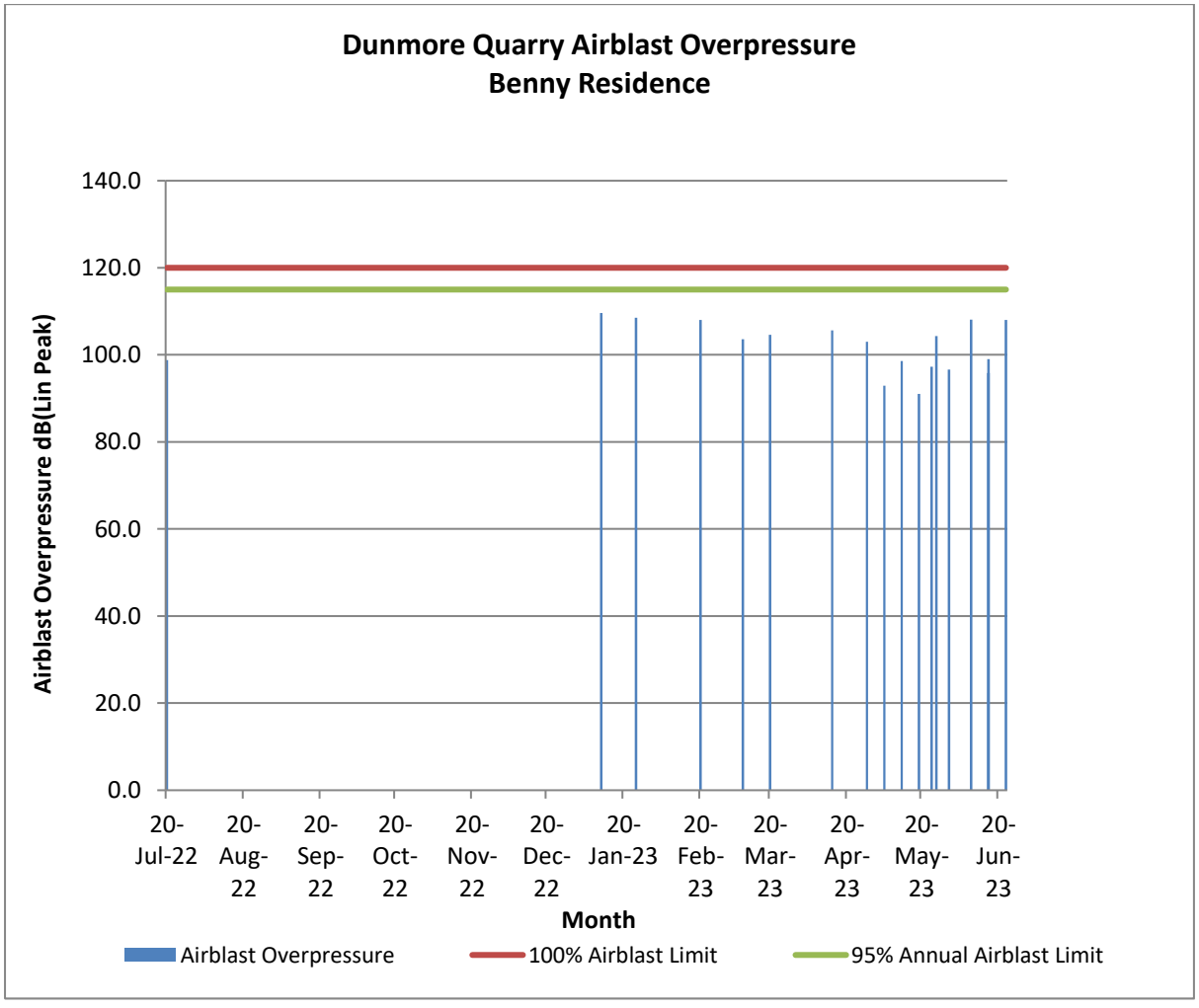


Figure 11 FY23 Overpressure Data

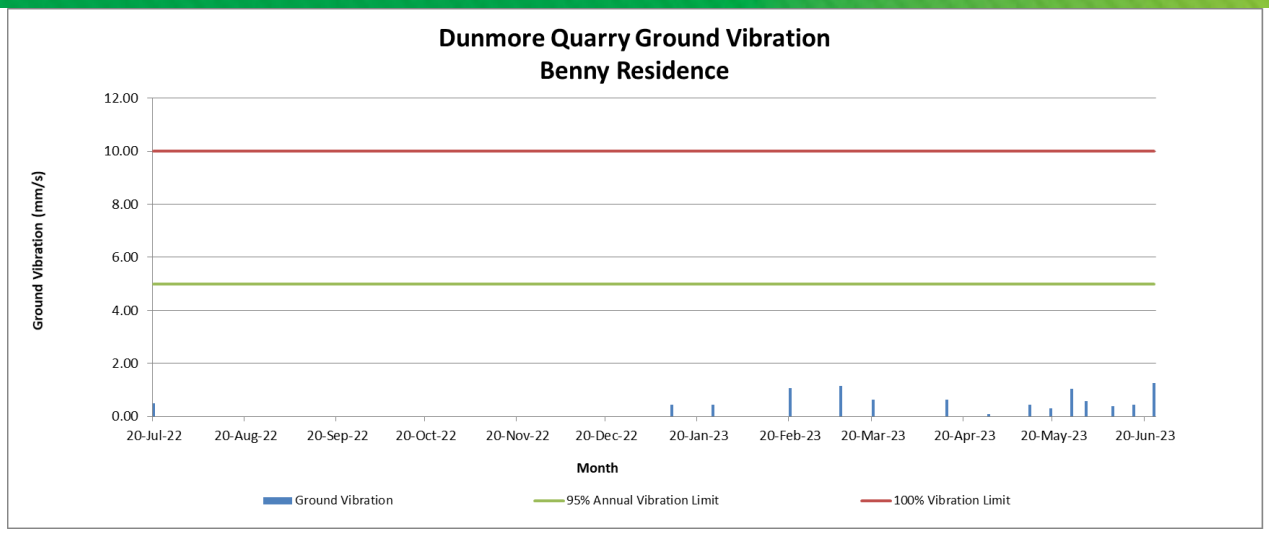


Figure 12 FY23 Ground Vibration Data

There were no blasts above the prescribed limits during the FY23 reporting period.

5.3.3. Blast Monitoring Long Term Analysis and Trends

A visual representation of historical blast monitoring data can be seen below in Figures 13 and 14.

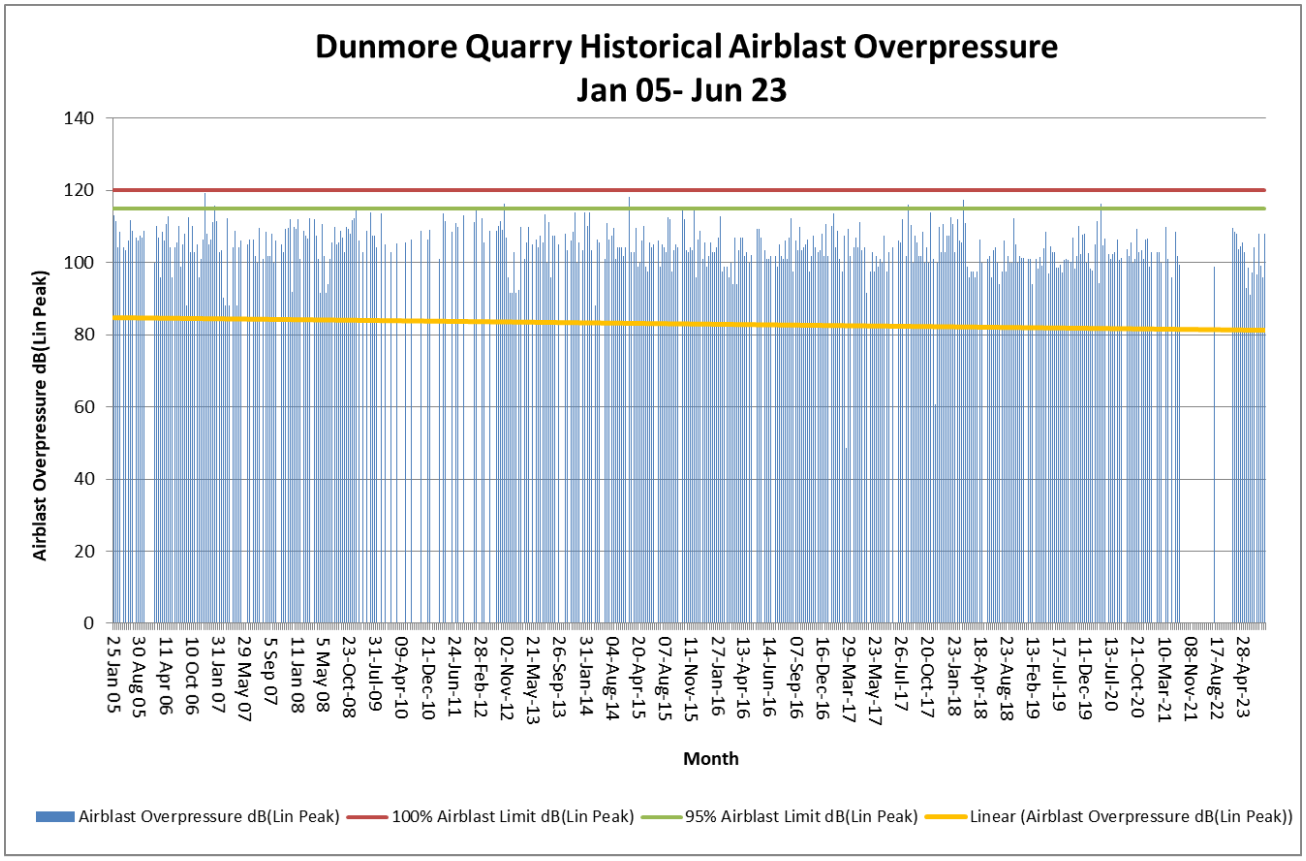


Figure 13 Historical Overpressure Data

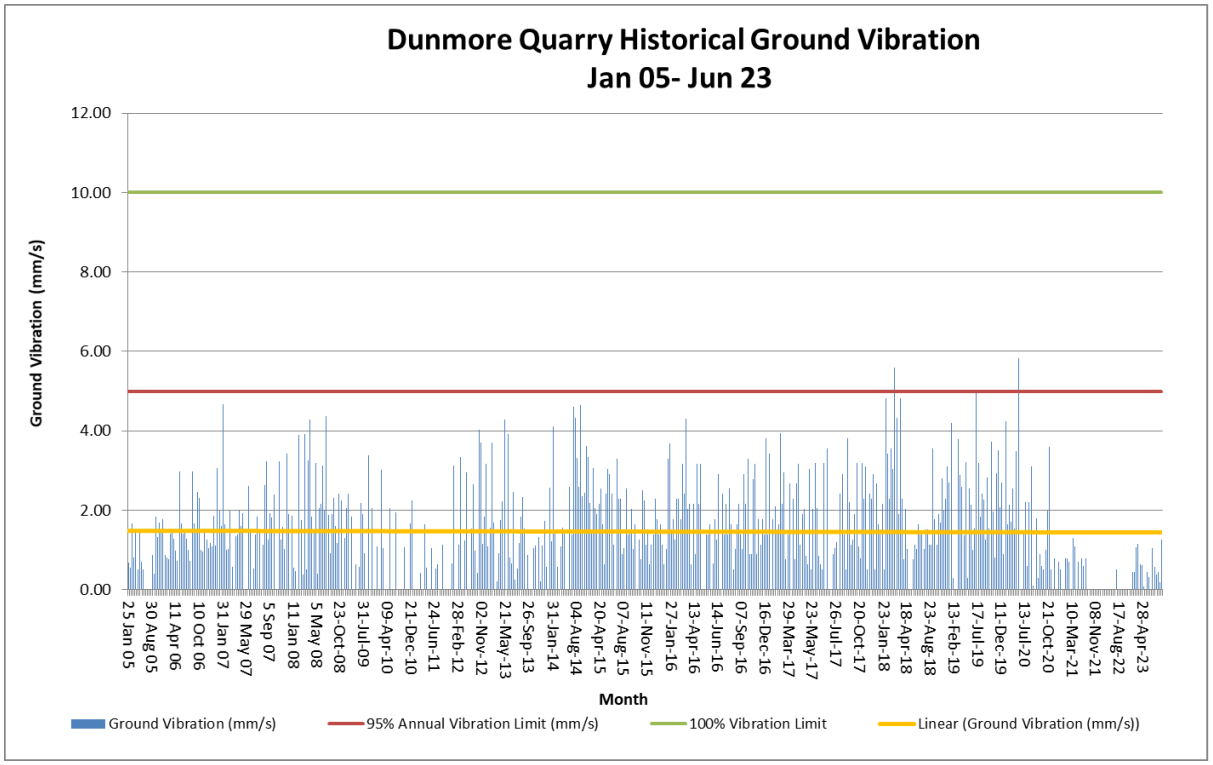


Figure 14 Historical Ground Vibration Data

5.3.4. Blast Monitoring Summary and Opportunities for Improvement

The blast data has confirmed compliance with the required assessment criteria but also indicate that blast management over recent years has resulted in an overall reduction in both overpressure and ground vibration at the nearest residential receptors. No additional blast management initiatives are therefore considered necessary, however the design of future blasting associated with the proposed 8 ha northern extension into the RIC slot will require further evaluation. Any additional blast management initiatives required will be detailed in a revised Blast Management Plan which will be prepared once the RIC proposal has been approved.

5.4. Noise Monitoring

Annual Noise Monitoring is undertaken annually in winter to determine quarry contribution to noise at private residences. Monitoring results demonstrated compliance with prescribed assessment criteria during all monitored time periods.

5.4.1. Noise Monitoring Impact Assessment Criteria

S4.C4 outlines the relevant noise assessment criteria to be adopted for the annual monitoring, shown in Table 15 below. The location of these monitoring points are represented by NM-1 to NM-5 as displayed in Figure 15.

Noise monitoring is completed in July each year which typically represents the worst-case meteorological conditions for noise propagation.

Table 13 Noise Monitoring Impact Assessment Criteria

Receiver Location	Noise Limits dB (A)					
	LA_{eq} (15 minute)				LA_{eq} (1 minute)	
	Day (7am - 6pm)	Evening (6pm - 10pm)	Night (10pm - 7am)	Morning Shoulder (6am - 7am)	Night (10pm - 7am)	Morning Shoulder (6am - 7am)
Location K Stocker Residence	49	44	38	47	48	55
Location O Dunmore Lakes	49	44	38	47	48	55
Location J Creagan Residence	Negotiated Agreement in Place					
Location AA	38	38	38	38	45	45
Locations AB and T	36	36	36	36		
Location D, F, G and Z	40	40	40	40		
Location S	37	37	37	37		
Other privately owned residence	35	35	35	35		

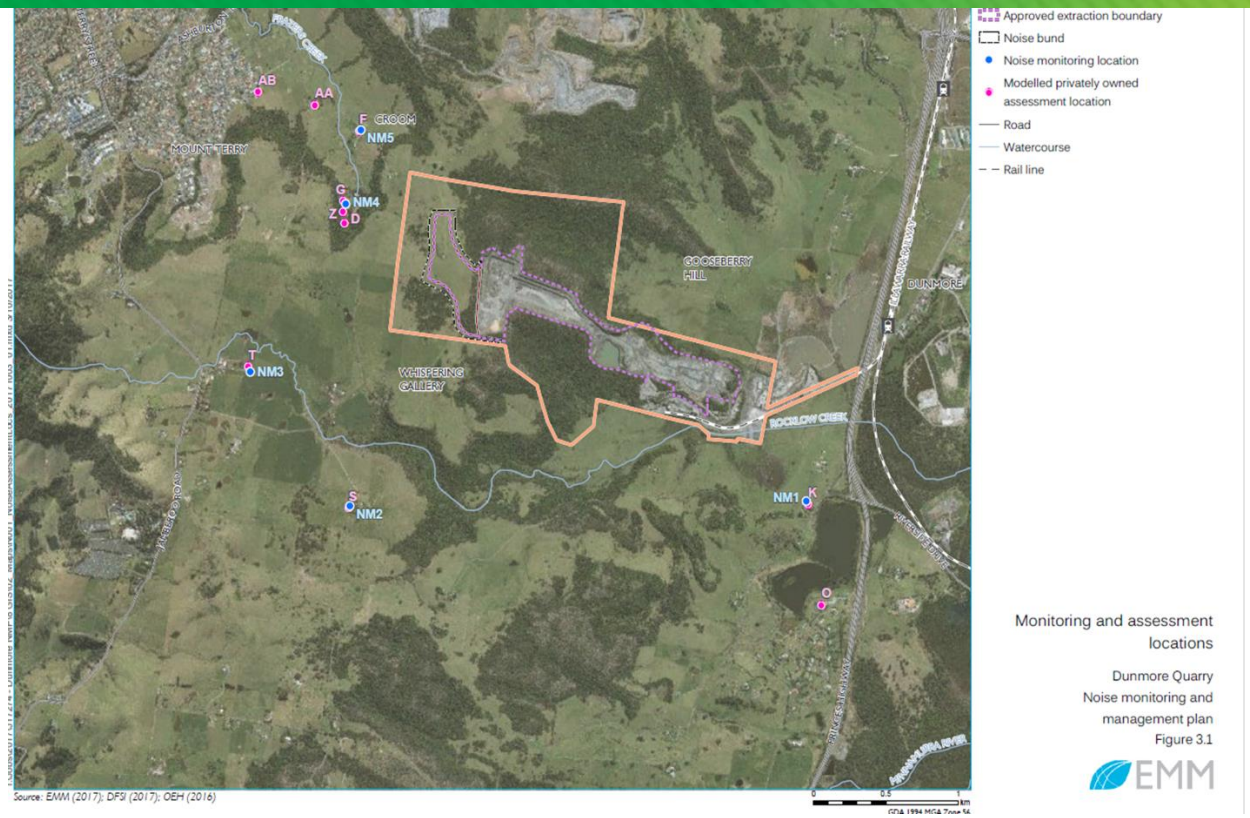


Figure 15 Noise Monitoring Locations

5.4.2. Noise Monitoring FY23 Performance Review

A summary of the attended noise monitoring results against the modelled MOD 9 quarry operations is shown below in Table 16. Noise monitoring is conducted at the end of each calendar year, consistent with previous review periods.

Table 14 Attended noise monitoring results

Post Modification 9 Noise Monitoring Results NM1 (representative of resident K and O)				
	Day	Evening	Morning Shoulder	
Noise	dB $LA_{eq(15min)}$	dB $LA_{eq(15min)}$	dB $LA_{eq(15min)}$	dB $LA_{eq(1min)}$
Limit	49	44	47	55
Predicted	35	35	35	
2018	40	40	40	50
2019	45	41	47	55
2020	49	44	47	55
2021	45	40	40	45
2022	40	36	40	47
Post Modification 9 Noise Monitoring Results NM2 (representative of resident S)				
	Day	Evening	Morning Shoulder	
	dB $LA_{eq(15min)}$	dB $LA_{eq(15min)}$	dB $LA_{eq(15min)}$	dB $LA_{eq(1min)}$
Limit	37	37	37	45
Predicted	35	35	35	
2018	30	30	30	32
2019	33	30	32	40
2020	36	35	37	45
2021	35	30	35	40
2022	33	31	31	45
Post Modification 9 Noise Monitoring Results NM3 (representative of resident T)				
	Day	Evening	Morning Shoulder	
	dB $LA_{eq(15min)}$	dB $LA_{eq(15min)}$	dB $LA_{eq(15min)}$	dB $LA_{eq(1min)}$
Limit	36	36	36	45
Predicted	35	35	35	
2018	35	35	35	40
2019	32	30	31	40

2020	35	35	35	45
2021	35	30	30	35
2022	30	30	30	45
Post Modification 9 Noise Monitoring Results NM4 (representative of resident G,D,Z)				
	Day	**Evening**	**Morning Shoulder**	
	dB $LA_{eq(15min)}$	**dB $LA_{eq(15min)}$**	**dB $LA_{eq(15min)}$**	**dB $LA_{eq(1min)}$**
Limit	40	40	40	45
Predicted	35	35	35	
2018	30	30	30	30
2019	33	30	31	40
2020	35	35	35	45
2021	35	30	30	35
2022	40	40	40	45
Post Modification 9 Noise Monitoring Results NM5 (representative of resident F, AA,AB)				
	Day	**Evening**	**Morning Shoulder**	
	dB $LA_{eq(15min)}$	**dB $LA_{eq(15min)}$**	**dB $LA_{eq(15min)}$**	**dB $LA_{eq(1min)}$**
Limit	40	40	40	45
Predicted	35	35	35	
2018	30	30	30	30
2019	35	30	34	40
2020	40	35	40	45
2021	30	30	30	35
2022	30	30	33	45

During the reporting period monitoring points were denoted as compliant during all time windows. Prior to MOD 9, location K and O (now monitored under NM-1) had been monitored separately. The land Location A was acquired by Boral in 2016 and as such is no longer monitored.

5.4.3. Noise Monitoring Long Term Analysis and Trends

There has only been five years of monitoring under the current monitoring program post MOD 9 operations and over time trends will become more apparent. NM-1 has been monitored for a number of years as part of the previously approved monitoring program. The trends of NM-1 over the last 13 years can be seen below in Figure 16. A summary of the noise monitoring results post MOD 9 can be seen in Figures 17 to 21. The monitoring data,

which is attached as Appendix C, demonstrates compliance with the noise assessment criteria.

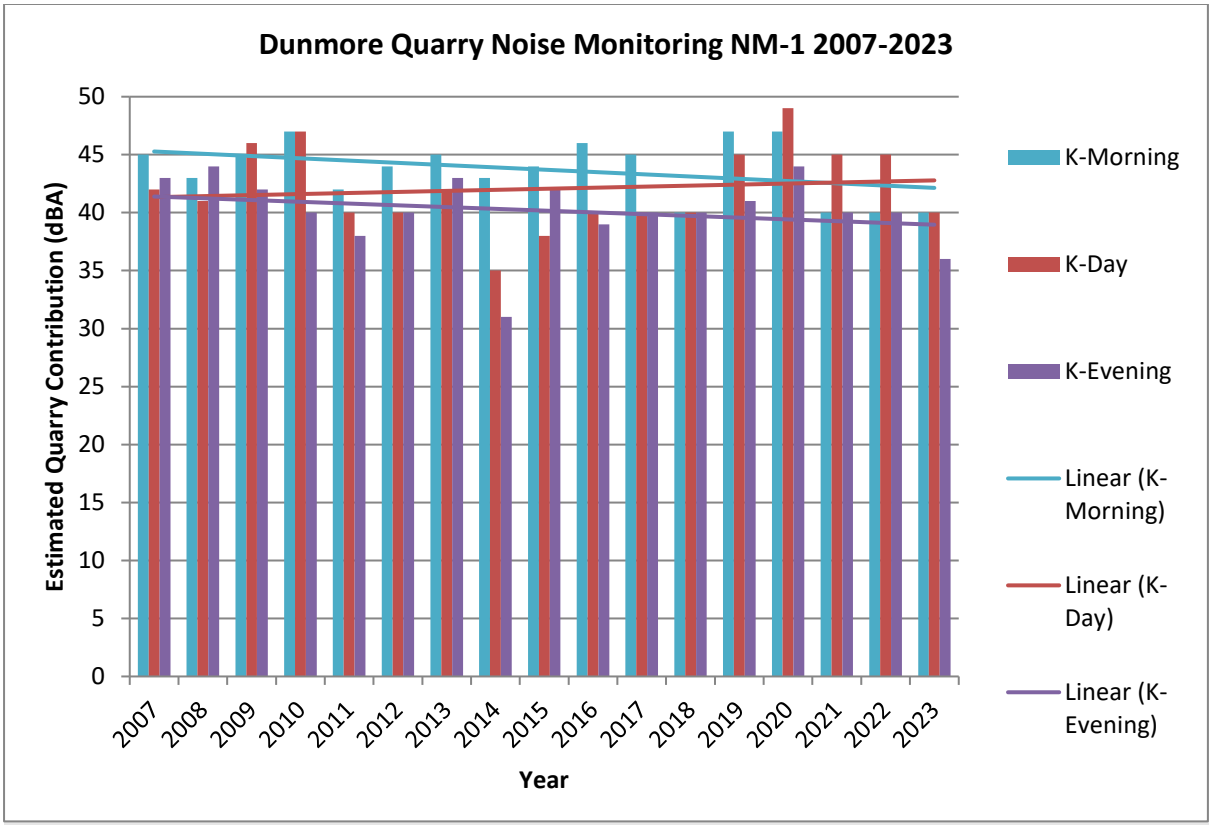


Figure 16 Long term noise monitoring at NM-1 results since 2007

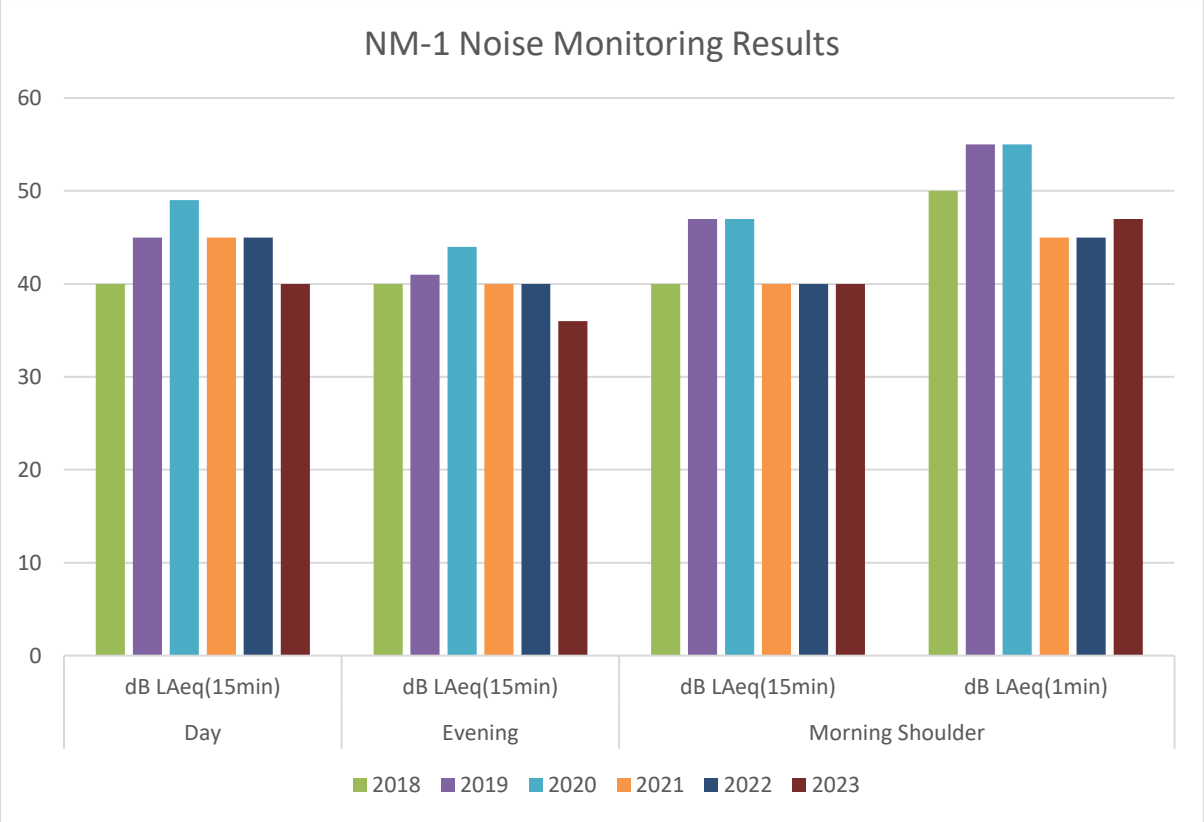


Figure 17 NM-1 Noise monitoring results since MOD-9

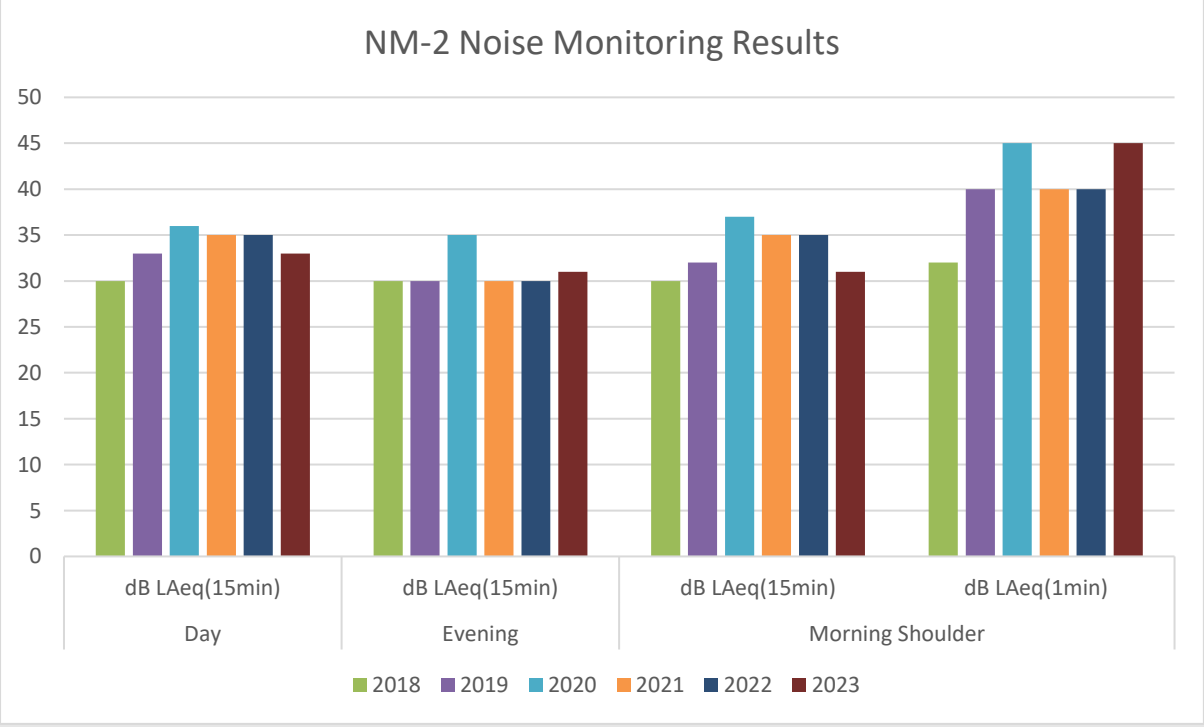


Figure 18 NM-2 Noise monitoring results since MOD-9

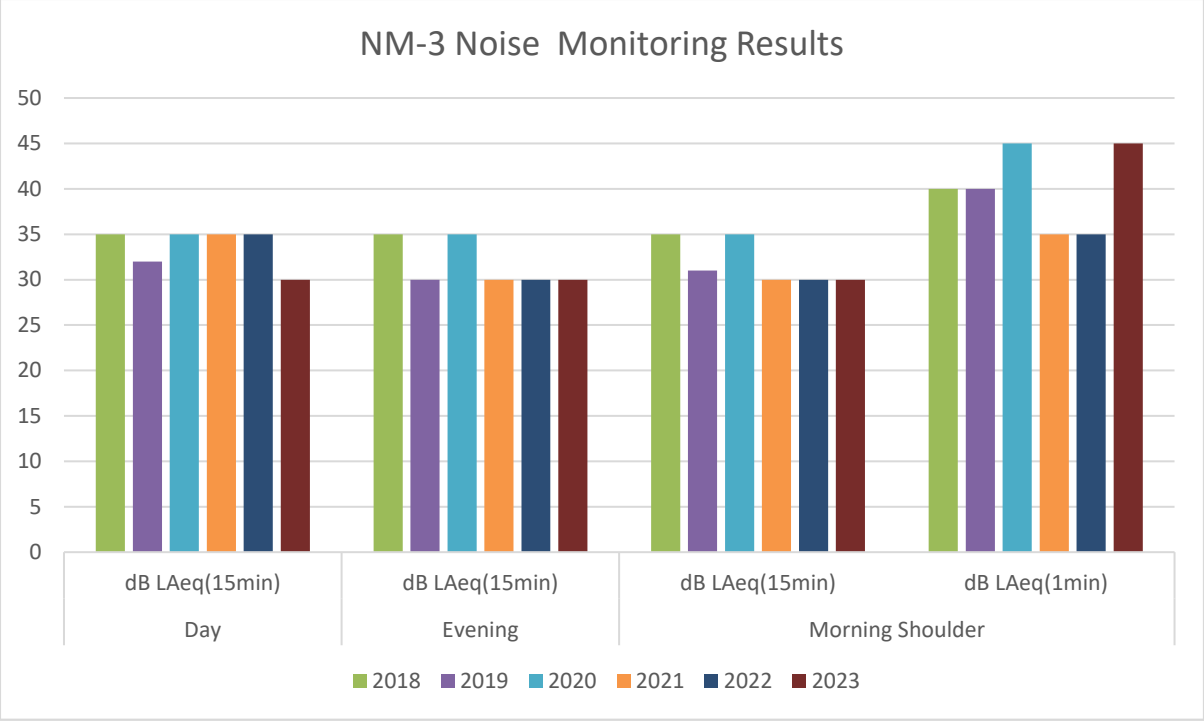


Figure 19 NM-3 Noise monitoring results since MOD-9

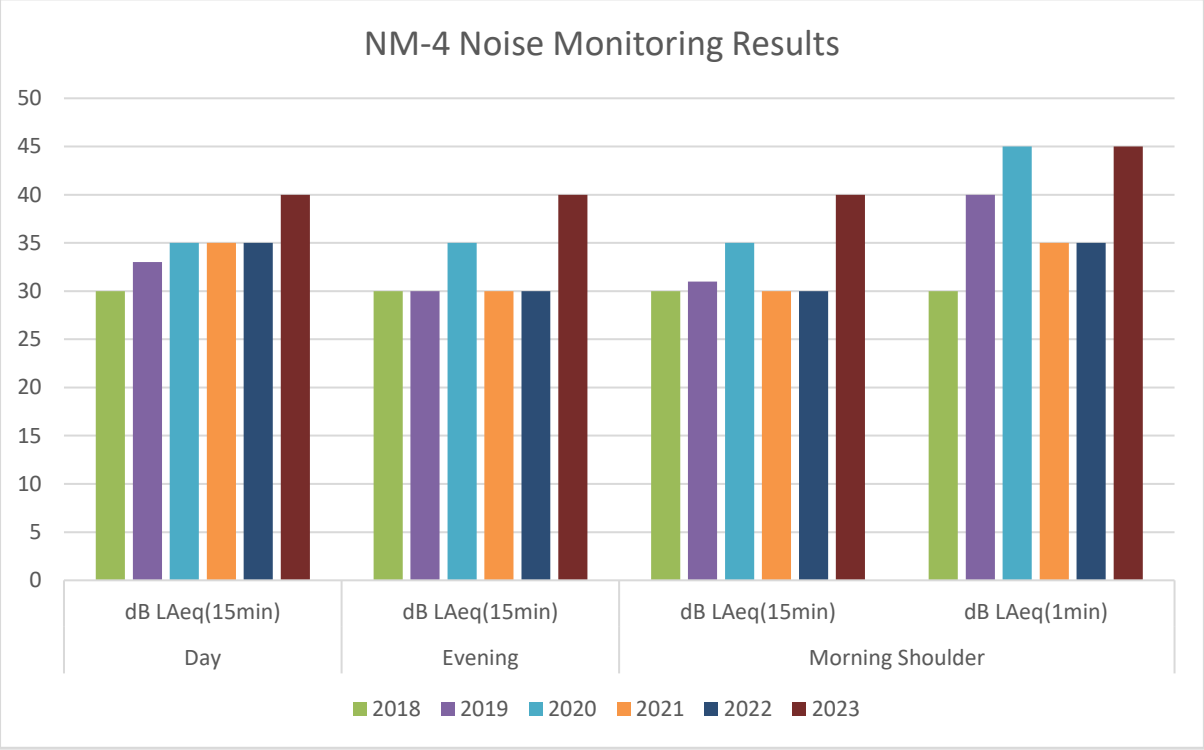


Figure 20 NM-4 Noise monitoring results since MOD-9

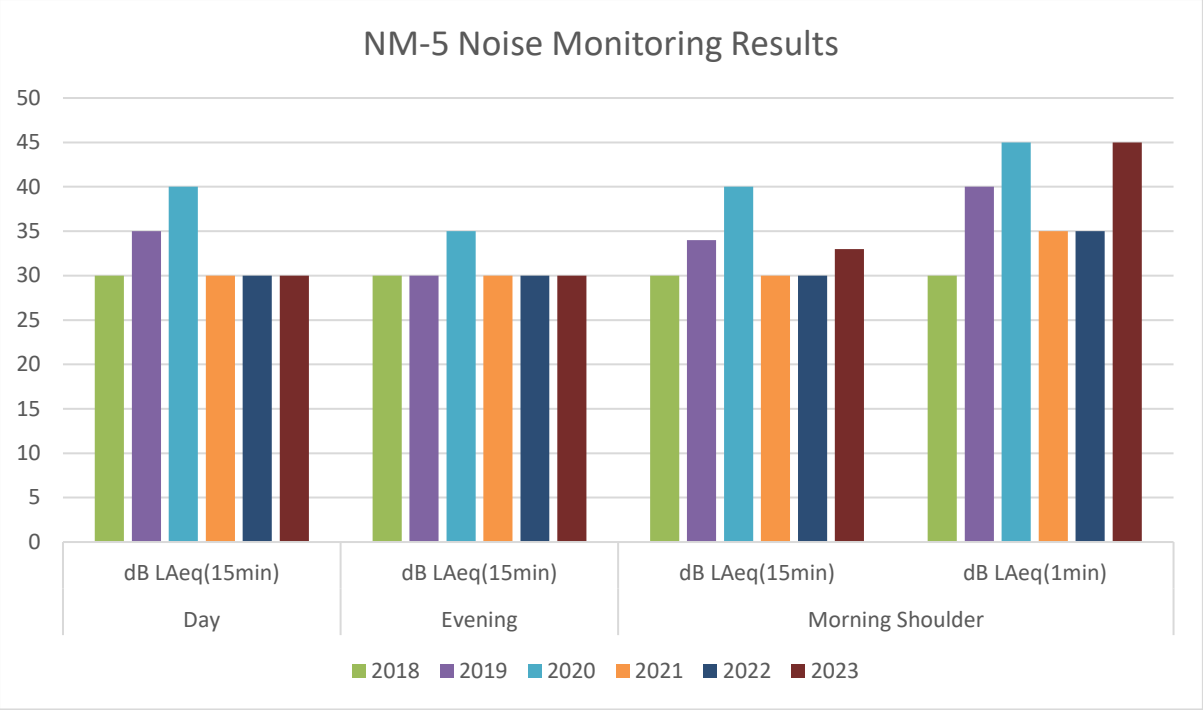


Figure 21 NM-5 Noise monitoring results since MOD-9

Typically noise measurements have decreased or remained stable over time at NM-1. Noise monitoring results at NM-1 to NM-5 were similar to the previous year and within compliance limits.

5.4.4. Noise Monitoring Summary and Opportunities for Improvement

As previously discussed, all monitoring points were measured below relevant limits. Noise monitoring will continue as per previous years.

5.5. Surface Water Monitoring

Dunmore Quarry operates under a well-established water management system which incorporates separation of clean water, largely through natural topographic features and the control of dirty water through a series of pollution control structures. The main pollution control structure is the Upper Dam which receives runoff from most of the extraction area. This is an in-pit sump constructed on the quarry floor and can only discharge via pumping to the Middle Dam. The Middle Dam discharges internally via channels and culverts to the Lower Dam which is licensed (EPL7) to discharge into Rocklow Creek. These structures contain the vast majority of dirty runoff from the quarry however some minor road drainage is directed into the silt ponds of the Dunmore Sand & Soil operation.

Under normal weather conditions, the water management system is a closed circuit with contained water being recycled for quarry uses such as dust suppression. Excess water is only discharged through the licensed discharge point following prolonged rainfall events. The license also recognises that during prolonged wet weather or intense storm events, discharges will occur into Rocklow Creek and that additional background monitoring within the creek is required in order to determine if any offsite impacts occur. The additional monitoring occurs on a daily basis during such discharges.

Figure 22 outlines the current monitoring points. There are three offsite discharge points for the operation as described below:

- EPL6 which is a controlled discharge from the Lower Dam using a biofiltration swale to treat water prior to entering Rocklow Creek.
- EPL7 which is the spillway of the Lower Dam which only discharges during high rainfall events.
- EPL10 which is the upper emergency spillway of Middle Dam. Water spilling from the main spillway of Middle Dam flows into the Lower Dam.

Figure 22 Surface water monitoring points

5.5.1. Surface Water Quality Impact Assessment

S4.C28 refers discharge limits to the limits imposed by EPL 77 which states that the site will comply with discharge limits from condition L2.4 and Section 120 of the *POEO Act*. EPL 77 describes discharge limits at the licenced discharge point for controlled discharge at the site via the bio-filtration swale at monitoring location EPL6. Total Suspended Solids must not exceed 50mg/L at this point.

A second discharge point is nominated in EPL 77 for uncontrolled discharge at the spillway at the Lower Dam at monitoring location EPL7. No TSS limits apply for EPL7 as it is a spillway, which only typically discharges if the dam design capacity (designed to hold 90.7mm in 5 days) is exceeded.

Monthly monitoring is undertaken at the Lower Dam at GS-1, GS-2 and GS-3 at Rocklow Creek to determine ambient conditions upstream, in the immediate vicinity of the Lower Dam spillway and downstream respectively.

Monitoring is also undertaken daily during any discharge event via either the licenced discharge mechanism at EPL6, or via uncontrolled discharge via the Lower Dam spillway at EPL7. Upstream and downstream monitoring points at Rocklow Creek at GS3 are also sampled to determine if any impacts to water quality have occurred.

5.5.2. Surface Water Quality FY23 Performance Review

Monthly ambient water quality monitoring of the Lower Dam at GS-4/EPL#8 is shown below in Table 17. For comparison, monitoring points upstream (GS-1) and downstream (GS-2) of the Lower Dam are also shown to indicate the typical water quality along Rocklow Creek. Please note there are no discharge limits applicable to the ambient water quality of the dam as it is offline to Rocklow Creek during normal operations.

Monthly monitoring results at Rocklow Creek indicate the following:

- Ambient conditions upstream of the Lower Dam at GS-1 are generally lower values when compared to the WQOs and discharge limits. Despite this, the area is associated with water bodies that are impacted by active cattle grazing. Cattle tend to stir up water during grazing and are often observed within Rocklow Creek during monthly sampling events, especially during drought conditions.
- Ambient conditions in the vicinity of the mixing zone at GS-2 are typically within discharge limits. Occasional elevations can occur during high intensity flood events. Water levels can be low or dry during extended dry spells/drought.
- Ambient conditions at GS-3 downstream of Rocklow Creek are generally within the discharge parameters with the exception of TSS. This location is sometimes dry and affected by saline tidal inflow as well as being impacted by cattle grazing. During dry periods, water level tends to be quite low. Cattle tend to stir up water during grazing and are often observed within Rocklow Creek during monthly sampling events.

Table 15 Water quality monitoring results at GS-1, GS-4/EPL#8, and GS-2 over the reporting period.

	GS-1 Upstream of Rocklow				EPL#8 Lower Dam			
Month	pH	Turbidity (NTU)	EC (µS/cm)	TSS(mg/L)	pH	Turbidity (NTU)	EC (µS/cm)	TSS
Jul-22	7.8	8.8	300	3	8.2	75	483	62
Aug-22	7.2	3.2	302	4	8.3	210	451	108
Sep-22	7.1	2.1	375	9	8.3	80	492	114
Oct-22	7.1	28	136	38	8.3	45	280	481
Nov-22	7	3.2	313	5	8.1	140	510	49
Dec-22	7.2	6.4	317	10	8.2	140	623	136
Jan-23	7	4.1	315	2	8.2	120	583	96
Feb-23	7	5.6	311	4	8.2	300	405	247
Mar-23	6.9	3.9	266	3	8.3	170	423	113
Apr-23	7	1.5	328	7	8.2	160	469	138
May-23	6.9	1.9	338	3	8.1	160	493	125
Jun-23	7	5.4	333	8	8.2	100	517	81
FY23 Av	7.1	6.2	302.8	8.0	8.2	141.7	477.4	145.8

	GS-2 Downstream of Rocklow Mixing Zone				GS-3 Downstream of Rocklow at Property Boundary			
Month	pH	Turbidity (NTU)	EC (µS/cm)	TSS(mg/L)	pH	Turbidity (NTU)	EC (µS/cm)	TSS(mg/L)
Jul-22	7.1	12	302	6.5	7	22	315	34
Aug-22	7.3	40	387	32	7.5	75	404	106
Sep-22	7.8	120	484	93	7.1	37	297	38
Oct-22	7.4	37	168	49	7	26	132	22
Nov-22	7.1	4.5	369	7	7.5	50	381	52
Dec-22	7.7	13	491	22	7.6	18	911	31
Jan-23	6.8	9	412	17	6.3	18	1248	26
Feb-23	7.9	230	409	190	7.2	11	346	8
Mar-23	7.7	130	408	101	7	8.1	321	18
Apr-23	6.8	2.8	356	13	6.9	20	399	32
May-23	6.9	14	386	6	6.7	45	467	72
Jun-23	7	12	441	14	6.8	50	498	46
FY23 Av	7.3	52.0	384.4	45.9	7.1	31.7	476.6	40.4

There were five major rain events in the reporting period which led to discharge from the Lower Dam via the spillway at EPL7. These events include:

- 477mm between 2 and 5 July 2022
- 99mm between 6 and 9 October 2022
- 124mm between 21 and 25 October 2022
- 188mm between 8 and 11 February 2023
- 64mm between 13 and 15 March 2023.

These events were outside the dam design capacity, which are designed to hold a 95th percentile 5-day rainfall event (90.7mm). During instances where sampling points were inaccessible due to site flooding, sampling was delayed due to safety and access concerns and the EPA were notified and satisfied with the arrangements.

The results of wet weather discharge monitoring over the reporting period is summarised in Table 18.

Table 16 Wet Weather Discharge Monitoring

Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
EPL#7	06/07/2022	7	24	224	14
EPL#9	06/07/2022	8.2	34	369	6
EPL#10	06/07/2022	7.4	25	190	17
GS-1	06/07/2022	6.8	36	211	9
EPL#7	07/07/2022	7.1	22	410	6.5
EPL#9	07/07/2022	8.1	32	374	4.5
EPL#10	07/07/2022	7	22	204	7
GS-1	07/07/2022	7.1	20	237	4
EPL#7	08/07/2022	8	150	428	122
EPL#9	08/07/2022	8.3	35	261	6.5
EPL#10	08/07/2022	7.1	16	388	21
GS-1	08/07/2022	7	13	220	3.5
EPL#7	09/07/2022	7.7	120	224	86
EPL#9	09/07/2022	6.9	17	369	18
EPL#10	09/07/2022	8.1	39	190	16
GS-1	09/07/2022	6.8	14	211	2.5
EPL#7	10/07/2022	7.1	60	256	43
EPL#9	10/07/2022	6.8	29	240	19
EPL#10	10/07/2022	8	40	404	17

Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
GS-1	10/07/2022	6.9	37	205	27
EPL#7	11/07/2022	6.8	28	243	14
EPL#9	11/07/2022	7	25	236	189
EPL#10	11/07/2022	7.7	38	402	33
GS-1	11/07/2022	6.9	23	214	9
EPL#7	12/07/2022	7.1	27	304	9.5
EPL#9	12/07/2022	6.7	27	279	28
EPL#10	12/07/2022	7.7	40	404	19
GS-1	12/07/2022	6.8	16	236	2
EPL#7	13/07/2022	7.3	36	334	14
EPL#9	13/07/2022	7	13	277	9.5
EPL#10	13/07/2022	8	42	377	17
GS-1	13/07/2022	6.8	15	226	8.5
EPL#7	14/07/2022	7.3	19	312	10
EPL#9	14/07/2022	7.2	10	292	6
EPL#10	14/07/2022	7.8	36	374	14
GS-1	14/07/2022	7.3	11	279	7
GS-1	15/07/2022	7.9	15	445	124
EPL#7	15/07/2022	7	12	312	8.5
EPL#19	15/07/2022	8.5	45	388	21
EPL#9	15/07/2022	7.1	13	259	7.5
EPL#7	16/07/2022	8.1	150	447	100
EPL#9	16/07/2022	7	9.8	316	11
EPL#10	16/07/2022	8	40	370	20
GS-1	16/07/2022	6.9	8.4	249	5
EPL#7	17/07/2022	7.2	25	330	9
EPL#9	17/07/2022	7.1	15	335	15
EPL#10	17/07/2022	8	37	369	11
GS-1	17/07/2022	6.9	5.9	251	1
EPL#7	18/07/2022	7.1	13	324	4

Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
EPL#9	18/07/2022	7.2	8.9	337	5
EPL#10	18/07/2022	8.2	37	374	8.5
GS-1	18/07/2022	6.8	5.21	258	4
EPL#7	19/07/2022	7.3	12	334	11
EPL#9	19/07/2022	7.2	10	348	10
EPL#10	19/07/2022	8.2	36	378	8
GS-1	19/07/2022	6.8	4.7	261	3.5
EPL#7	20/07/2022	7	13	319	8.5
EPL#9	20/07/2022	7	15	347	20
EPL#10	20/07/2022	7.8	34	527	11
GS-1	20/07/2022	6.7	5	330	4
EPL#7	21/07/2022	7	22	317	6
EPL#9	21/07/2022	8.1	220	458	132
EPL#10	21/07/2022	8.2	36	370	13
GS-1	21/07/2022	6.9	5	266	1
EPL#7	22/07/2022	7.4	23	320	8.5
EPL#9	22/07/2022	7.4	12	329	4.5
EPL#10	22/07/2022	8.4	36	374	6.5
GS-1	22/07/2022	7.3	7.5	274	4
EPL#7	23/07/2022	7.3	37	278	20
EPL#9	23/07/2022	7.3	27	287	20
EPL#10	23/07/2022	8.3	50	367	9
GS-1	23/07/2022	7.3	26	251	19
EPL#7	24/07/2022	7.4	19	279	10
EPL#9	24/07/2022	7.2	15	291	7.5
EPL#10	24/07/2022	8.5	45	348	18
GS-1	24/07/2022	7.1	19	254	10
EPL#7	25/07/2022	8.2	140	438	58
EPL#9	25/07/2022	7	15	301	18
EPL#10	25/07/2022	8.6	50	360	8

Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
GS-1	25/07/2022	7	12	283	12
EPL#7	26/07/2022	7.1	12	302	6.5
EPL#9	26/07/2022	7	22	315	34
EPL#10	26/07/2022	8.4	50	348	10
GS-1	26/07/2022	7.8	8.8	300	3
EPL#7	27/07/2022	8.2	180	447	86
EPL#9	27/07/2022	7.3	11	333	10
EPL#10	27/07/2022	8.2	45	365	10
GS-1	27/07/2022	7	6.6	268	1.5
EPL#7	28/07/2022	8.1	150	441	86
EPL#9	28/07/2022	7.4	38	342	60
EPL#10	28/07/2022	8.2	42	370	9
GS-1	28/07/2022	7	5.2	275	1.5
EPL#7	29/07/2022	7.1	16	326	8.5
EPL#9	29/07/2022	6.9	29	350	40
EPL#10	29/07/2022	8.3	42	371	11
GS-1	29/07/2022	6.9	4.4	374	2
EPL#7	30/07/2022	7.5	130	448	60
EPL#9	30/07/2022	7.4	14	349	13
EPL#10	30/07/2022	7.5	50	385	22
GS-1	30/07/2022	7.1	3.3	270	4
EPL#7	31/07/2022	7.4	35	388	12
EPL#9	31/07/2022	7.2	14	380	14
EPL#10	31/07/2022	7.6	40	374	11
GS-1	31/07/2022	7.3	2.6	277	4
EPL#7	01/08/2022	7.6	17	359	6.5
EPL#9	01/08/2022	7.3	10	365	11
EPL#10	01/08/2022	8.2	39	377	10
GS-1	01/08/2022	7.3	5.9	329	8
EPL#7	02/08/2022	8	90	435	34

Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
EPL#9	02/08/2022	7.4	16	388	20
EPL#10	02/08/2022	8.5	34	380	24
GS-1	02/08/2022	7	1.3	273	1.5
EPL#7	03/08/2022	7.9	17	389	11
EPL#9	03/08/2022	7.2	13	374	9
EPL#10	03/08/2022	8.5	40	384	6.5
GS-1	03/08/2022	7.1	2.5	284	1.5
EPL#7	04/08/2022	7.1	11	342	6.5
EPL#9	04/08/2022	6.9	60	386	89
EPL#10	04/08/2022	8.5	33	380	5
GS-1	04/08/2022	6.9	3.4	286	1
EPL#7	05/08/2022	7	17	374	11
EPL#9	05/08/2022	6.9	21	390	18
EPL#10	05/08/2022	8.1	30	384	6.5
GS-1	05/08/2022	7	2.2	296	0.5
EPL#7	06/08/2022	7.2	10	331	8
EPL#9	06/08/2022	7.9	21	426	24
EPL#10	06/08/2022	8.6	30	380	8
GS-1	06/08/2022	7.1	2.2	280	< 0.1
EPL#7	07/08/2022	8.1	95	443	68
EPL#9	07/08/2022	7.4	18	382	18
EPL#10	07/08/2022	8.5	30	382	10
GS-1	07/08/2022	7.2	1.8	288	< 0.1
EPL#7	08/08/2022	8.4	100	457	38
EPL#9	08/08/2022	7.4	26	390	32
EPL#10	08/08/2022	8.2	28	388	8.5
GS-1	08/08/2022	7.4	28	391	18
EPL#7	09/08/2022	7.2	6.4	344	12
EPL#9	09/08/2022	7.4	21	376	23
EPL#10	09/08/2022	8.4	25	372	10
GS-1	09/08/2022	7.2	7.9	305	8

Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
EPL#7	10/08/2022	8.1	22	438	77
EPL#9	10/08/2022	7.1	80	380	129
EPL#10	10/08/2022	8.2	25	374	12
GS-1	10/08/2022	6.8	1.3	284	1
EPL#7	11/08/2022	7.5	37	387	22
EPL#9	11/08/2022	7	36	389	36
EPL#10	11/08/2022	8.4	28	384	5
GS-1	11/08/2022	7	1.4	295	< 0.1
EPL#7	12/08/2022	7.2	34	370	13
EPL#9	12/08/2022	6.8	44	401	51
EPL#10	12/08/2022	8.5	25	386	12
GS-1	12/08/2022	6.8	1.7	298	1
EPL#7	10/10/2022	7.7	50	202	118
EPL#9	10/10/2022	7.3	29	211	8
EPL#10	10/10/2022	8.2	85	427	40
GS-1	10/10/2022	7.2	26	179	15
EPL#7	11/10/2022	6.9	19	265	20
EPL#9	11/10/2022	6.9	16	235	11
EPL#10	11/10/2022	8.2	45	419	34
GS-1	11/10/2022	7.1	15	238	5
EPL#7	12/10/2022	7.2	45	281	206
EPL#9	12/10/2022	7.9	16	301	24
EPL#10	12/10/2022	8.3	60	485	43
GS-1	12/10/2022	7	14	288	8
EPL#7	13/10/2022	7	12	276	18
EPL#9	13/10/2022	7.6	14	312	15
EPL#10	13/10/2022	8.4	65	434	46
GS-1	13/10/2022	7	13	240	4

Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
EPL#7	14/10/2022		90	435	51
EPL#9	14/10/2022	7.2	85	293	25
EPL#10	14/10/2022	7.2	9.4	285	17
GS-1	14/10/2022	7	6.4	254	2
EPL#7	15/10/2022	7.7	28	373	53
EPL#9	15/10/2022	7.3	12	304	19
EPL#10	15/10/2022	8.4	39	434	35
GS-1	15/10/2022	7.1	6.7	257	9
EPL#7	16/10/2022	7.6	50	358	36
EPL#9	16/10/2022	7.1	20	320	35
EPL#10	16/10/2022	8.3	70	433	41
GS-1	16/10/2022	7.1	4.9	235	1
EPL#7	17/10/2022	7.5	16	376	3
EPL#9	17/10/2022	7.2	4	330	22
EPL#10	17/10/2022	8.5	40	440	30
GS-1	17/10/2022	6.9	2.4	272	4
EPL#7	18/10/2022	7.4	11	363	14
EPL#9	18/10/2022	7	6.4	334	29
EPL#10	18/10/2022	8.4	39	444	26
GS-1	18/10/2022	7	2.6	277	9
EPL#7	19/10/2022	7.4	50	401	24
EPL#9	19/10/2022	7.8	5.6	334	2
EPL#10	19/10/2022	8.5	65	438	9
GS-1	19/10/2022	7.5	3.9	282	2
EPL#7	20/10/2022	7.3	11	335	5
EPL#9	20/10/2022	7.3	12	351	6
EPL#10	20/10/2022	8.9	45	441	11
GS-1	20/10/2022	7.1	2.2	284	2

Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
EPL#7	22/10/2022	6.9	21	199	44
EPL#9	22/10/2022	6.9	18	181	40
EPL#10	22/10/2022	8.4	35	391	75
GS-1	22/10/2022	7	17	181	14
EPL#7	23/10/2022	7	21	211	46
EPL#9	23/10/2022	6.9	14	219	28
EPL#10	23/10/2022	8.4	30	398	36
GS-1	23/10/2022	8.1	14	256	11
EPL#7	24/10/2022	7.4	50	407	145
EPL#9	24/10/2022	7.5	12	226	8
EPL#10	24/10/2022	8.2	38	377	72
GS-1	24/10/2022	6.9	13	200	8
EPL#7	25/10/2022	7.4	37	281	206
EPL#9	25/10/2022	7	26	485	43
EPL#10	25/10/2022	8.6	65	288	8
GS-1	25/10/2022	7.1	28	136	38
EPL#7	26/10/2022	7	50	181	57
EPL#9	26/10/2022	7.2	27	183	34
EPL#10	26/10/2022	8.2	55	361	77
GS-1	26/10/2022	7.1	25	167	24
EPL#7	27/10/2022	7	26	218	20
EPL#9	27/10/2022	7	17	216	27
EPL#10	27/10/2022	8.4	45	524	92
GS-1	27/10/2022	7.3	18	212	18
EPL#7	28/10/2022	7.9	180	336	131
EPL#9	28/10/2022	8.3	35	276	35
EPL#10	28/10/2022	8.5	130	352	70
GS-1	28/10/2022	8	17	254	16

Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
EPL#7	29/10/2022	7.8	28	299	26
EPL#9	29/10/2022	7.2	13	265	15
EPL#10	29/10/2022	8.4	130	371	78
GS-1	29/10/2022	7	16	222	22
EPL#7	30/10/2022	7.4	48	330	39
EPL#9	30/10/2022	7.1	12	278	23
EPL#10	30/10/2022	8.7	120	366	72
GS-1	30/10/2022	7	11	239	7
EPL#7	31/10/2022	7.8	70	390	10
EPL#9	31/10/2022	7	13	301	16
EPL#10	31/10/2022	8.4	100	366	60
GS-1	31/10/2022	6.9	8.7	241	4
EPL#7	1/11/2022	7.2	19	267	6
EPL#9	1/11/2022	7.3	20	301	18
EPL#10	1/11/2022	8.3	100	366	42
GS-1	1/11/2022	7.1	10	238	1
EPL#7	2/11/2022	8.1	150	414	83
EPL#9	2/11/2022	7.6	18	290	25
EPL#10	2/11/2022	8.4	100	372	16
GS-1	2/11/2022	7.1	8.9	257	5
EPL#7	3/11/2022	7.4	16	309	10
EPL#9	3/11/2022	7.6	18	311	24
EPL#10	3/11/2022	8.5	95	384	34
GS-1	3/11/2022	7	7.5	263	2
EPL#7	4/11/2022	7.5	24	339	14
EPL#9	4/11/2022	7.4	13	231	8
EPL#10	4/11/2022	8.3	110	387	48
GS-1	4/11/2022	7.6	4.4	314	4

Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
EPL#7	5/11/2022	7.7	55	390	39
EPL#9	5/11/2022	7.2	30	330	44
EPL#10	5/11/2022	8.6	90	392	31
GS-1	5/11/2022	7.4	10	270	7
EPL#7	6/11/2022	7.8	70	434	38
EPL#9	6/11/2022	8	36	396	31
EPL#10	6/11/2022	8.6	90	392	30
GS-1	6/11/2022	7.1	2.4	274	2
EPL#7	7/11/2022	7.6	13	352	16
EPL#9	7/11/2022	7	28	364	53
EPL#10	7/11/2022	8.5	70	397	18
GS-1	7/11/2022	7.1	3.5	278	15
EPL#7	8/11/2022	7.6	22	399	14
EPL#9	8/11/2022	7.8	18	369	22
EPL#10	8/11/2022	8.5	60	400	9
GS-1	8/11/2022	7	3.2	274	2
EPL#7	9/11/2022	8	38	409	22
EPL#9	9/11/2022	6.4	23	406	38
EPL#10	9/11/2022	6.6	70	481	31
GS-1	9/11/2022	6.9	2.1	277	10
EPL#7	10/11/2022	7.5	70	379	65
EPL#9	10/11/2022	6.7	20	458	35
EPL#10	10/11/2022	8.7	70	406	15
GS-1	10/11/2022	7.1	2.4	279	2
EPL#7	11/11/2022	7.3	17	379	15
EPL#9	11/11/2022	7.7	23	432	34
EPL#10	11/11/2022	8.8	70	405	22
GS-1	11/11/2022	9.3	65	346	125

Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
EPL#7	16/02/2023	8	170	418	121
EPL#9	16/02/2023	6.8	14	315	24
EPL#10	16/02/2023	7.1	120	277	56
GS-1	16/02/2023	7	3.4	275	2
EPL#7	17/02/2023	7.8	110	421	52
EPL#9	17/02/2023	7	15	325	14
EPL#10	17/02/2023	8.4	110	394	33
GS-1	17/02/2023	7.1	2.8	276	8
EPL#7	18/02/2023	8	65	422	82
EPL#9	18/02/2023	7	5.3	343	16
EPL#10	18/02/2023	8.1	110	400	55
GS-1	18/02/2023	7.1	1.5	298	5
EPL#7	19/02/2023	8	45	435	99
EPL#9	19/02/2023	7.4	5.8	391	16
EPL#10	19/02/2023	7.9	75	393	34
GS-1	19/02/2023	7.1	0.45	296	4
EPL#7	20/02/2023	7.6	75	437	68
EPL#9	20/02/2023	7	6.8	375	19
EPL#10	20/02/2023	8.4	100	390	21
GS-1	20/02/2023	7	1.5	303	6
EPL#7	21/02/2023	7.6	55	454	50
EPL#9	21/02/2023	7	2.9	385	8
EPL#10	21/02/2023	8.6	100	394	47
GS-1	21/02/2023	7	1	305	10
EPL#7	22/02/2023	8.1	500	394	690
EPL#9	22/02/2023	7.2	25	362	20
EPL#10	22/02/2023	8.4	110	385	35
GS-1	22/02/2023	7.2	3.6	301	4

Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
EPL#7	23/02/2023	7.9	230	409	190
EPL#9	23/02/2023	7.2	11	346	8
EPL#10	23/02/2023	8.3	130	385	41
GS-1	23/02/2023	7	5.6	311	4
EPL#7	24/02/2023	8.1	220	419	160
EPL#9	24/02/2023	7.3	5.4	345	4
EPL#10	24/02/2023	8.4	120	383	33
GS-1	24/02/2023	7.3	3.3	276	6
EPL#7	25/02/2023	7.6	100	398	65
EPL#9	25/02/2023	7.1	7.1	370	17
EPL#10	25/02/2023	7.6	100	391	41
GS-1	25/02/2023	7.4	2.7	340	5
EPL#7	26/02/2023	8.1	140	435	113
EPL#9	26/02/2023	7.4	8.7	416	15
EPL#10	26/02/2023	8.2	110	389	36
GS-1	26/02/2023	7	0.9	320	2
EPL#7	27/02/2023	7.1	45	398	40
EPL#9	27/02/2023	7	4.8	378	12
EPL#10	27/02/2023	8.3	110	390	38
GS-1	27/02/2023	7	1	317	4
EPL#7	28/02/2023	7.5	120	449	92
EPL#9	28/02/2023	6.9	7.8	387	14
EPL#10	28/02/2023	8.2	110	391	36
GS-1	28/02/2023	6.9	2	319	3
EPL#7	1/03/2023	7.9	130	451	112
EPL#9	1/03/2023	7	7.9	388	25
EPL#10	1/03/2023	7.9	110	391	31
GS-1	1/03/2023	6.9	1	324	5

Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
EPL#7	2/03/2023	7.8	120	459	95
EPL#9	2/03/2023	7	3.7	381	8
EPL#10	2/03/2023	7.5	100	395	36
GS-1	2/03/2023	6.8	2.1	323	8
EPL#7	3/03/2023	7.6	120	457	99
EPL#9	3/03/2023	7	4.6	388	9
EPL#10	3/03/2023	7.7	100	391	25
GS-1	3/03/2023	6.9	1.2	323	5
EPL#7	15/03/2023	7.2	85	234	60
EPL#9	15/03/2023	6.7	39	184	41
EPL#10	15/03/2023	8.7	80	274	9
GS-1	15/03/2023	7	26	194	15
EPL#7	16/03/2023	6.9	130	249	190
EPL#9	16/03/2023	6.7	22	223	28
EPL#10	16/03/2023	9.3	90	364	49
GS-1	16/03/2023	7	19	212	3
EPL#7	17/03/2023	8	210	341	132
EPL#9	17/03/2023	7.2	14	267	31
EPL#10	17/03/2023	9	85	374	31
GS-1	17/03/2023	7	13	229	7
EPL#7	18/03/2023	7.9	220	356	140
EPL#9	18/03/2023	7.2	12	276	21
EPL#10	18/03/2023	9.5	85	379	36
GS-1	18/03/2023	7	10	246	10
EPL#7	19/03/2023	8.1	190	383	129
EPL#9	19/03/2023	6.9	19	286	39
EPL#10	19/03/2023	9.5	85	384	30
GS-1	19/03/2023	7	8.2	248	5

Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
EPL#7	20/03/2023	7.7	120	392	56
EPL#9	20/03/2023	6.9	8.2	298	16
EPL#10	20/03/2023	9.4	75	380	14
GS-1	20/03/2023	6.9	6.7	253	7
EPL#7	21/03/2023	8	180	403	136
EPL#9	21/03/2023	7	8.3	324	9
EPL#10	21/03/2023	9.1	60	385	13
GS-1	21/03/2023	7	4.9	254	6
EPL#7	22/03/2023	7.8	170	419	152
EPL#9	22/03/2023	7	20	324	6
EPL#10	22/03/2023	8.6	75	386	14
GS-1	22/03/2023	6.9	5.3	263	8
EPL#7	23/03/2023	7.7	130	408	101
EPL#9	23/03/2023	7	8.1	321	18
EPL#10	23/03/2023	8.3	75	389	19
GS-1	23/03/2023	6.9	3.9	266	3
EPL#7	24/03/2023	8.3	210	423	154
EPL#9	24/03/2023	7.2	6.7	324	8
EPL#10	24/03/2023	8.3	80	381	10
GS-1	24/03/2023	6.9	3.4	271	2

Elevated TSS levels occurred after all significant rainfall events at EPL#7 as indicated in Table 18. As noted above all five flood events were well above the dam holding capacity of 90.7mm causing discharge via the designed spillway. The spillway is designed with gabion rock and riparian zone reeds in the immediate vicinity. Downstream water levels at GS-3 were similar to upstream levels during all spillway discharge events. No breach of consent condition occurred as the rainfall event was outside of the design capacity of the dam as denoted by S4.C30.

5.5.3. Surface Water Long Term Analysis and Trends

The Lower Dam (GS-4/EPL#8) ambient water quality for FY23 exhibited readings that were above average for TSS, close to average for turbidity, above average for pH and below average for Conductivity. These trends are attributed to above average rainfall and extreme flooding events experienced throughout the reporting period. These trends are visible in Figures 23 to Figure 26 below.

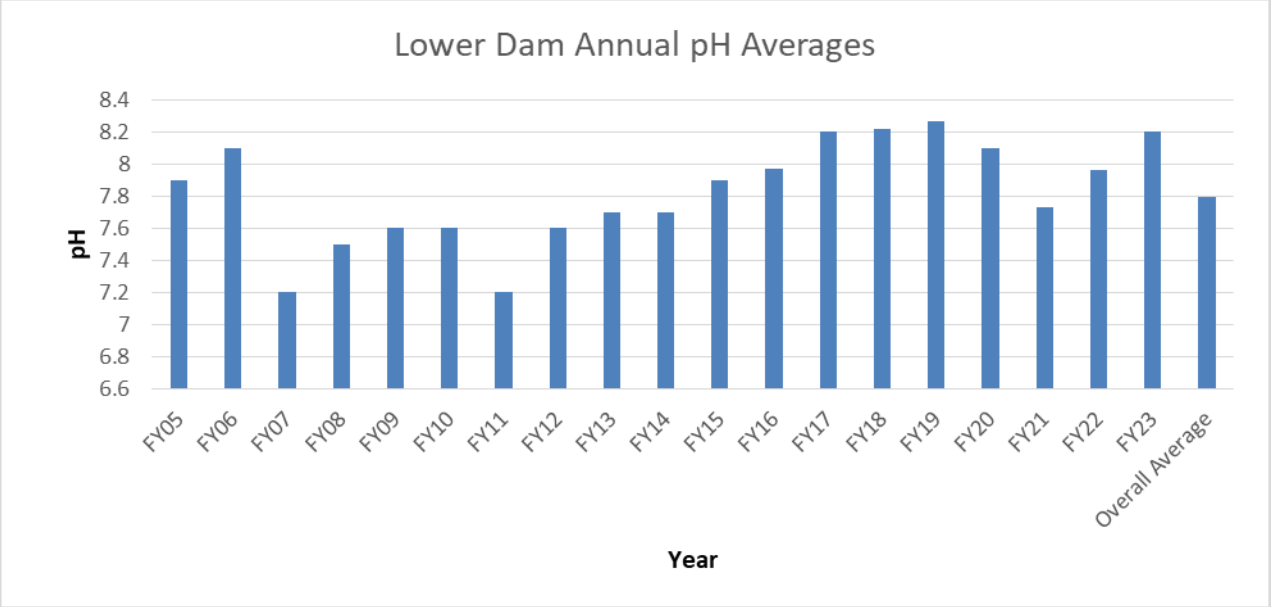


Figure 23 Lower Dam Annual pH Averages

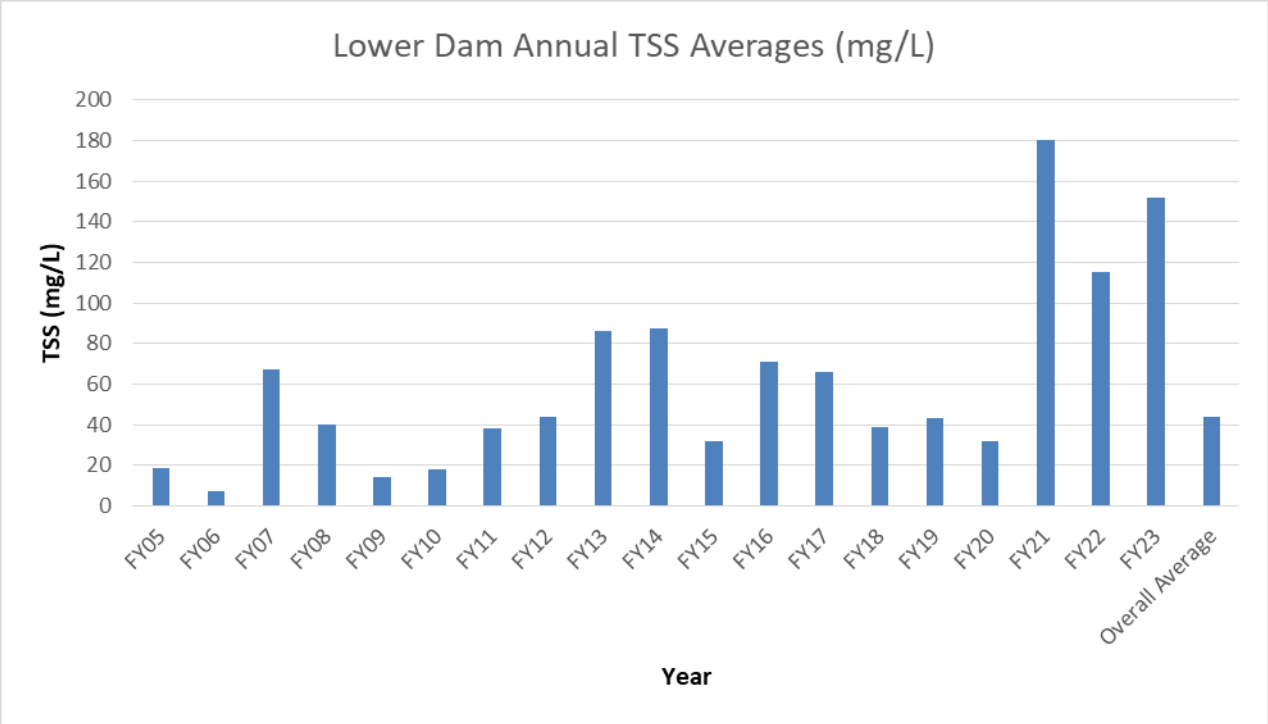


Figure 24 Lower Dam Annual TSS Averages

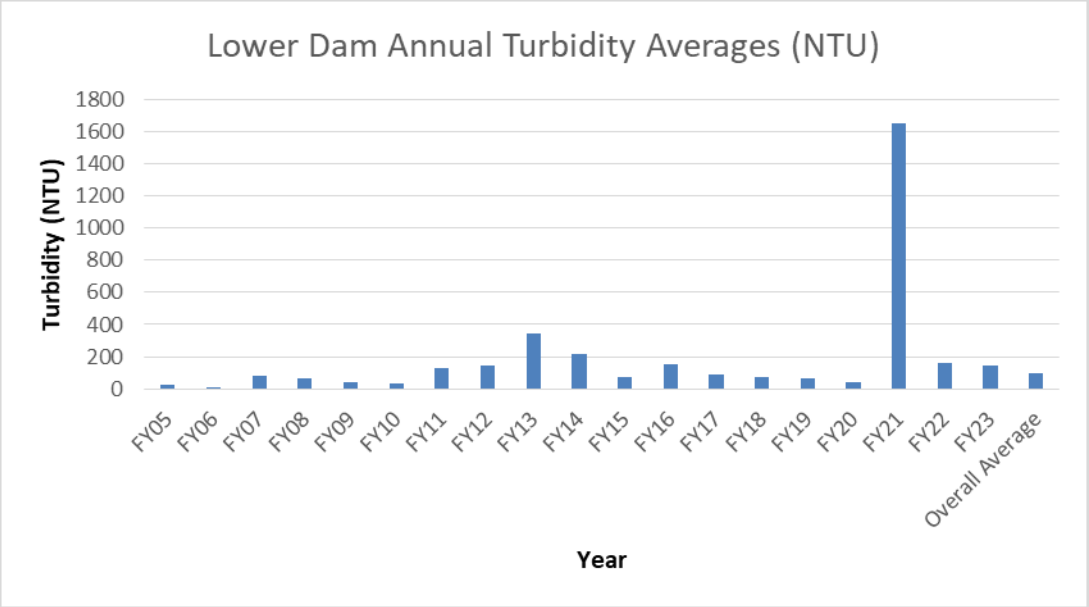


Figure 25 Lower Dam Annual Turbidity Averages

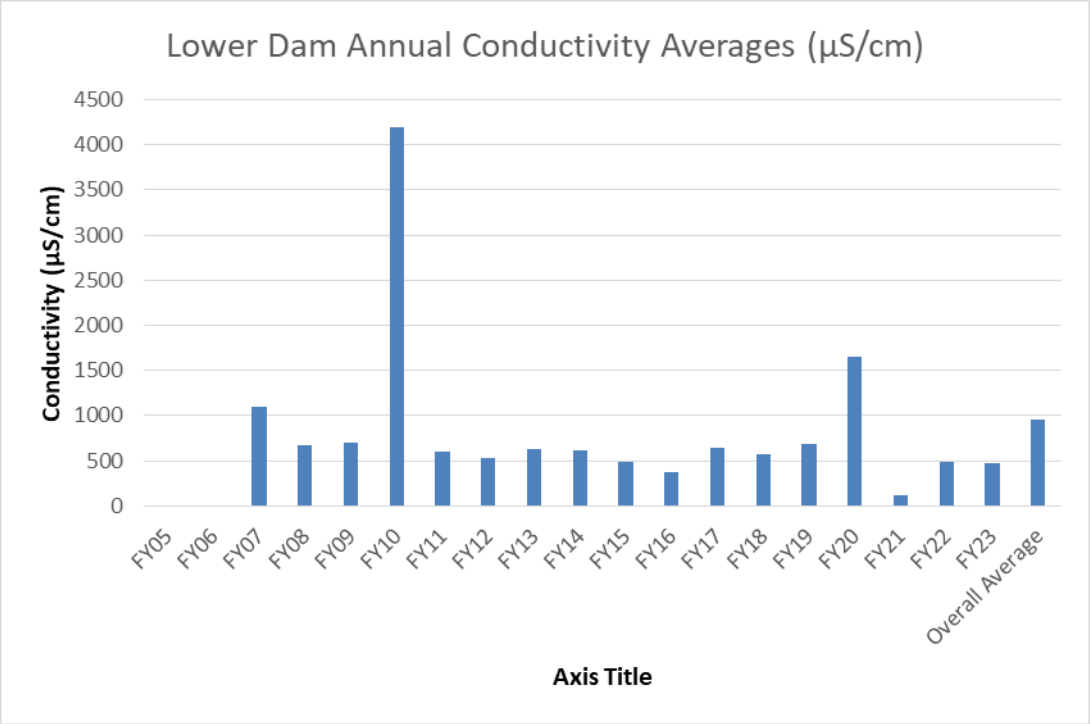


Figure 26 Lower Dam Annual Conductivity Averages

5.5.4. Water Balance and Consumption

The majority of surface water runoff from the quarry is captured in the sites' water management dams. Captured surface water runoff is either used as process water within the quarry operations (e.g. for dust suppression), lost to evaporation or seepage, or discharged to receiving waters.

The quarry is licenced to take surface water from Rocklow Creek. This allocation, under WAL#25152, is 227ML/year and is extracted via a 100mm centrifugal pump. No water take was initiated from Rocklow Creek during the reporting period. NRAR has delayed rollout of

new metering framework for non-urban water take for coastal regions until 1 December 2023 for pumps below 500 mm.

All process water was sourced by either the Lower Dam, Middle Dam or Croome Sumps, which are offline from Rocklow Creek as per water management upgrades undertaken in 2008 under MOD 4. The Location of water storage infrastructure is shown below in Figure 27.

Figure 27 Water Storage Locations

The updated WMP outlines a range of water balance scenarios based on different climate conditions. The wet year scenarios (90th percentile 1,658mm rainfall) best reflects rainfall for the FY23 period (annual rainfall was 1,715mm) as shown in Figure 28. As a result, the process water use was modelled to be 176ML for the reporting period with a change of storage of +137ML over the year within the three dam storages, indicating that water take was well within licenced volumes.

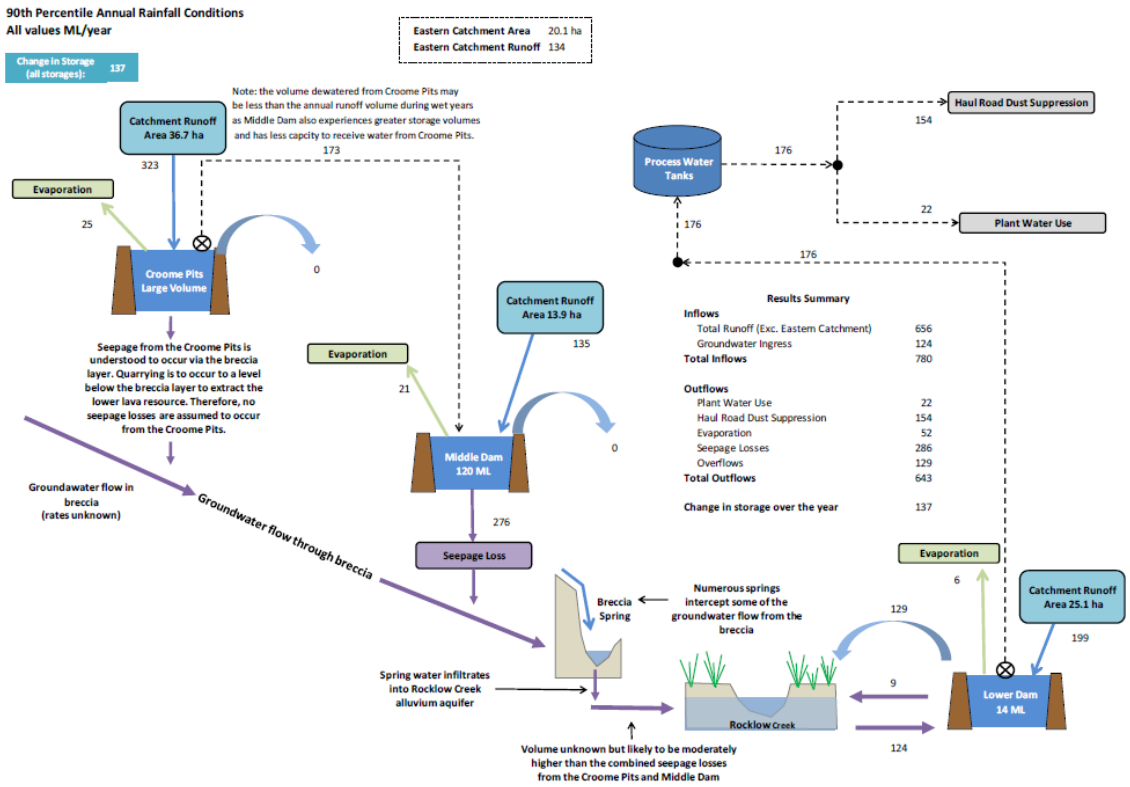


Figure 4.8 Existing water management system: typical wet year results

Figure 28 Existing water management system: typical wet year water balance

5.5.5. Surface Water Quality Summary and Opportunities for Improvement

The water management system has been progressively updated over the past few years. The main changes have included:

- An increase in storage capacity of the Middle Dam and the improved spillway arrangement;
- An upgraded drainage system between the Middle Dam and the Lower Dam;
- An upgraded water recycling ability for the quarry;
- An extended ambient water quality program.

The improvements to the water management system outlined in the updated WMP will reduce the instances where Rocklow Creek inundates the Lower Dam causing it to fill up. A summary of these improvements is reproduced in Table 19 below and will be addressed in the updated WMP.

Table 17 Proposed Water Management System Improvements

Proposed Modification	Outcome
Relocate spillway to south-east side of the dam where Rocklow Creek levels are expected to be lower during large runoff events.	• Significantly reduce the frequency of uncontrolled inflows from Rocklow Creek inundating the Lower Dam. • Improve water treatment function of Lower Dam during Rocklow Creek flood events.

Relocate primary sedimentation chamber to western end of dam. Raise embankment at existing spillway location from 2.8 to 4.0 m AHD.	• Inflows will occur at the opposite end of the dam to outflows, resulting in longer residence time and improved sediment treatment function. • Provide vehicle access to primary sedimentation chamber to allow for sediment removal as required.
Extend the dam footprint to the east by approximately 1,600m2 and excavate to 2.0 m AHD.	• Provide an additional 1.1 ML of storage above 2.0 m AHD. • Establish a macrophyte zone near the dam outlet.
The relocated spillway will have an invert level of 3.1 m AHD1, which will be 300 mm higher than the existing level (2.8 m AHD).	• Reduce the frequency of Rocklow Creek floodwaters inundating the Lower Dam. • Provide an additional 2.0 ML of storage above 2.0 m AHD.
Establish macrophyte zone within extended dam footprint area.	• Provide beneficial water quality treatment during significant rainfall (discharge) events.

5.6. Ground Water Monitoring

An annual groundwater monitoring report has been prepared by EMM Consulting Pty Ltd, in accordance with condition 44C. This report is included in full within Appendix E. The monitoring program uses the established down gradient bores at Dunmore Sand and Soil (DG-31, DG-59 and BH-F) and four established up gradient bores at Dunmore Quarry (GW-1, GW-2 and GW-3). Location of Groundwater monitoring bores are shown below in Figure 29.

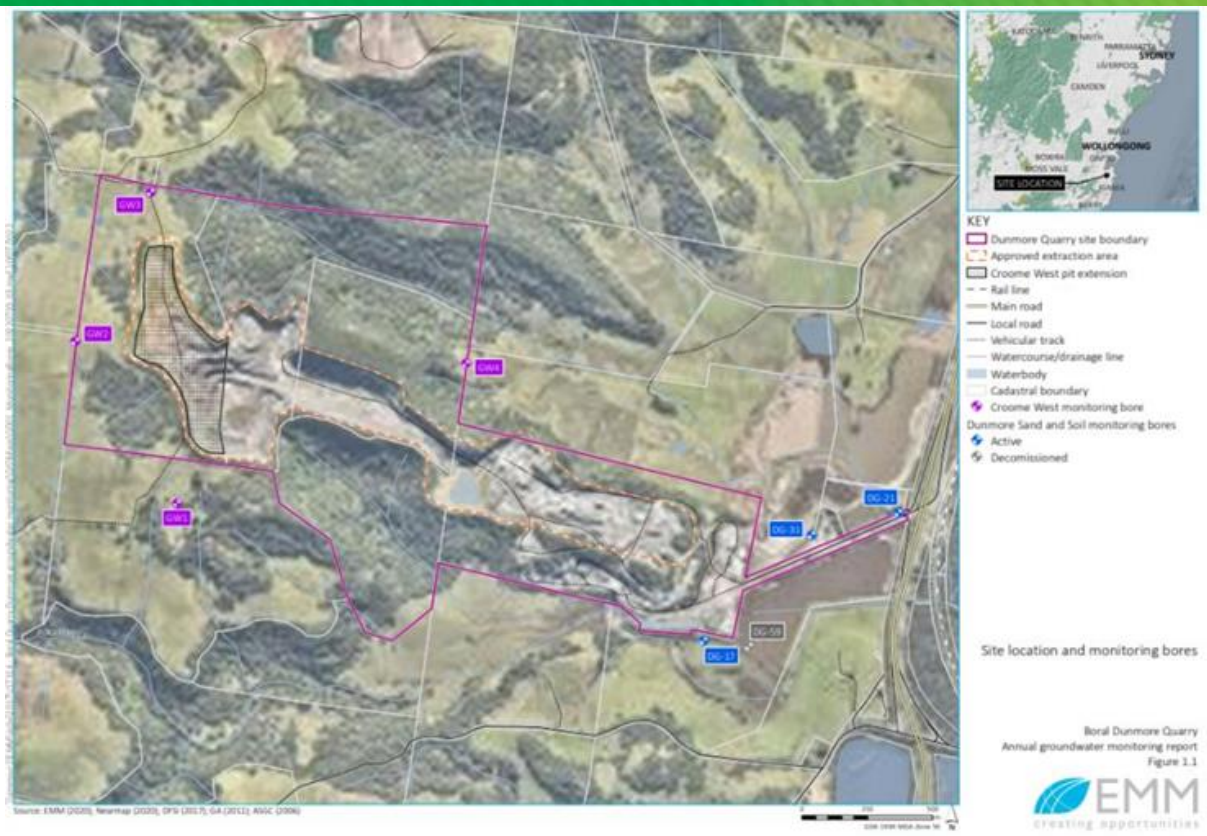


Figure 29 Groundwater Monitoring Bores

The monitoring bores are located up hydraulic gradient from current quarrying activities and are therefore considered representative of baseline conditions (both water levels and quality). Groundwater monitoring for the up-gradient bores includes six-hourly groundwater level measurements and six monthly groundwater sampling events

5.6.1. Groundwater Monitoring Impact Assessment Criteria

Groundwater impacts relating to quality and water levels downgradient are assessed in relation to the up-gradient (baseline) conditions located in bores GW-1, GW-2, GW-3 and GW-4 and against the site conceptual model which was formulated as part of the MOD 9 Croome West Expansion.

5.6.2. Groundwater Monitoring FY23 Performance Review

Groundwater levels are recorded every six-hours allowing water level trends to be identified in the alluvium and the Bumbo Latite. Continued six monthly sampling of water quality at the Croome West sites and quarterly sampling at the DSS sites has also established useful trends.

The main findings for the FY23 monitoring year regarding water levels are:

- Groundwater levels in the alluvium (DG-17, DG-31 and DG-21) are comparable to previous monitoring events and are generally less than 3 metres below ground level (mbgl). The shallow alluvium shows a direct and immediate response to rainfall at DG-17 and DG-31. The groundwater level at DG-21 does not respond to rainfall recharge.

- The groundwater level at GW1 has historically shown a direct response to rainfall recharge during periods of above average rainfall. Comparatively, GW2 and GW3 show little to no response to rainfall.
- Groundwater quality data collected during the FY23 monitoring year was generally consistent with previous years. It was noted that a shift towards a more bicarbonate dominant water type was observed at GW1 and GW4, indicating increased groundwater mixing.
- The dissolved metal results were comparable to previous sampling results. Iron was typically higher in the alluvial groundwater and manganese was typically higher at the Latite monitoring bores GW1 and GW2.
- Nitrate results at GW3 continue to be an order of magnitude higher than the other Latite and alluvial bores, which could be related to the Breccia layer. Total phosphorus results continue to be an order of magnitude higher at DG-17 compared to the other alluvial and Latite bores.

The results for the FY23 monitoring year are consistent with the conceptual model for the project. There does not appear to be any impact on groundwater levels or quality in the Bumbo Latite or Kiama Sandstone associated with the Croome West pit extension activities.

5.6.3. Groundwater Monitoring Summary and Opportunities for Improvement

As per S4.C43: *on the provision of two years of monitoring data that shows negligible impact on the regional groundwater network the Secretary may agree to suspend monitoring of regional groundwater levels and/or quality.* The two-year groundwater monitoring period has shown negligible impact to the monitored groundwater system.

However, in the interest of collecting additional groundwater site data and continuing groundwater monitoring whilst Boral are still continuing extraction in the Croome West pit, it is proposed to continue with the current monitoring regime at the quarry.

5.7. Flora and Fauna Management and Rehabilitation

Most areas of the site are currently operational and as such rehabilitation is not able to commence on the majority of areas within the quarry until the completion of extraction activities. When practical, progressive rehabilitation of the site will be undertaken in conjunction with on-going quarrying works. Hydroseeding of the Croome West Bund is now well established with trees as shown below in Figure 30.

Figure 30 Hydroseeding cover and trees over Croome West Bund

Rehabilitation activities undertaken to date have been in accordance with the updated Flora and Fauna Management by EMM (2019) and Rehabilitation Management Plan prepared by Arcadis (2016).

There are three (3) designated conservation areas for Dunmore Quarry as shown in Figure 31 below. These areas are referred to as the Compensatory Habitat Area (CHA), Remnant Vegetation Conservation Area (RCVA), and Offset Area (OA). Works in the last reporting period focussed on the CHA and OA and are summarised in the Annual Monitoring report located in Appendix E.

In the last 12 months, rehabilitation within the quarry itself has continued on the Croome West amenity bund.

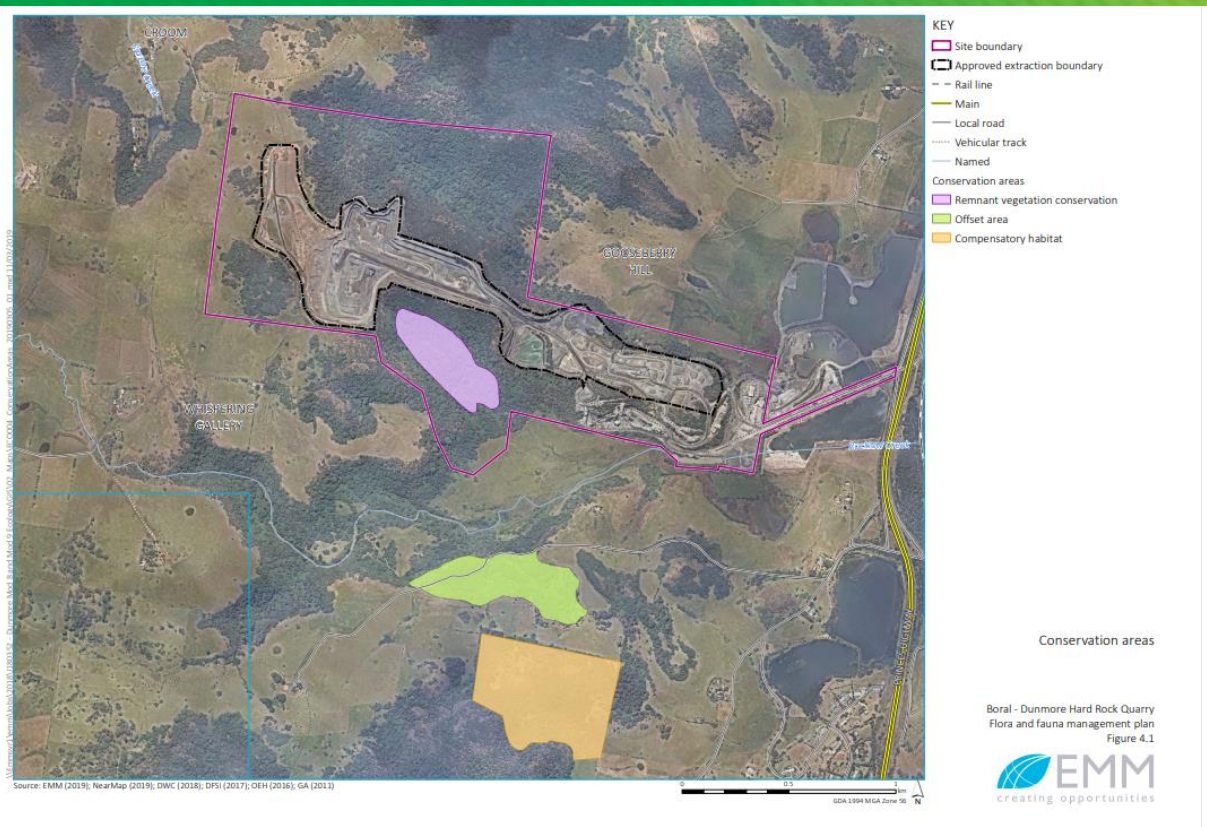


Figure 31 Conservation Areas

5.7.1. Flora and Fauna Impact and Rehabilitation Assessment Criteria

Completion criteria were designed in the updates to the FFMP, which was approved June 2019.

The following completion criteria are outlined for the Compensatory Habitat Area (CHA):

- establishment of a dominant native canopy cover across the Compensatory Habitat Area, as per below:
  - midstory canopy cover of 50% for areas of Melaleuca Armillaris Tall Shrubland; and
  - overstory canopy cover of 15% for areas of Illawarra Lowlands Grassy Woodland;
- removal of woody weeds across the Compensatory Habitat Area; and
- reduction in exotic groundcover to less than 30% over five consecutive monitoring periods.

Once these completion criteria have been met, no further management of this area is required under this FFMP and Conditions 46(a) and 49 are deemed to have been satisfied.

The following completion criteria are outlined for the Remnant Vegetation Conservation Area (RCVA):

- maintenance of high-quality intact remnants, with no significant change in cover of native species;
- establishment of a dominant native canopy cover of 15% in the lower (south-eastern) portion of the Remnant Vegetation Conservation Area; and

- Establishment of a predominantly native (>50%) groundcover, with maintenance of this native groundcover over five consecutive monitoring periods.

Once these completion criteria have been met, no further management of this area is required under this FFMP, and Conditions 46(b) and 50 are deemed to have been satisfied.

There are no completion criteria set for the Offset Area (OA) as the area is managed via an in-perpetuity arrangement via a Conservation Agreement. A Conservation Agreement between the Minister administering the *National Parks and Wildlife Act (1974)* and Boral Resources for Dunmore Quarry was signed by NSW Minister for the Environment on February 2011. The NSW Minister for the Environment confirmed signing the Dunmore Quarry Conservation Agreement and acknowledged that the Conservation Agreement satisfied condition 46A of DA 470-11-2003, for the long term security of the Offset Area.

5.7.2. Flora and Fauna and Rehabilitation FY23 Performance Review

A summary of the bushland regeneration works undertaken within the three active bushland restoration zones is outlined in Bushland Restoration Project Final Report contained in Appendix F.

5.7.2.1. Zone 1 Remnant Vegetation Conservation Area

Zone 1 consists of a large gully with a south easterly aspect and a drainage line that forms part of the Rocklow Creek catchment. The 15 hectare site contains a subtropical rainforest with a diverse range of canopy species including Sassafras (*Doryphora sassafras*), Myrtle Ebony (*Diospyros pentamera*) and all five of the local Fig (*Ficus sp.*) species. An abundance of vines also exist within this remnant vegetation area including Round Vine (*Legnephora moorei*), Kangaroo Grape (*Cissus Antarctica*) and Milk Vine (*Marsdenia spp.*), and many species of ferns are present as epiphytes, lithophytes and within the ground layer. Large amounts of woody weeds and Lanatana have invaded this area. No works were carried out within this zone due to inaccessibility of the site during wet periods and cattle accessing the site where fencing is inadequate.

5.7.2.2. Zone 2 Offset Area

The contract period bush regeneration works for the OA focused on secondary and primary weed control within the woodland and rainforest remnants and the rainforest ecotone at the eastern extent of this zone. Regeneration of native canopy species within these areas this year has been rapid and a connected sub-canopy exists within the RF remnant.

Primary weed control was carried out at the eastern extent of this zone during this contract period. Additional populations of the threatened plant species White Wax Flower (*Cynanchum elegans*) were located within the ecotone between the rainforest and woodland remnants. Mass regeneration of Illawarra Zieria (*Zieria granulata*) has been observed within some areas and *Homalanthus stillingiifolius* has emerged within the site and is regenerating naturally and secondary populations of this regionally rare plant can be found throughout the site.

Table 20 Zone 2a vegetation condition summary

Zone 2a: Melaleuca armillaris Tall Shrubland

Photo Point	**A1, A3**		
Commencement of works date	September 2021		
Monitoring Survey Date	24th August 2023		
Vegetation Condition		**Percentage Cover prior to works**	**Percentage Cover post works**
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by	80% native cover 20% weed cover	100% native cover 0% weed cover
Shrub layer	The shrub layer surrounding this photo point is dominated by	30% native cover 70% weed cover	100% native cover 0% weed cover
Ground Layer	The ground layer surrounding this photo point is dominated by native and weed grasses as well as a range of annual weeds and woody weed seedlings such as	40% native cover 60% weed cover	95% native cover 5% weed cover

* indicates exotic plant species

Table 21 Zone 2b vegetation condition summary

Zone 2b: Illawarra Subtropical Rainforest

Photo Point	**B1**		
Commencement of works date	September 2021		
Monitoring Survey Date	24th August 2023		
Vegetation Condition		**Percentage Cover prior to works**	**Percentage Cover post works**
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of rainforest species such as *Polysias elegans* Pittosporum undulatum Eucalyptus amplifolia	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by rainforest species such as	95% native cover 5% weed cover	100% native cover
Shrub layer	The shrub layer surrounding this photo point is dominated by small regenerating rainforest species and *Solanum mauritianum**	20% native cover 80% weed cover	100% native cover
Ground Layer	The ground layer surrounding this photo point is dominated by regenerating native rainforest trees and ferns as well as a range of annual weeds and invasive vines such as Bidens*, Cape Ivy*, Moth Vine*	40% native cover 60% weed cover	90% native cover 10% weed cover

* indicates exotic plant species

Table 22 Zone 2c vegetation condition summary

Zone 2c: Illawarra Grassy Woodland

Photo Point	**A2**		
Commencement of works date	September 2021		
Monitoring Survey Date	24th August 2023		
Vegetation Condition		**Percentage Cover prior to works**	**Percentage Cover post works**
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of *Melaleuca armillaris* *Eucalyptus tereticornis*	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by *Notolea venosa* *Dodonea viscose* *Acaica maidenii* *Olea europaea* subsp. *cuspidata**	80% native cover 20% weed cover	100% native cover 0% weed cover
Shrub layer	The shrub layer surrounding this photo point is dominated by *Lantana camara** *Indigofera australis*	30% native cover 70% weed cover	100% native cover 0% weed cover
Ground Layer	The ground layer surrounding this photo point is dominated by native and weed grasses as well as a range of annual weeds and woody weed seedlings such as *Lantana camara** *Bidens pilosa**	40% native cover 60% weed cover	80% native cover 20% weed cover

* indicates exotic plant species

Zone 2 Photographs

A1 Photo point prior to commencement of works in 2017

A1 Photo point after primary weed control and maintenance, August 2023

A3 Photo point prior to commencement of works in 2017

A3 Photo point showing regeneration of woodland species and Zieria granualata, August 2022

Mature Forest Red Gum (Eucalyptus tereticornis) surrounded by dense woody weeds such as Lantana prior to commencement of works in 2017

The same view post works demonstrating woodland regeneration after Lantana removal, August 2022

Primary weed control area within the rainforest and woodland ecotone The same view, August 2022

The same view showing native regeneration where Lantana has been removed August 2022

Regeneration of rainforest such as Giant Stinging Tree since Lantana removal was completed, August 2022

The same view August 2023

Big male Kangaroo within the Zone 2 woodland remnant

Native Passionfruit (*Passiflora herbertiana*) particularly abundant within these areas

Figure 32 Photomontage of vegetation condition at Zone 2

5.7.2.3. Zone 3 Compensatory Habitat Area

The CHA zone is located south of Rocklow Road and consists of a large bushland remnant on a hilltop with a small ephemeral creek line within a gully to the south of the hill. The total site area of this zone covers approximately 23.1 hectares. The majority of this zone is perched on the rocky hillside and supports the *Melalecua armillaris* tall shrubland vegetation community. The gully drops at the southern end of the zone, which is well defined by the presence of rainforest species and some very impressive land large Moreton Bay Fig (*Ficus macrophylla*) trees.

Extensive revegetation has been carried out within this zone within the southern gully and on the eastern and western edges of the zone. Hundreds of thousands of trees have been planted within this zone and are now reaching maturity. Many open areas that have been cleared of vegetation also exist within this zone with the majority of these clearings occurring on the rocky hill tops.

Works within this zone have focused on treating woody weeds within the establishing revegetation along the western boundary if the zone.

Table 23 Zone 3a vegetation condition summary

Vegetation Condition Assessment

The vegetation condition assessments are based on a 20m² area surrounding the established photo points within each zone.

Photo Point	**3A**		
Commencement of works date	September 2021		
Monitoring Survey Date	24th August 2023		
Vegetation Condition		**Percentage Cover prior to works**	**Percentage Cover post works**
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of revegetation *Melaleuca armillaris* *Eucalyptus saligna* *Acacia maidenii*	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by *Hakea salicifolia* *Dodonaea viscosa* *Glochidion ferdinandi*	100% native cover 0% weed cover	100% native cover 0% weed cover
Shrub layer	The shrub layer surrounding this photo point is dominated by *Lantana camara** *Solanum mauritianum**	100% native cover 0% weed cover	0% native cover 0% weed cover
Ground Layer	The ground layer surrounding this photo point is dominated by native and weed grasses as well as a range of annual weeds and woody weed seedlings such as *Sida rhombifolia** *Bidens pilosa** *Sigesbeckia orientalis*	40% native cover 60% weed cover	80% native cover 20% weed cover

Table 24 Zone 3b vegetation condition summary

Photo Point	**3B**		
Commencement of works date	September 2021		
Monitoring Survey Date	24th August 2023		
Vegetation Condition		**Percentage Cover prior to works**	**Percentage Cover post works**
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of revegetation *Melaleuca armillaris* *Eucalyptus saligna* *Acacia maidenii*	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by *Hakea salicifolia* *Dodonaea viscosa* *Glochidion ferdinandi*	100% native cover 0% weed cover	100% native cover 0% weed cover
Shrub layer	The shrub layer surrounding this photo point is dominated by *Lantana camara** *Solanum mauritianum**	100% native cover 0% weed cover	0% native cover 0% weed cover
Ground Layer	The ground layer surrounding this photo point is dominated by native and weed grasses as well as a range of annual weeds and woody weed seedlings such as *Sida rhombifolia** *Bidens pilosa** *Sigesbeckia orientalis*	40% native cover 60% weed cover	80% native cover 20% weed cover

Table 25 Zone 3c vegetation condition summary

Photo Point	**3C**		
Commencement of works date	September 2021		
Monitoring Survey Date	24th August 2023		
Vegetation Condition		**Percentage Cover prior to works**	**Percentage Cover post works**
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of *Melaleuca armillaris* *Acacia maidenii*	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by *Clerodendrum tomentosum* *Maclura cochinensis* *Ehretia accuminata* *Solanum mauritianum**	80% native cover 20% weed cover	100% native cover 0% weed cover
Shrub layer	The shrub layer surrounding this photo point is dominated by *Lantana camara** *Zieria granulata* *Croton verreauxii*	70% native cover 30% weed cover	100% native cover 0% weed cover
Ground Layer	The ground layer surrounding this photo point is dominated by native and weed grasses as well as a range of annual weeds and woody weed seedlings such as *Lantana camara** *Bidens pilosa** *Pellaea falcata* *Ehrharta erecta* is present within this area and will not be treated as resources don't allow for this activity	60% native cover 30% weed cover	80% native cover 20% weed cover

Table 26 Zone 3d vegetation condition summary

Photo Point	**3D**		
Commencement of works date	September 2021		
Monitoring Survey Date	24th August 2023		
Vegetation Condition		**Percentage Cover prior to works**	**Percentage Cover post works**
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of *Ficus macrophylla*	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by *Elaeodendron australe* *Clerodendrum tomentosum* *Maclura cochinensis*	100% native cover 20% weed cover	100% native cover 0% weed cover
Shrub layer	The shrub layer surrounding this photo point is dominated by *Lantana camara** *Cestrum nocturnum* *Pittosporum multiflorum*	30% native cover 70% weed cover	100% native cover 0% weed cover
Ground Layer	The ground layer surrounding this photo point is dominated by native and weed grasses as well as a range of annual weeds and woody weed seedlings such as *Oplismenus imbecillis* *Bidens pilosa** *Solanum pseudocapsicuum**	40% native cover 60% weed cover	70% native cover 30% weed cover

Zone 3 Photographs

3B Photo point prior to commencement of works

The same view after intensive hand removal of weeds, August 2023

3B Photo point prior to commencement of works

The same view after intensive hand removal of weeds, August 2023

Figure 33 Photomontage of vegetation condition at Zone 3

5.7.3. Flora and Fauna and Rehabilitation Summary and Opportunities for Improvement

Works will continue in line with the completion criteria thresholds during the next reporting period. Gorse weed will be treated at the beginning of the new financial year.

A review of the fencing requirements will be undertaken for Zone 1.

5.8. Heritage Conservation

Dunmore Quarry operate under an Aboriginal Cultural Heritage Management Plan which details the required Aboriginal heritage management and mitigation measures. The plan was prepared in consultation with OEH and Registered Aboriginal Parties and is available on the Boral Dunmore website. Archaeological salvage excavation and mitigation measures have been completed. Boral is currently undertaking environmental studies for the proposed quarry pit extension. This project will involve disturbing an additional 8 ha of land adjacent to the existing quarry void. The environmental studies will include an Aboriginal and cultural heritage assessment which once approved will require an updated Aboriginal Cultural Heritage Management Plan to be prepared. This will likely occur in the 2024/25 reporting period.

5.9. Waste Minimisation

Boral is committed to continuing non-production waste management minimisation in accordance with the waste hierarchy and minimising the amount of waste sent to landfill. To achieve this, all liquid and solid wastes are classified and sorted so they can be appropriately re-used or recycled. Waste is managed by appropriately licenced sub-contractors and entered into a waste tracking register.

To deter illegal dumping, Shellharbour Council installed cameras around the surrounds of Dunmore Quarry and Dunmore Sand and Soil. Council indicated that two prosecutions have resulted from investigations aided by the installation of the cameras.

Boral is committed to ensuring its extraction and processing activities produces minimal waste rock material. Approximately 30% of the hard rock processed at Dunmore Quarry becomes material of less than 4mm in diameter, which are known as quarry fines. In the past, quarry fines were considered a product waste and stockpiled due to having no steady market, however the material is now used in manufactured sand (as opposed to natural sand) production.

During the reporting period 97,996 tonnes of quarry fines were utilised for manufactured sand production, backfilling and progressive rehabilitation.

5.9.1. Waste Tracking Register

A detailed breakdown of the waste collected on-site during the reporting period is shown below in Table 28. Yearly trends are shown in Table 29.

Table 27 Waste Tracking Data

Month	General Waste (t)	Cardboard (t)	Commingle (t)	Timber (t)	Scrap Metal (t)	Oil & Oily Water (L)	Effluent (L)	Filter (t)*	Rags (t)**
Jul-22	1.95	0.16	0.02	0	0	6,200	26,000	1.64	0
Aug-22	10.60	0.14	0.08	0	0	0	21,500	0	0.41

Sep-22	5.31	0.10	0.05	0.44	0	22,300	16,000	0	0
Oct-22	1.91	0.11	0	0	0	0	46,500	0	0
Nov-22	1.60	0.18	0.05	0	0	0	25,000	0	0
Dec-22	1.57	0.06	0.05	0	0	0	26,500	0	0
Jan-23	5.94	0.13	0.04	1.56	0	7,840	10,000	0	0
Feb-23	12.00	0.07	0.03	0	0	0	16,000	0	0
Mar-23	2.14	0.06	0.04	1.54	0	8,300	33,500	0	0
Apr-23	2.95	0.18	0.02	0	0	0	26,500	0	0
May-23	0.84	0.14	0.02	0	0	8,360	22,000	8.00	2.00
Jun-23	9.09	0.11	0.04	1.06	0	0	34,000	0	0
Total	**55.89**	**1.44**	**0.42**	**4.60**	**0**	**53000**	**303500**	**9.64**	**2.41**

Table 28 Historical Waste Data

Waste Classification		FY19	FY20	FY21	FY22	FY23
Solid Waste	General Waste (t)	41.814	34.398	37.237	36.951	55.89
	Cardboard Tonnes (t)	0.93	3.355	2.32	1.623	1.44
	Timber Tonnes (t)	13.24	10.24	10.24	1.16	4.60
	Comingle Recycling (t)	0.63	3.825	0.255	0.266	0.42
	Used Oil Filters/ Rags (t)	0.936	1.072	2.46	8.2	12.07
	Scrap Metal (t)	110	79.64	557.46	0	0
Liquid Waste	Oil/Oily Water Litres (L)	46,900	68,883	41,900	17,280	53,000
	Effluent Litres (L)	140,000	190,000	170,208	11,111	303,500
	Other Litres (L)	0	0	0	0	0

The quantity of waste in FY23 was consistent with historical results across all categories, in accordance with Table 29.

We continue to track tyre management.

5.9.2. Waste Minimisation Opportunities for Improvement

Further work will continue with subcontractors to optimise the record keeping for waste collection data. Work will continue to consolidate the recycling improvements undertaken in FY23. A centralised waste management contract has been established with Cleanaway, which will assist in the tracking and reporting of waste.

5.10. Incident and Emergency Response

The following management actions were undertaken in regard to incident and emergency response.

- The Pollution Incident Response Management Plan was reviewed and updated in February 2023. The current version is available online at https://www.boral.com.au/our-commitment/environmental-reporting.

5.11. Dangerous and Hazardous Goods Storage

Storage of dangerous goods and hazardous material have continued as per established operations. All dangerous goods and chemicals are handled and transported in accordance with the AS1940 and AS25956 and the Dangerous Goods Code and S4.C72.

6. Community

The Dunmore Quarry Community Consultative Committee (CCC) continues to serve as a valuable dialogue between Boral and the local community with valuable input and feedback being provided by the community regarding quarry operations and plans. The CCC is run as per S5.C6 and the Departments Community Consultative Committee Guidelines for State Significant Developments (2016).

Members include:

- An independent chairperson.
- At least 2 representatives from Boral (typically the environmental co-ordinator and quarry manager).
- A member from Shellharbour City Council.
- Three local community representatives.

Members are informed of the environmental performance of the site, provided with an update on operations, and given a chance to tour the site and ask questions they may have regarding the operation. CCC members have also been diligent in disseminating the information from the meetings to other interested community members in the local area. The minutes of each meeting is published in the Boral website.

https://www.boral.com.au/locations/boral-dunmore-operations

The CCC met twice during the FY23 reporting period (August 2022 and February 2023).

6.1. Environmental Complaints Management

There were no environmental complaints received during the reporting period.

A graph showing the community complaints over time can be seen in Figure 40.

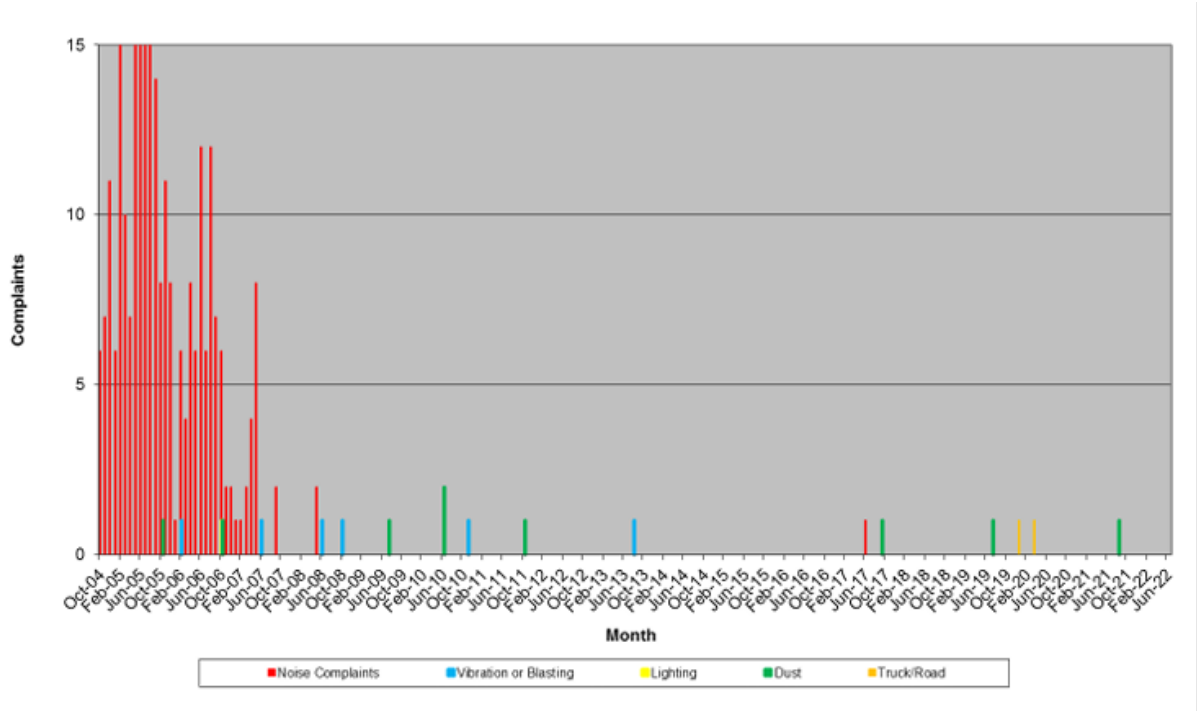


Figure 34 Historical Community Complaints

6.2. Summary of Regulatory Notifications

Zero regulatory notifications were received during the FY23 reporting period.

7. Activities to be completed by the Next Reporting Period

Table 29 Activities to be Completed by the Next Reporting Period (FY22)

Reference	Description of Action
AR 1	Update Water Management Plan as part of MOD 12 post approval documentation.
AR 2	Real time weather system to be investigated.
AR 3	Real time dust monitoring system transition phase to be completed with alert system and HVAS assessment undertaken.
AR 4	Transport Options Review complete and submitted to DPE.
AR 5	Independent audit completed for 2023.
AR 6	Rehabilitation Management Plan to be continued.
AR 7	Rehabilitation Bond to be completed based on approval of calculation report by DPE.
AR 8	Complete re-fencing of rehabilitation areas to limit intrusion of cattle.

8. Conclusion

Dunmore Quarry has continued to focus on ensuring the environment and neighbouring community are not adversely impacted by quarry operations. Throughout this reporting period extraction and processing of quarry materials has remained consistent with previous years.

The FY23 period had a strong focus on maintaining regulatory compliance and optimising management actions established in the FY24 reporting period.

The next reporting period will continue to focus on continuing to ensure compliance and optimising processes to allow this.

9. Appendix A Meteorological Monitoring Locations Data and Graphs

The location of the onsite weather station is shown Figure 41 below.

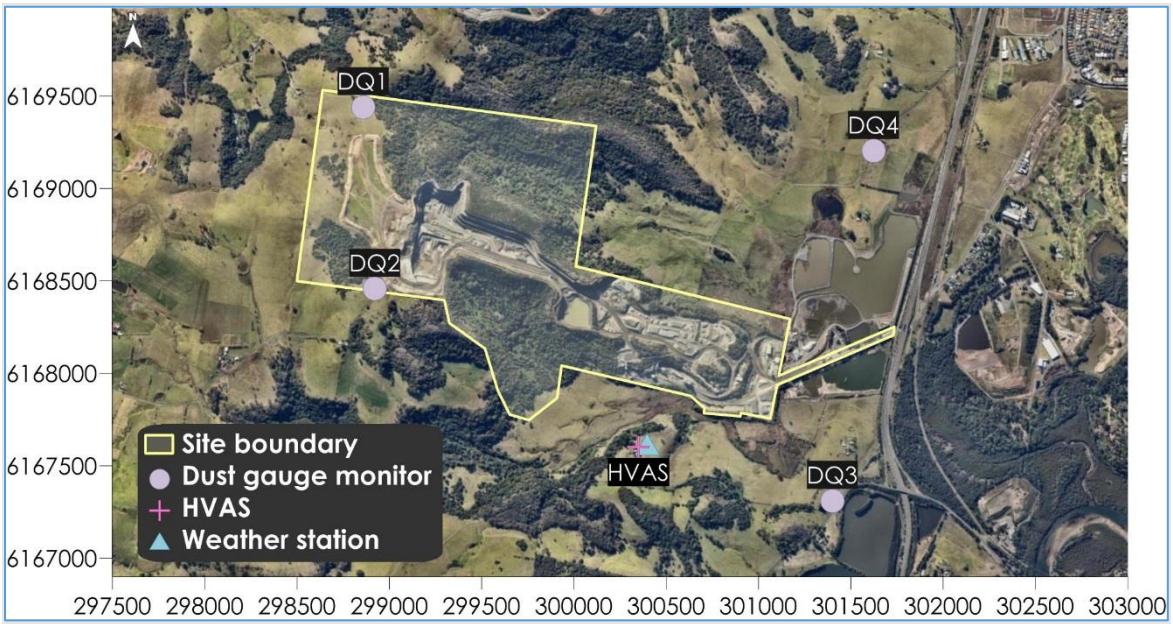


Figure 35 Meteorological Monitoring Locations

A monthly review of weather data is undertaken by the environmental co-ordinator. Important meteorological conditions assessed are rainfall, wind speed direction and atmospheric stability.

Rainfall data has been collected since FY2003. A summary of the rainfall measured from the Dunmore Quarry weather station is shown below in Table 32. Values shown in red relate to periods where rainfall was above the regional average.

Table 30 Rainfall Data Summary

Rainfall (mm)			
Month	**FY23**	**Site Average**	**Regional Average**
July	450	79.4	49
August	39.4	64.5	53.5
September	145.2	52.3	42.7
October	243.8	80.1	64.5
November	61.2	91.7	83.1
December	41.8	82.0	67
January	125	90.4	72.9
February	225.4	155.7	140.5
March	153	166.7	122.3

Rainfall (mm)			
Month	FY23	Site Average	Regional Average
April	140.4	93.3	73.8
May	77.6	78.7	55.8
June	12.6	104.5	93.7
Total	1715.4	1070.4	925.6

Table 31 Historical Rainfall Data

	Rainfall (mm)																					
Month	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	Site Average	Regional Average
July	20	23.5	54.2	41	96	30.5	63.5	35.5	78	194	39	61.7	5	48	97.5	25	6	20.5	264.2	14.8	450	79.4	49
August	13.5	38.5	23	3	42.5	58.5	39	0.5	72	85.5	4.5	17	252	327	76	39	31	39	187.1	73.4	39.4	64.5	53.5
September	14	7.5	40.6	33	101	39	56	19.5	145.5	58.5	11.5	85.5	48.7	82	51	1	41.5	59.5	11.3	46.37	145.2	52.3	42.7
October	6.5	49	245.4	48	0	17	79	125.5	126	124.5	83.5	6.5	102.5	36.5	32	14.5	128	38.5	114.4	61.85	243.8	80.1	64.5
November	17	149.5	126.8	144.5	39.5	161.5	46.5	65	198	163.5	25	173	24	48	33	85	92	25.5	83	164.1	61.2	91.7	83.1
December	70	40.5	136.2	36.5	54	120	112.5	80.5	147.5	63	32	70.5	233.5	116.5	58	53	90.5	2.5	83.8	78.36	41.8	82.0	67
January	68	30.5	128.8	90	0	65.5	9.5	79	59.5	50.5	183	43.5	192.5	155.5	32.5	36	143.5	65	189.3	151	125	90.4	72.9
February	112	70	180.4	87.1	186.5	351.5	107.5	197.5	48	257.5	142.5	59	112.5	29.5	283	128.5	35.5	272.5	88.4	295.8	225.4	155.7	140.5
March	121	84	118	43.5	67.5	36.5	39	74	362.5	196	23.5	326	57	145	441	41.5	156.5	65.5	278.5	670.6	153	166.7	122.3
April	91.5	200	24.4	8	145	90.5	106	63	37.4	87.5	136	64.5	305	37.5	40.5	26.1	48.5	85	5.9	216.8	140.4	93.3	73.8
May	427.5	43.5	85.6	65.5	23	8	20	80.5	58.3	9.5	81	13	53.5	35.5	51.5	44	13.5	52	206.1	202.8	77.6	78.7	55.8
June	74.5	42	84.4	124	318.5	85.5	67	52	92	89	239	34	76	429	57	133.5	103	35	44	1.8	12.6	104.5	93.7
Total	1036	778.5	1248	724.1	1074	1064	745.5	872.5	1425	1379	1001	954.2	1462	1490	1253	627.1	889.5	760.5	1556	1978	1715	1144.3	925.6

Monthly wind roses and seasonal wind roses are shown in Figure 42 to Figure 53. Please note calm is defined as winds averaging less than 0.3m/s over the averaging period.

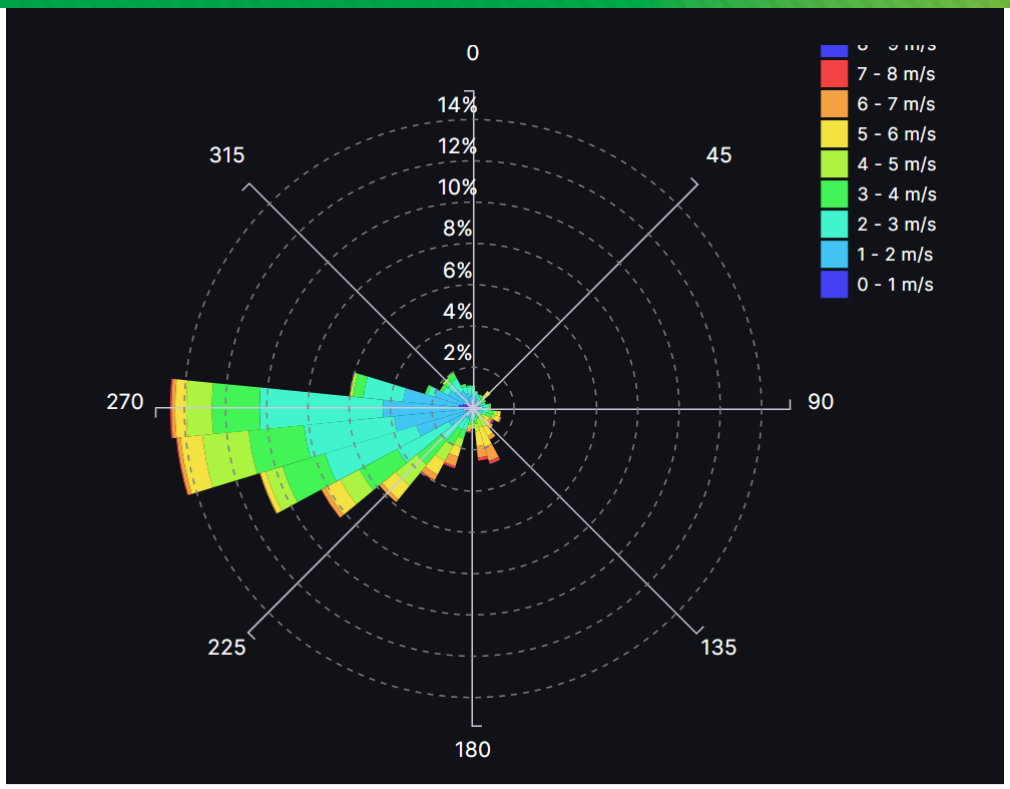


Figure 3632 July 2022 Wind Rose

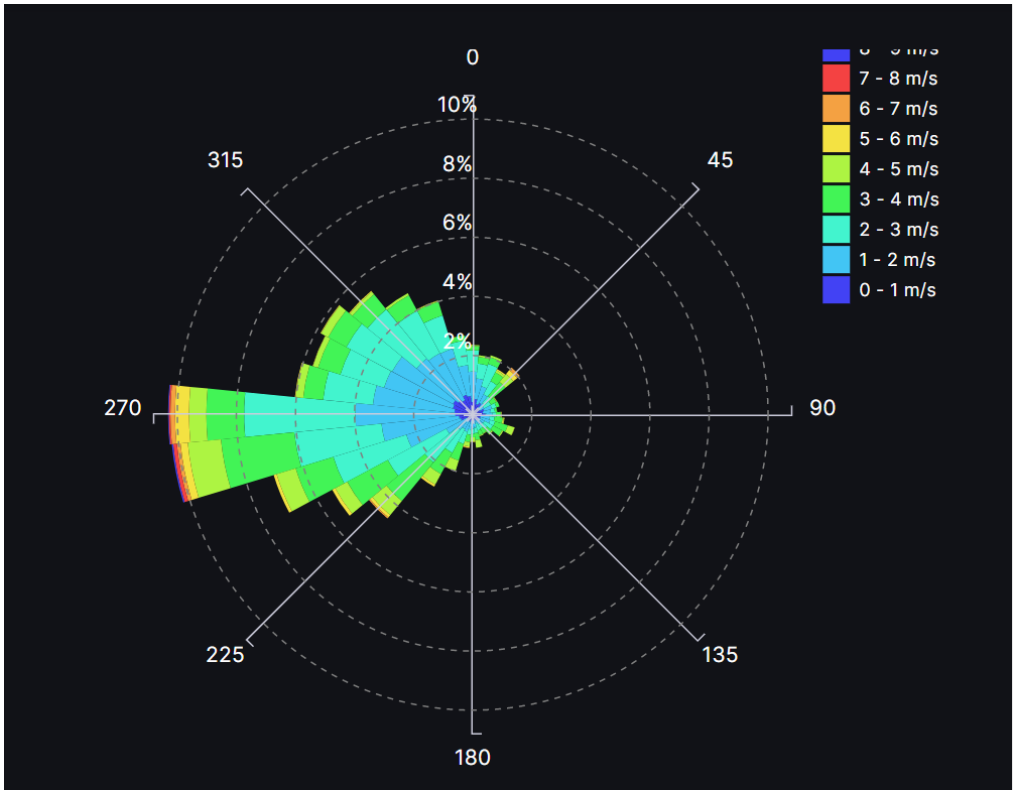


Figure 37 August 2022 Wind Rose

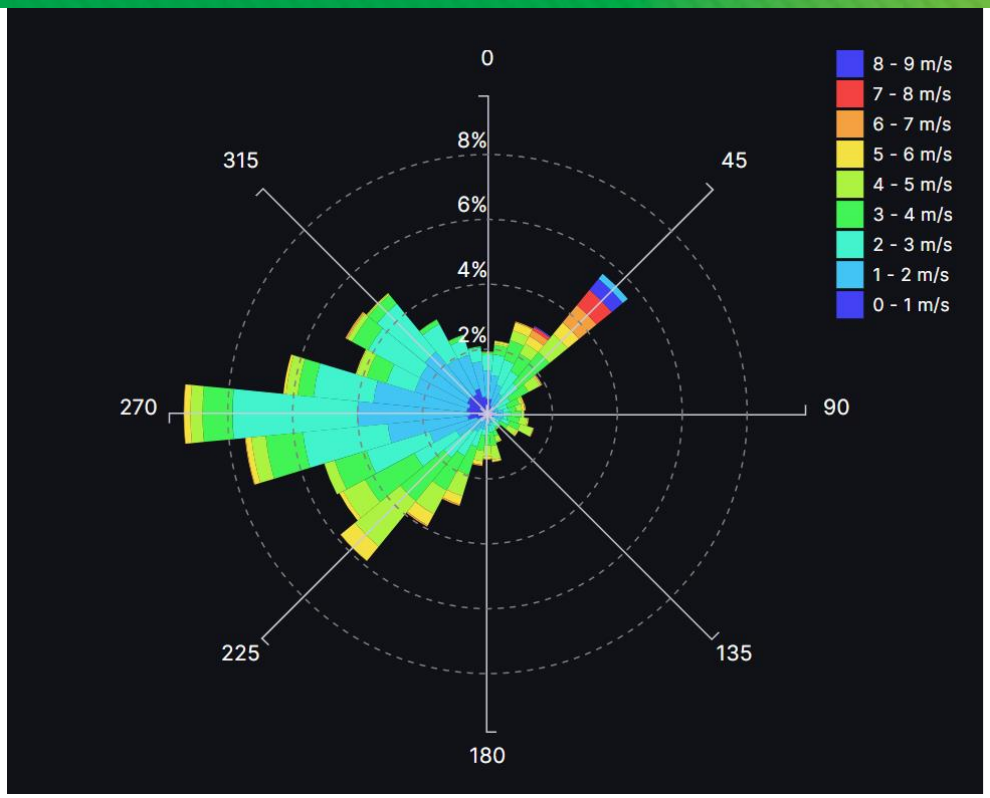


Figure 38 September 2022 Wind Rose

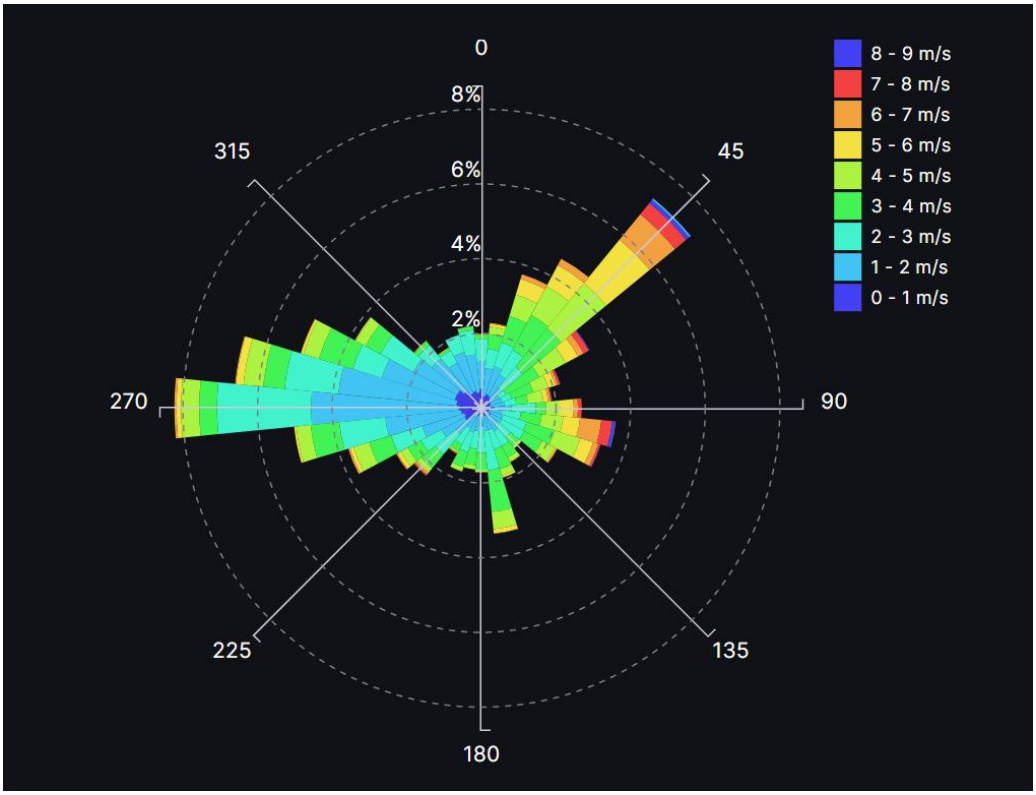


Figure 39 October 2022 Wind Rose

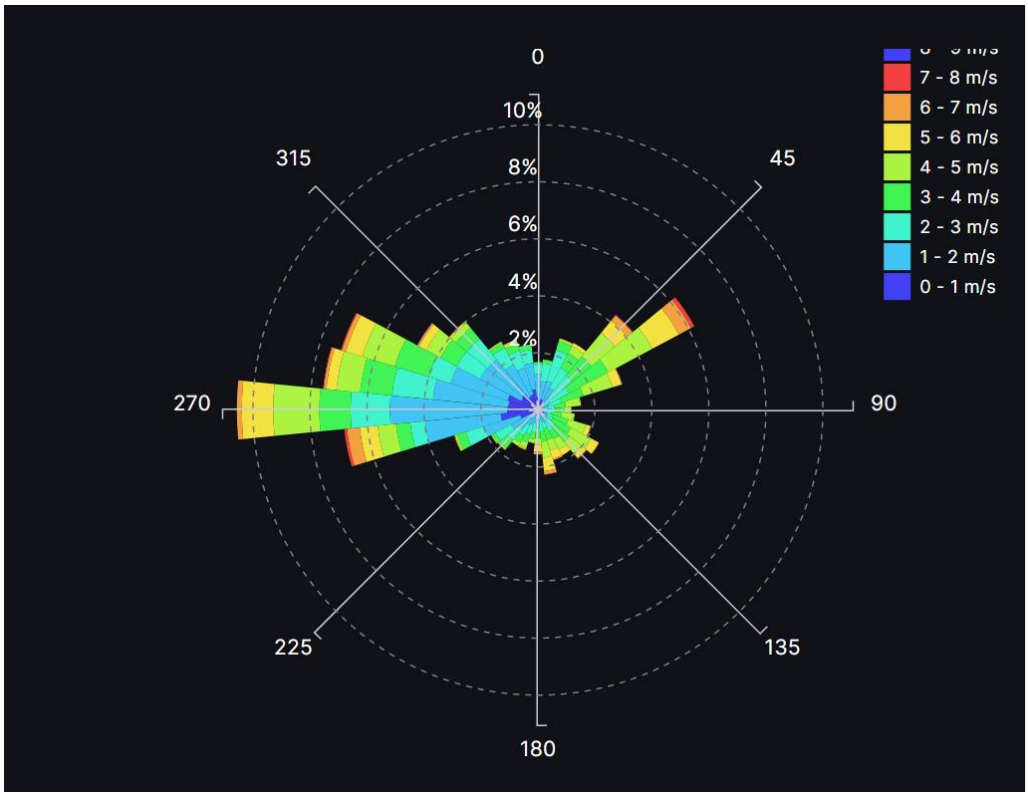


Figure 40 November 2022 Wind Rose

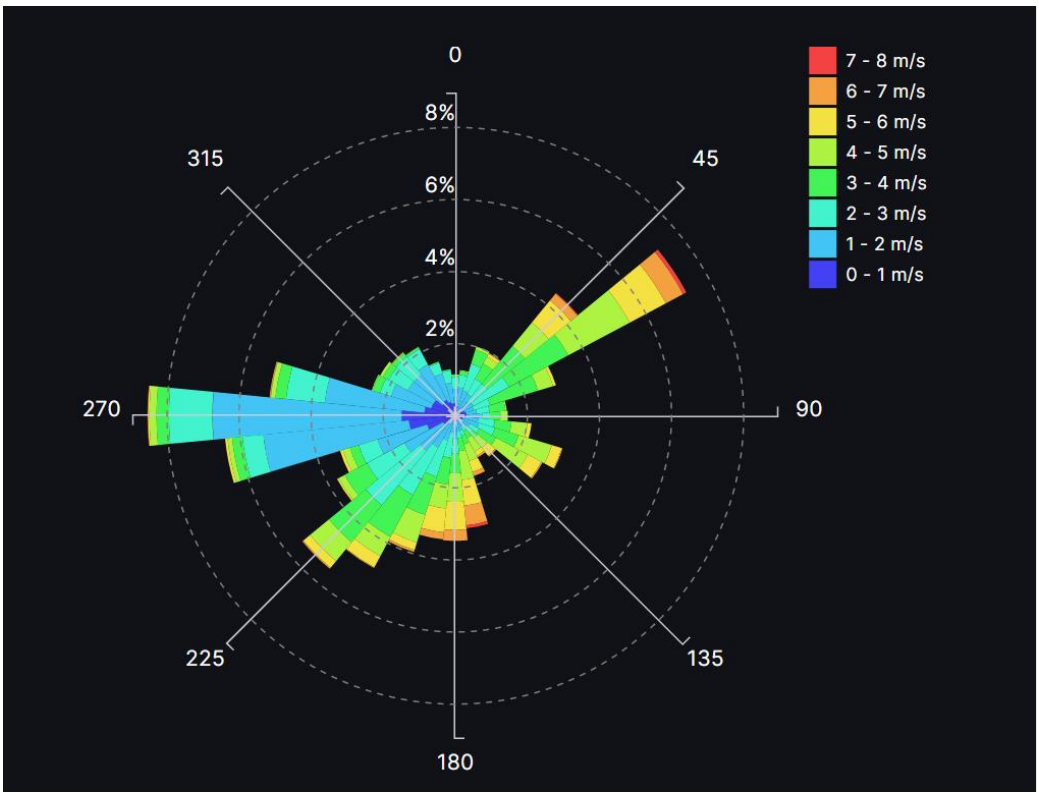


Figure 41 December 2022 Wind Rose

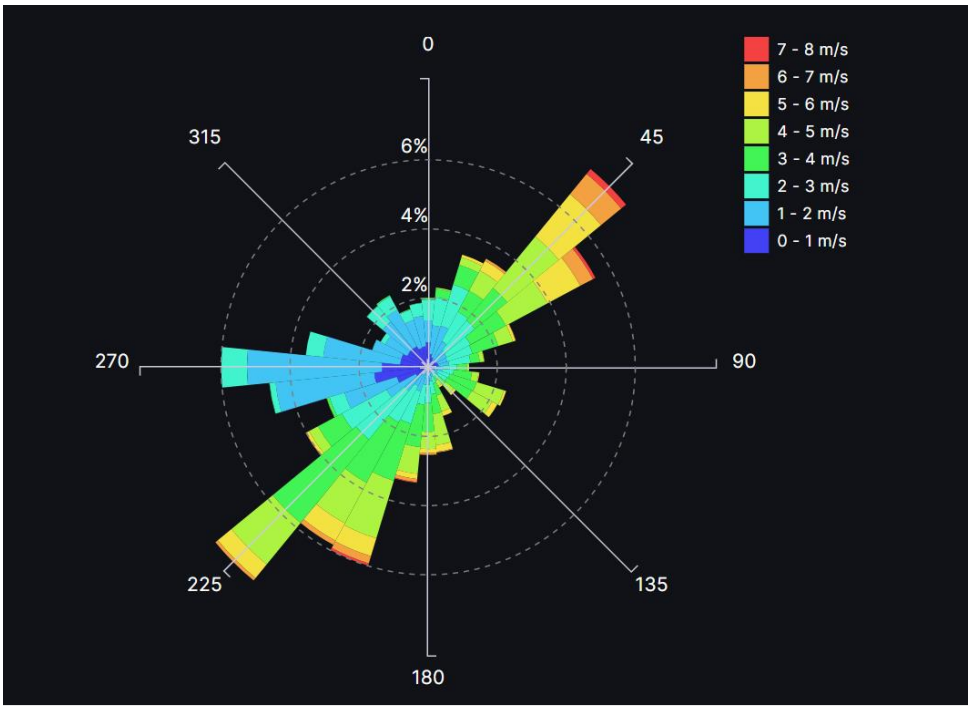


Figure 42 January 2023 Wind Rose

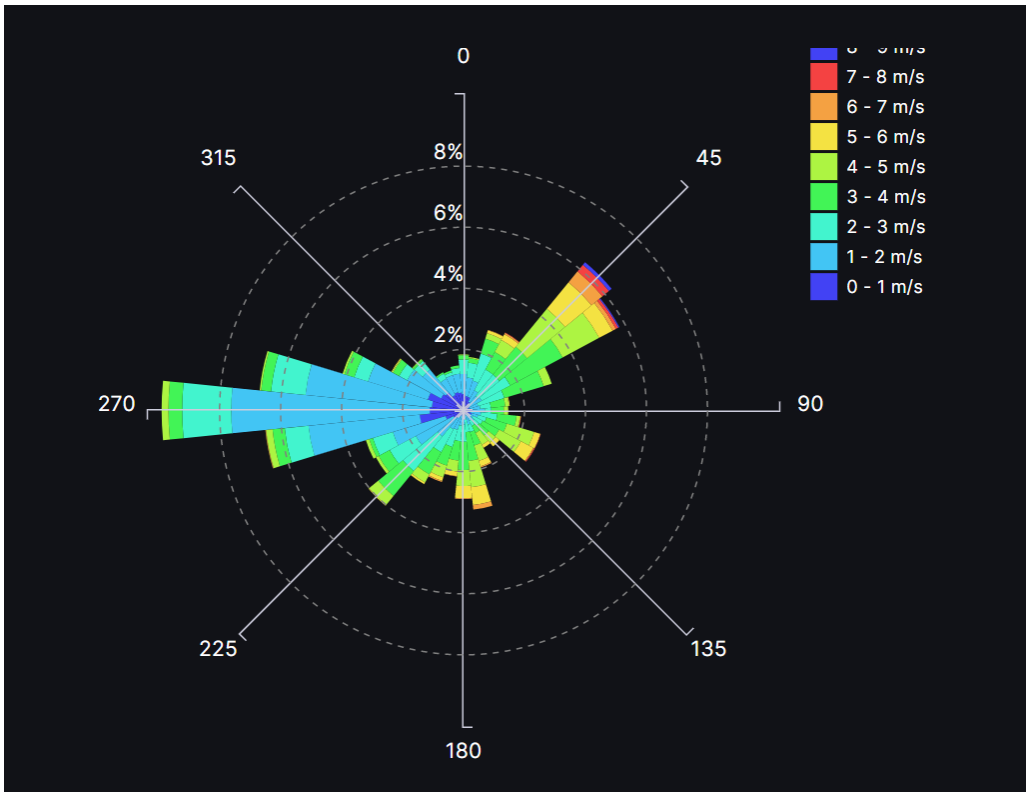


Figure 43 February 2023 Wind Rose

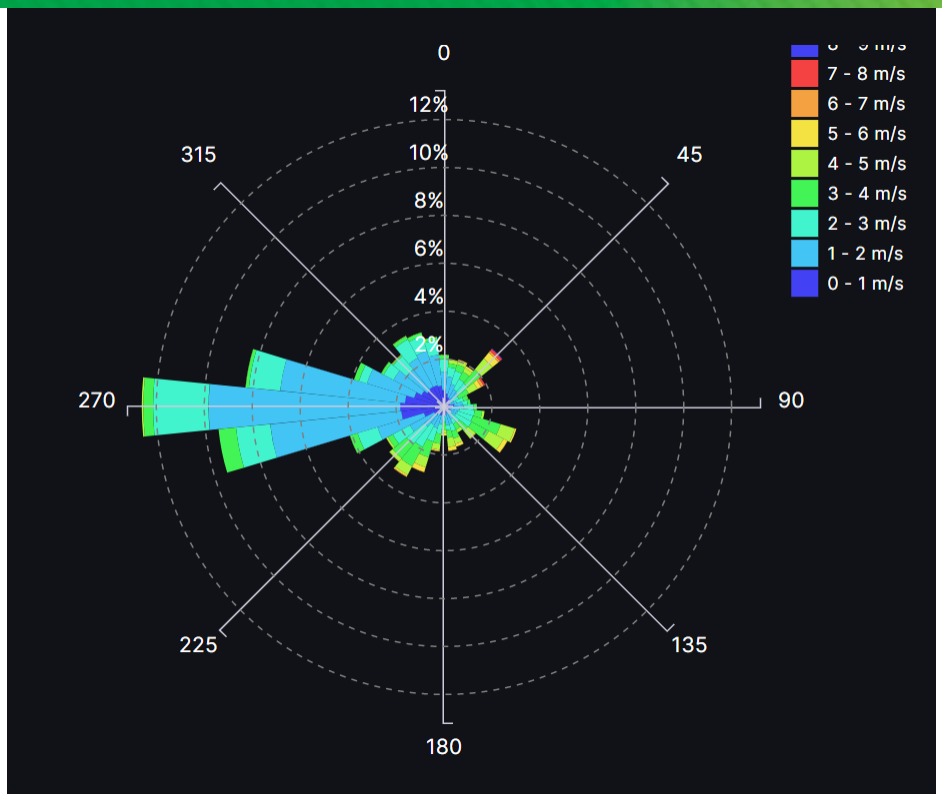


Figure 44 March 2023 Wind Rose

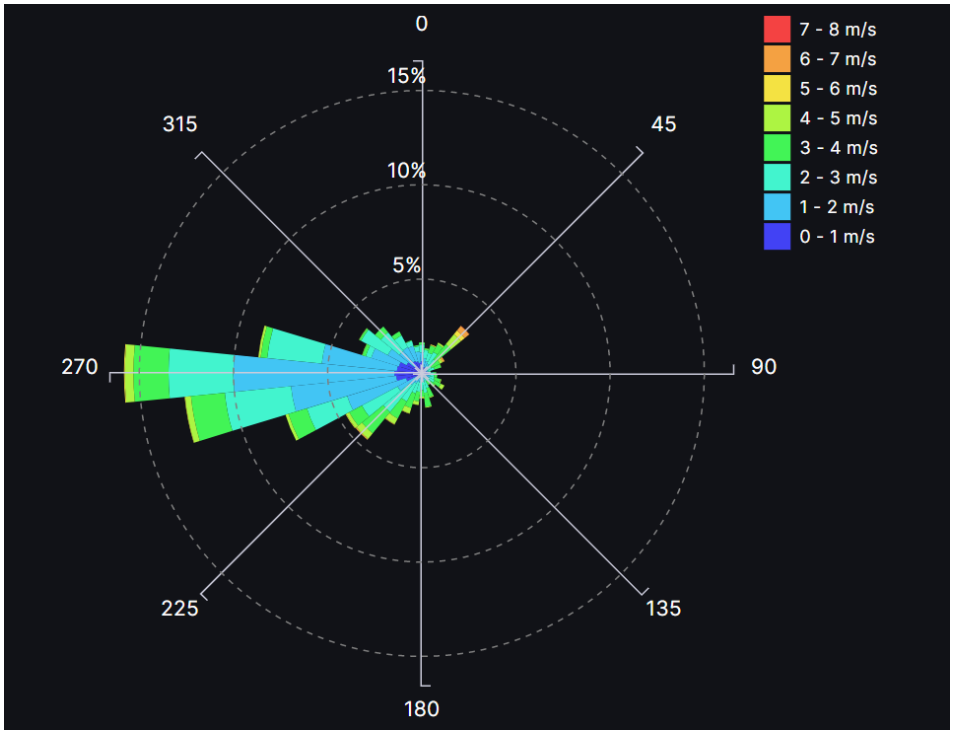


Figure 45 April 2023 Wind Rose

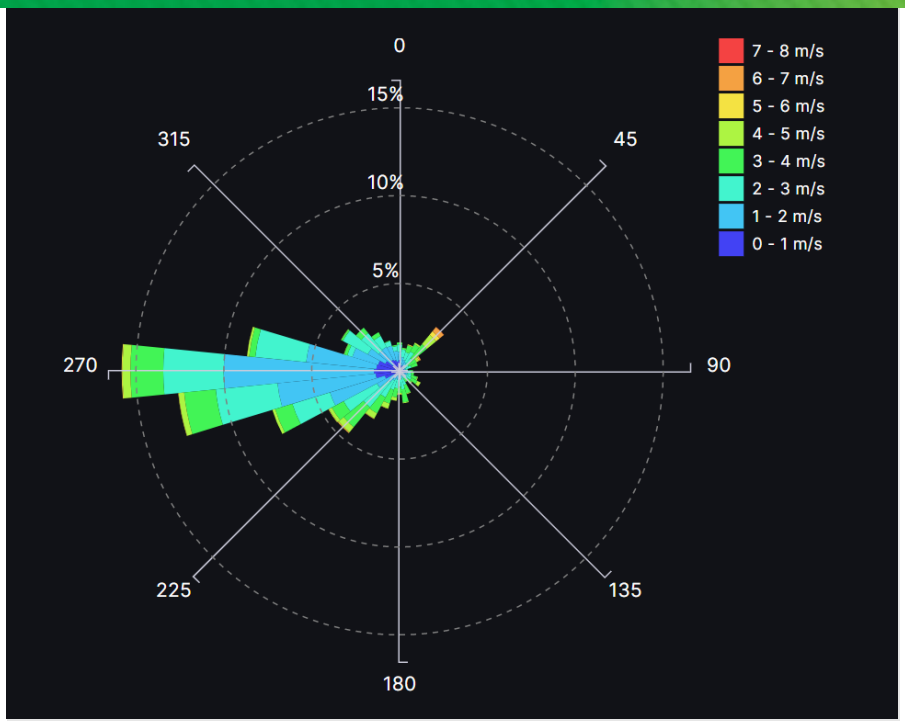


Figure 46 May 2023 Wind Rose

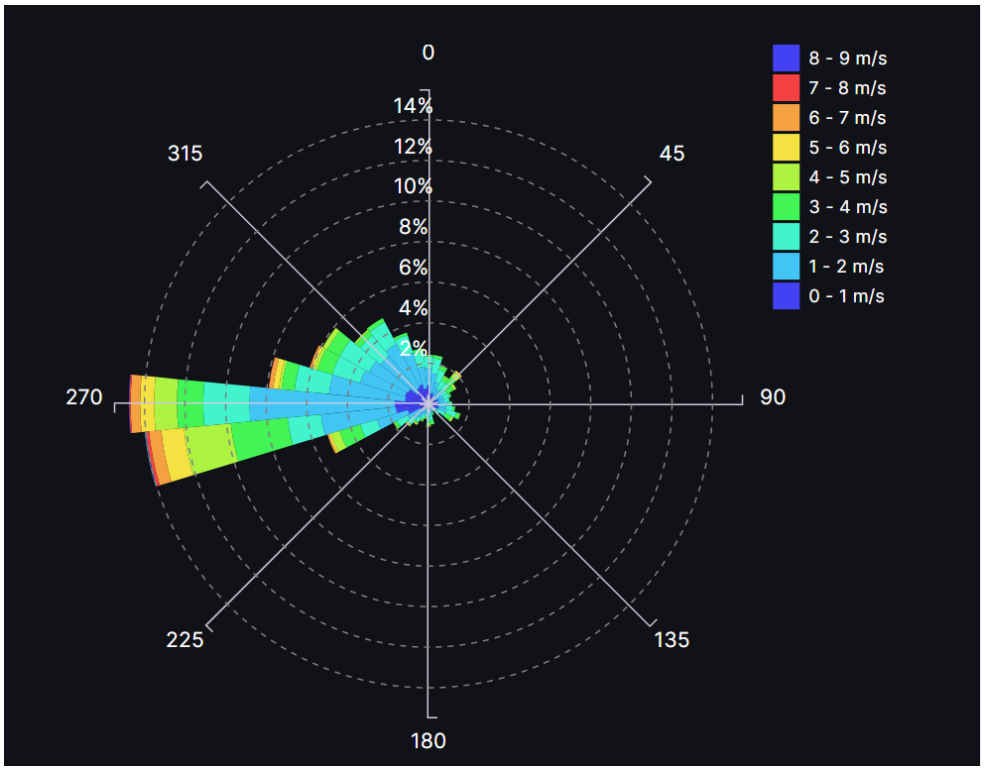


Figure 47 June 2023 Wind Rose

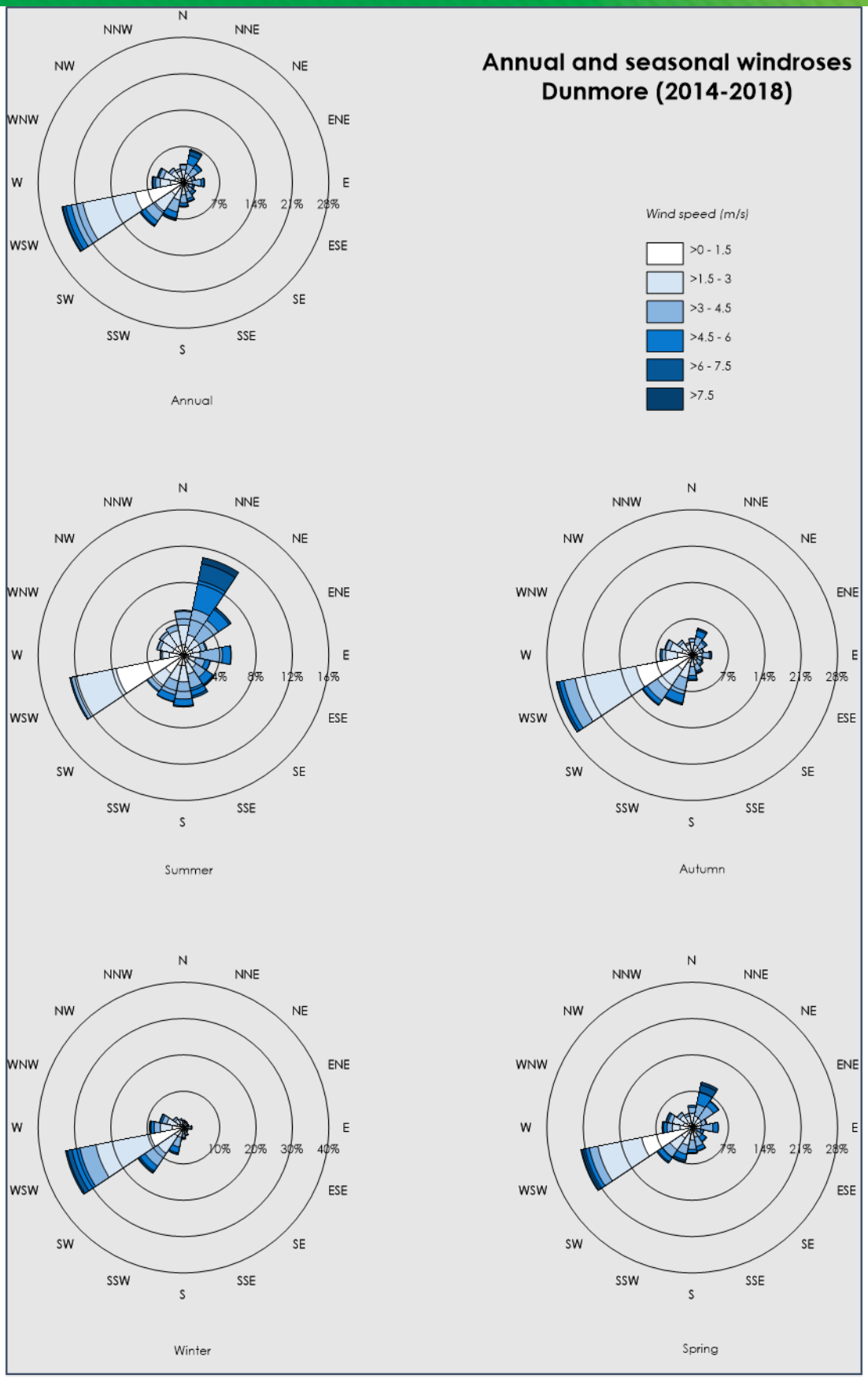


Figure 48 Dunmore Seasonal Wind Rose Data

10. Appendix B Air Quality Monitoring Additional Data and Graphs

Monthly breakdown of deposited dust monitoring is shown in Table 34. Dominant wind directions and production data are also shown within this table.

Table 32 Historical Deposited Dust Results

Month	Site 1 grams/m²/month		Site 2 grams/m²/month		Site 3 grams/m²/month		Site 4 grams/m²/month		Dominant Wind Direction	Direction of Strongest Winds	Production Tonnes
	Insoluble Solids	Ash	Insoluble Solids	Ash	Insoluble Solids	Ash	Insoluble Solids	Ash			(t)
05/06 Average	5.85	2.66	4.48	1.67	4.85	2.22	3.9	1.92			
06/07 Average	5.4	2.13	2.48	1.53	2.79	1.89	4.31	2.44			
07/08 Average	3.26	1.67	2.37	1.3	3.89	2.9	5.55	3.17			
08/09 Average	6.6	2.63	3.01	2.1	3.12	2.17	2.71	1.66			
09/10 Average	4.65	3.03	4.41	2.6	5.02	3.49	3.15	2.33			
10/11 Average	3.35	1.43	5.86	3.92	3.43	2.09	2.53	1.6			
11/12 Average	3.74	1.92	3.28	1.7	5.03	3.44	2.75	1.81			
12/13 Average	3.73	1.65	2.61	1.65	5.87	3.6	3.36	2.36			
13/14 Average	9.56	4.94	3.63	1.79	4.61	3.28	3.2	2			
14/15 Average	5.63	2.72	2.38	1.44	7.36	4.42	3.1	1.98			
15/16 Adjusted Average	3.46	1.66	3.12	1.77	7.2	4.45	3.01	1.84			
16/17 Average	2.2	1.42	3.36	1.96	2.28	1.56	2.01	1.3			
17/18 Average	2.93	2	4.2	3.14	2.36	1.65	2.84	1.79			
18/19 Average	3.05	1.84	2.95	1.92	3.66	2.01	2.81	1.59			
19/20 Average	2.61	1.76	3.45	2.43	2.66	1.94	2.1	1.51			
20/21 Average	1.88	1.16	1.70	1.08	1.94	1.12	1.89	1.12			
20/22 Average	1.42	0.61	1.71	0.69	1.25	0.65	1.64	0.93			
Jul-2022	0.14	0.11	0.69	0.46	5.06	3.16	0.63	0.36	W (14%)	W	83,734
Aug-2022	0.82	0.43	0.32	0.24	1.82	1.74	0.98	0.73	W (10%)	WSW	115,703
Sep-2022	2.10	1.14	2.49	1.4	2.32	1.45	2.32	1.30	W (8%)	NE	139,399
Oct-2022	1.59	0.54	2.05	0.37	*	*	1.15	0.69	W (8%)	NE	121,184
Nov-2022	1.32	0.94	0.87	0.69	1.24	0.76	1.45	1.29	W (10%)	NE	173,839
Dec-2022	11.74	6.72	3.27	1.51	1.10	0.97	1.45	1.29	W (12%)	NE	90,741
Jan-2023	2.26	0.77	0.67	0.56	1.4	0.54	1.23	0.6	SW (7%)	NE	96,382
Feb-2023	2.20	0.66	1.89	0.66	1.98	1.68	1.26	0.66	W (9%)	NE	132,544
Mar-2023	0.77	0.59	1.64	1.19	6.83	2.55	2.41	2.17	W (12%)	NE	159,561
Apr-2023	0.89	0.88	1.02	0.7	2.64	1.15	1.3	0.77	W (16%)	NE	97,181
May-2023	*	*	0.5	0.48	0.65	0.63	1.01	0.63	W (21%)	WSW	216,961
Jun-2023	1.02	0.43	0.45	0.05	1.28	0.68	0.69	0.46	WSW (17%)	WSW	144,627
22/23 Average	2.26	1.20	1.32	0.69	2.39	1.39	1.32	0.91			

A graph of the historical deposited dust values compared to production is shown in green for each deposited dust site in Figures 55 to 58.

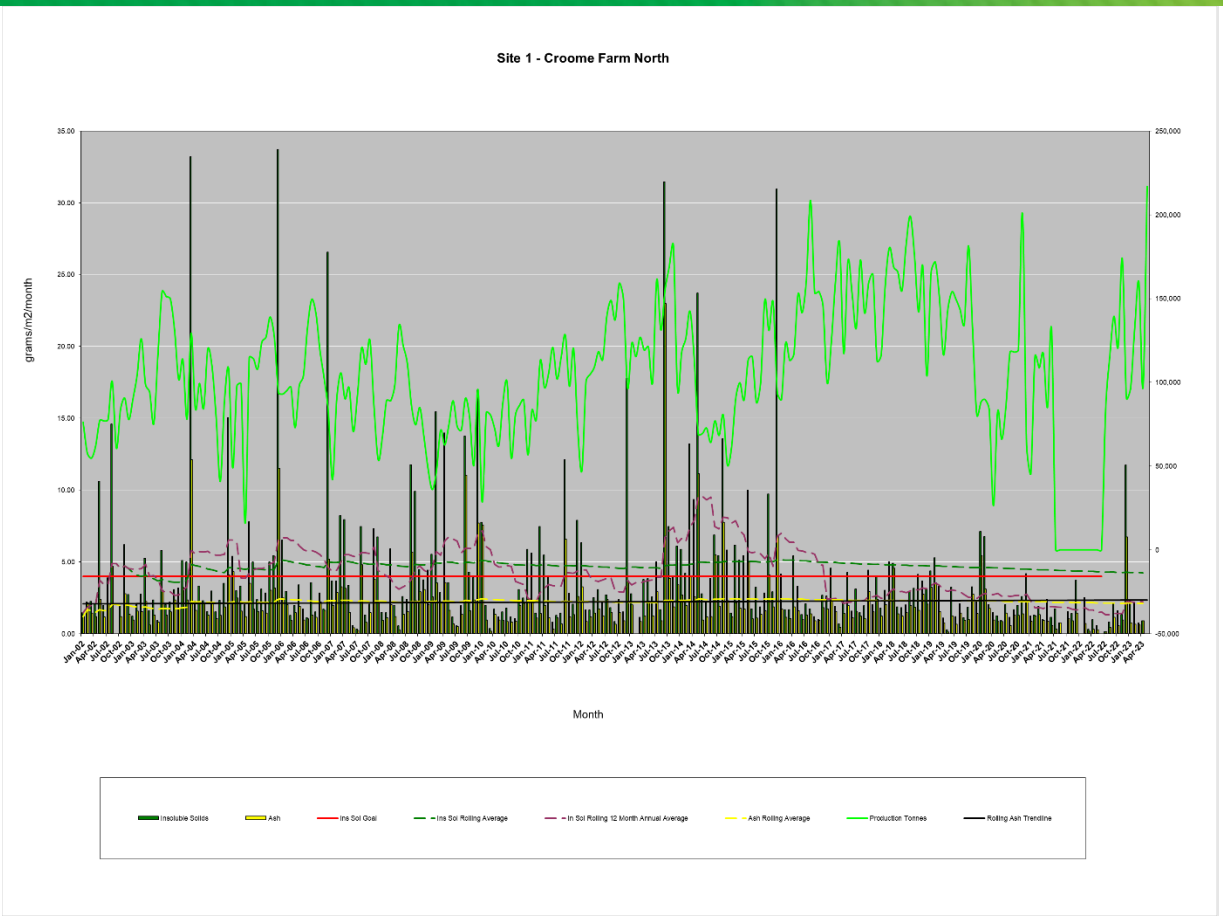


Figure 49 Historical Deposited Dust Values – DQ1

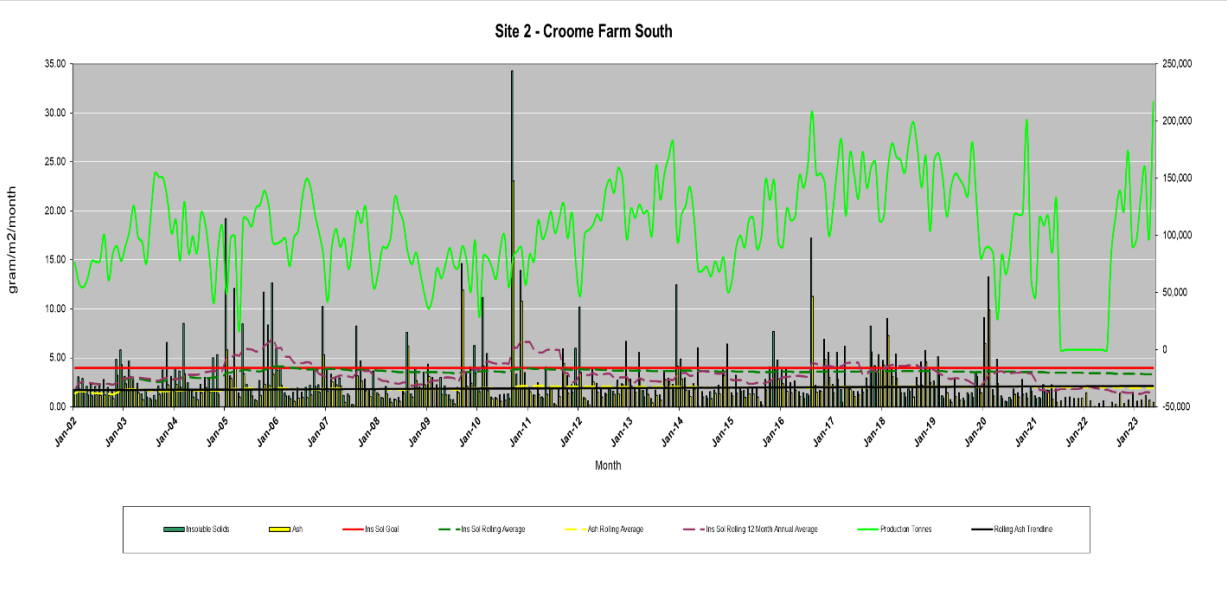


Figure 50 Historical Deposited Dust Values – DQ2

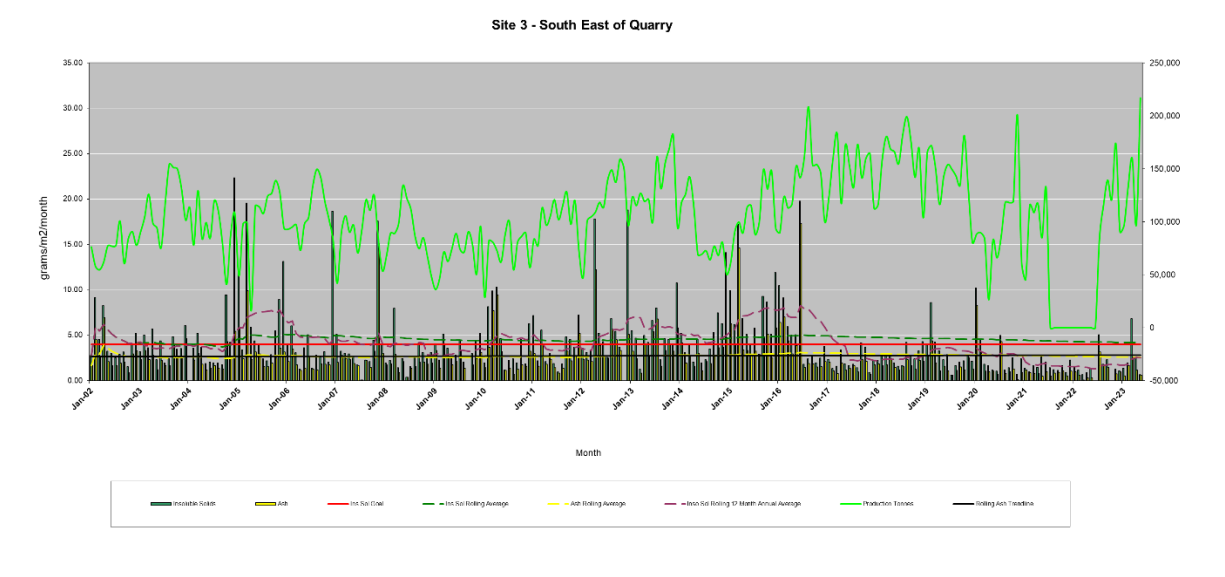


Figure 51 Historical Deposited Dust Values – DQ3

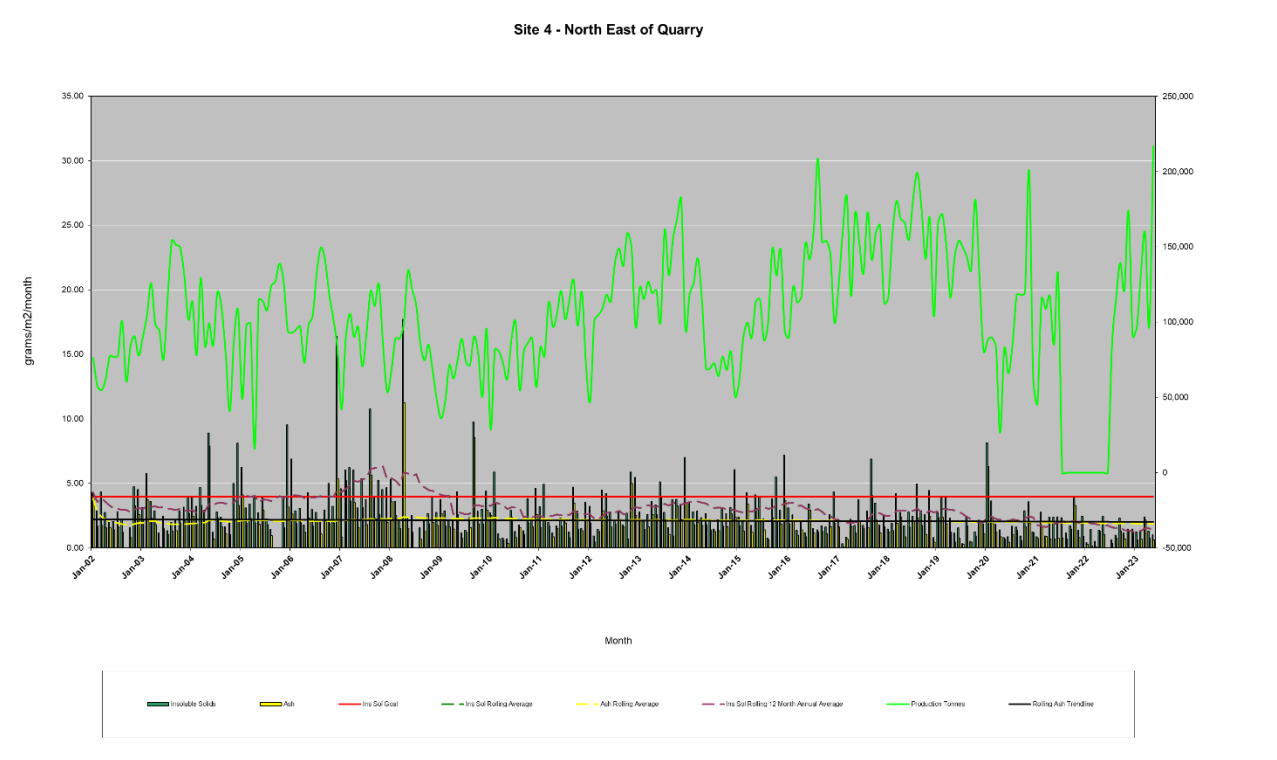


Figure 52 Historical Deposited Dust Values – DQ4

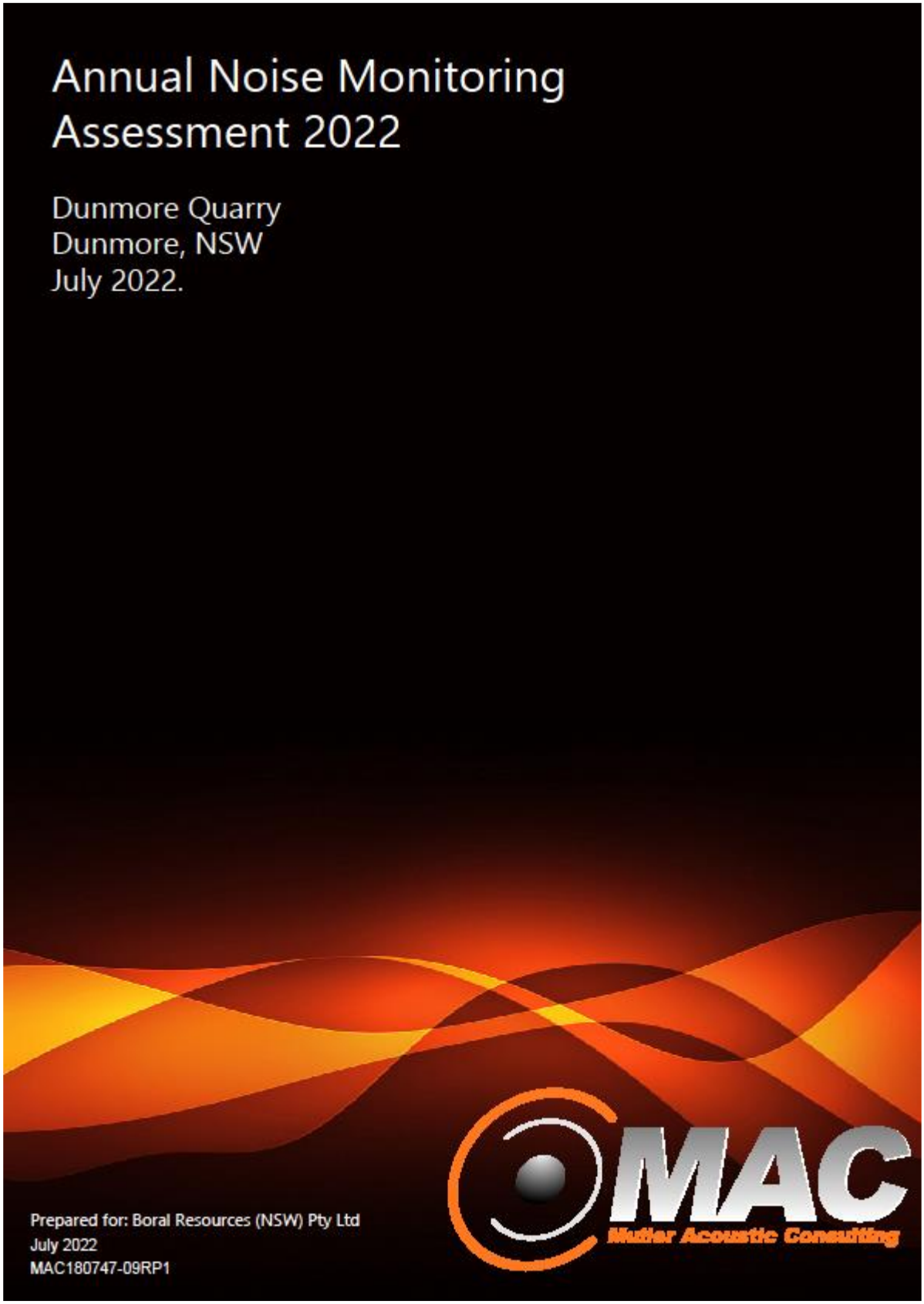
Table 33 Particulate Monitoring

Date	Sample Daily Average (µg/m$^{3)}$	Short Term Criteria 24-hr (50µg/m$^{3)}$	Long Term Criteria Annual (30µg/m$^{3)}$	Progressive Annual Average (µg/m3)
4/07/2022	0.18	50	30	6.80
10/07/2022	0.18	50	30	6.78
16/07/2022	2.55	50	30	6.80
22/07/2022	0.48	50	30	6.80
28/07/2022	0.36	50	30	6.79
3/08/2022	7.42	50	30	6.88
9/08/2022		50	30	6.96
15/08/2022	0.21	50	30	6.87
21/08/2022	0.65	50	30	6.88
27/08/2022	0.48	50	30	6.62
2/09/2022	1.49	50	30	6.55
8/09/2022	7.84	50	30	6.64
14/09/2022	3.03	50	30	6.55
20/09/2022	10.33	50	30	6.63
26/09/2022	20.68	50	30	6.86
2/10/2022	5.88	50	30	6.64
8/10/2022	1.78	50	30	6.57
14/10/2022	1.72	50	30	6.51
20/10/2022	1.13	50	30	6.21
26/10/2022	1.37	50	30	6.14
1/11/2022	12.23	50	30	6.03
7/11/2022	7.3	50	30	6.11
13/11/2022	5.8	50	30	5.91
19/11/2022	2.61	50	30	5.58
25/11/2022	1.6	50	30	5.45

1/12/2022	6.06	50	30	5.26
7/12/2022	9.74	50	30	5.00
13/12/2022	21.2	50	30	4.91
19/12/2022	14.13	50	30	5.02
25/12/2022	14.37	50	30	5.09
31/12/2022	13.66	50	30	5.24
6/01/2023	5.23	50	30	5.12
12/01/2023	14.55	50	30	5.17
18/01/2023	18.53	50	30	5.44
24/01/2023	25.28	50	30	5.74
30/01/2023	11.05	50	30	5.82
5/02/2023	10.51	50	30	5.68
11/02/2023	24.58	50	30	5.87
17/02/2023	17.04	50	30	6.09
23/02/2023	7.13	50	30	6.18
1/03/2023	16.39	50	30	6.43
7/03/2023	4.99	50	30	6.48
13/03/2023	6.2	50	30	6.38
19/03/2023	8.03	50	30	6.39
25/03/2023	5.52	50	30	6.40
31/03/2023		50	30	6.37
6/04/2023	5.94	50	30	6.46
12/04/2023	4.81	50	30	6.42
18/04/2023	3.8	50	30	6.45
24/04/2023	3.5	50	30	6.47
30/04/2023	2.02	50	30	6.48
6/05/2023	0.89	50	30	6.49
12/05/2023	7.66	50	30	6.61
18/05/2023	11.76	50	30	6.80

24/05/2023	4.61	50	30	6.87
30/05/2023		50	30	6.89
5/06/2023		50	30	6.93
11/06/2023	1.48	50	30	6.94
17/06/2023	2.49	50	30	6.94
23/06/2023	1.37	50	30	7.48
29/06/2023	0.6	50	30	7.18

11. Appendix C MAC Noise Monitoring Annual Compliance Report



Document Information

Annual Noise Monitoring Assessment 2022

Dunmore Quarry, Dunmore, NSW

July 2022

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MAC180747-09RP1	29 July 2022	Nicholas Shipman		Rod Linnett	

1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has completed a Noise Monitoring Assessment (NMA) on behalf of Boral for Dunmore Quarry (the 'quarry'), Tabbita Road, Dunmore, NSW.

The monitoring has been conducted in accordance with the Dunmore Quarry Noise Management Plan (NMP V4, December 2017) during July 2022 and forms the annual noise monitoring program to address conditions outlined in the Development Consent (Ref: 470-11-2003).

This report summarises the operator-attended noise monitoring results measured at five receivers in comparison to the relevant noise limits contained in the Development Consent and NMP.

The assessment has been conducted in general accordance with the following documents:

- NSW Environment Protection Authority (EPA), Noise Policy for Industry (NPI), 2017;
- Dunmore Quarry Noise Management Plan V4 (NMP), 2017 (EMM Consulting);
- Discussion Paper - Validation of Inversion Strength Estimation Method (EPA) 2014; and
- Australian Standard AS 1055:2018 - Acoustics - Description and measurement of environmental noise.

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A**.

2 Noise Criteria

The Dunmore Quarry Noise Management Plan (NMP) outlines the applicable noise criteria for residential receivers surrounding the quarry, and are presented in **Table 1**.

Table 1 Noise Limits

Description	Day (7am - 6pm)	Evening (6pm - 10pm)	Night (10pm - 7am)		Morning Shoulder (6am - 7am)	
	dB $L_{Aeq(15min)}$	dB $L_{Aeq(15min)}$	dB $L_{Aeq(15min)}$	dB $L_{A1(1min)}$	dB $L_{Aeq(15min)}$	dB $L_{A1(1min)}$
Location K Stocker	49	44	38	48	47	55
Location O Dunmore Lakes	49	44	38	48	47	55
Location J Creagan	Negotiated Agreement in place					
Location AA	38	38	38	45	38	45
Location AB and T	36	36	36	45	36	45
Locations D, F, G and Z	40	40	40	45	40	45
Location S	37	37	37	45	37	45

Source: Table 3 of Dunmore Quarry NMP.

3 Methodology

3.1 Locality

The quarry is located at Dunmore near Shellharbour, NSW. Receivers in the locality surrounding the quarry are primarily rural and residential. The quarry is surrounded by rural properties to the west, with the Princes Highway situated to the east of the site. Highway traffic is a dominant noise source for those receivers east of the quarry along with rural noise. The representative noise monitoring locations identified in Table 4.1 of the NMP with respect to the quarry are presented in the locality plan in **Figure 1**.

Table 2 presents the noise limits for each receiver as per the EPL.

Table 2 Attended Monitoring Locations and EPL Noise Limits

ID	Description	Day[1]	Evening[1]	Night[1]		Morning Shoulder[1]	
		dB, $L_{Aeq(15min)}$	dB, $L_{Aeq(15min)}$	dB, $L_{Aeq(15min)}$	dB, $L_{A1(1min)}$	dB, $L_{Aeq(15min)}$	dB, $L_{A1(1min)}$
NM1	Location K Stocker 40 Swamp Road Dunmore	49	44	38	48	47	55
NM2	Location S 86 Croome Vale Road, Croom	37	37	37	45	37	45
NM3	Location T 1338 Jamberoo Road Croom	36	36	36	45	36	45
NM4	Location G[2] 316 Croome Road Croom	40	40	40	45	40	45
NM5	Location F[3] 316 Croome Road Croom	40	40	40	45	40	45

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods and the morning shoulder period is from 6am to 7am.
Note 2: Representative location for western residences G, D, Z.
Note 3: Representative location for north western residences F, AA, AB.

3.2 Assessment Methodology

The attended noise measurements were conducted in general accordance with the procedures described in Australian Standard AS 1055:2018, "Acoustics - Description and Measurement of Environmental Noise" and the Dunmore Quarry NMP. Noise measurements of 15 minutes in duration were conducted at five locations (NM1-NM5) using a Svantek Type 1, 971 noise analyser between Tuesday 12 July 2022 and Thursday 14 July 2022 to satisfy the requirements of the NMP. The acoustic instrumentation used carries current NATA calibration and complies with AS IEC 61672.1-2019- Electroacoustics - Sound level meters - Specifications. Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA.

To understand meteorological conditions during the evening period, direct measurement of temperature profile was undertaken at Trevethan Reserve, Minnamurra at 2m above ground level and at 50m above ground level using a weather balloon on Tuesday 12 July 2022. It is noted that during the morning shoulder periods between Wednesday 13 July 2022 and Thursday 14 July 2022 temperature measurements were unable to be obtained as wind speeds were greater than 2m/s indicating an unstable atmosphere.

The results of the temperature measurements were used to determine the temperature lapse rate in general accordance with the Validation of Inversion Strength Estimation Method (2014). These measurements, in combination with the on site weather station provide a reference to validate the relevant meteorological conditions under which compliance is assessed.

Extraneous noise sources were excluded from the analysis to determine the dB $LA_{eq(15min)}$ quarry noise contribution for comparison against the relevant criteria. In the event of quarry attributed noise being above criteria, prevailing meteorological conditions for the monitoring period are sourced from the onsite meteorological station and analysed in accordance with Fact Sheet A4 of the NPI to determine the stability category present at the time of each attended measurement.

Where the quarry is inaudible, the contribution is estimated to be at least 10dBA below the ambient noise level.

MAC Muller Acoustic Consulting

FIGURE 1
PROJECT LAYOUT
REF: MAC180747

4 Results

A summary of the operator attended measurements at location NM1 to NM5 are presented **Table 3** to **Table 7** and provide the following information:

- Monitoring location.
- Date, time and assessment period.
- Observed Wind Speed (WS, m/s), Wind Direction (WD) and Temperature (Temp) in °C at 1.5m above the ground measured at the monitoring location.
- Measured Temperature (Temp) in °C at 2m and 50m above ground level at a representative location.
- Average Wind Speed (WS, m/s), Wind Direction (WD) and Temperature (Temp) in °C at 10m above ground level at the on-site weather station.
- Atmospheric stability class derived from the on-site weather station.
- Calculated temperature inversion strength.
- Ambient measured noise levels $L_{Aeq(15min)}$ and $L_{A90(15min)}$ in dB re 20µPa.
- Quarry $L_{Aeq(15min)}$ and $L_{A1(1min)}$ noise level contribution.
- Noise Limit $L_{Aeq(15min)}$ and $L_{A1(1min)}$.

Results of the attended noise survey identified that the quarry was generally inaudible during the measurement periods, however extraneous sources such as distant traffic, insects, aircraft, birds, livestock, local residential noise and dogs barking were audible during the survey period and dominated the results. Temperature data indicated that inversion strengths calculated from on-site measurements during the evening period of Tuesday 12 July 2022 were within the development consent conditions (ie lower than 6°C/100m). It is noted that temperate inversion data was unavailable during the morning shoulder periods due to increased wind speeds and unstable conditions.

Table 3 NM1 - Attended Noise Monitoring Summary

Date & Period	Time (hrs)	1.5m WS WD Temp	Descriptor		EPL Limits	Observed Meteorology							Description and SPL, dBA
			L_{Aeq}	L_{A90}	L_{Aeq} (15min)/ L_{A1} (1min)	WS (m/s)[1]	WD[1]	2m Temp°C	50m Temp°C	Delta Temp°C	Lapse Rate °C/100m[2]	Stability Class[1]	
13/07/2022 Morning Shoulder	06:39	2.5m/s WNW 10°C	60	47	47/55	3.2	WSW	N/A	N/A	N/A	N/A	D	Traffic 40-66 Wind in trees 42-48 Insects 40-52 Birds 40-54 Quarry 40-47 (less than 10sec)
Quarry Contribution													40dB LAeq(15min) 47dB LA1(1min)
12/07/2022 Day	13:45	0.8m/s WSW 16°C	62	50	49	3.1	ESE	N/A	N/A	N/A	N/A	E	Traffic 69-80 Local residential noise 50-56 Aircraft 54-55 Quarry inaudible
Quarry Contribution													<40dB LAeq(15min)
12/07/2022 Evening	21:34	0.2m/s WSW 9°C	54	46	44	1.9	W	8.6	7.5	-1.1	-2.3	E	Traffic 44-72 Insects 40-42 Local residential noise <35 Quarry inaudible
Quarry Contribution													<36dB LAeq(15min)

Note 1: Data from on-site weather station.
Note 2: Calculated from 2m and 50m temperature.

Table 4 NM2 - Attended Noise Monitoring Summary

Date & Period	Time (hrs)	1.5m WS WD Temp	Descriptor		EPL Limits	Observed Meteorology							Description and SPL, dBA
			L_{Aeq}	L_{A90}	L_{Aeq} (15min)/ L_{A1} (1min)	WS (m/s)[1]	WD[1]	2m Temp°C	50m Temp°C	Delta Temp°C	Lapse Rate °C/100m[2]	Stability Class[1]	
14/07/2022 Morning Shoulder	06:00	2m/s S 9°C	48	41	37/45	5	SW	N/A	N/A	N/A	N/A	D	Agriculture 40-43 Wind in trees 40-73 Traffic 41-46 Birds 40-48 Quarry inaudible
Quarry Contribution													<31dB LAeq(15min) <45dB LA1(1min)
12/07/2022 Day	15:48	0.2m/s NE 14°C	45	43	37	1.5	E	N/A	N/A	N/A	N/A	D	Birds 44-59 Agriculture 44-46 Creek flow <44 Traffic <44 Quarry inaudible
Quarry Contribution													<33dB LAeq(15min)
12/07/2022 Evening	20:16	0.1m/s N 10°C	53	41	37	2.4	W	9.2	8.4	-0.8	-1.5	F	Creek flow 40-43 Traffic 42-49 Livestock 42-44 Aircraft 41-60 Quarry inaudible
Quarry Contribution													<31dB LAeq(15min)

Note 1: Data from on-site weather station.
Note 2: Calculated from 2m and 50m temperature.

Table 5 NM3 - Attended Noise Monitoring Summary

Date & Period	Time (hrs)	1.5m WS WD Temp	Descriptor		EPL Limits	Observed Meteorology							Description and SPL, dBA
			L_{Aeq}	L_{A90}	$L_{Aeq\ (15min)}$ / $L_{A1\ (1min)}$	WS (m/s)[1]	WD[1]	2m Temp°C	50m Temp°C	Delta Temp°C	Lapse Rate °C/100m[2]	Stability Class[1]	
14/07/2022 Morning Shoulder	06:20	2.8m/s S 9°C	63	50	36/45	6.3	WSW	N/A	N/A	N/A	N/A	D	Wind in trees 46-74 Traffic 45-71 Quarry inaudible
Quarry Contribution													<40dB LAeq(15min) <45dB LA1(1min)
12/07/2022 Day	16:08	0.2m/s NE 14°C	59	39	36	0.8	E	N/A	N/A	N/A	N/A	D	Traffic 33-77 Birds 36-46 Aircraft <42 Quarry inaudible
Quarry Contribution													<30dB LAeq(15min)
12/07/2022 Evening	20:35	0.1m/s N 10°C	55	35	36	1.3	W	9.0	8.3	-0.7	-1.4	E	Creek flow 35-37 Insects <35 Traffic 38-78 Quarry inaudible
Quarry Contribution													<30dB LAeq(15min)

Note 1: Data from on-site weather station.
Note 2: Calculated from 2m and 50m temperature.

Table 6 NM4 - Attended Noise Monitoring Summary

Date & Period	Time (hrs)	1.5m WS WD Temp	Descriptor		EPL Limits	Observed Meteorology							Description and SPL, dBA
			L_{Aeq}	L_{A90}	$L_{Aeq\ (15min)}$ / $L_{A1\ (1min)}$	WS (m/s)[1]	WD[1]	2m Temp°C	50m Temp°C	Delta Temp°C	Lapse Rate °C/100m[2]	Stability Class[1]	
14/07/2022 Morning Shoulder	06:45	2.8m/s SE 9°C	56	50	40/45	4.4	WSW	N/A	N/A	N/A	N/A	D	Creek flow <46 Wind in trees 46-59 Traffic 46-68 Quarry inaudible
Quarry Contribution													<40dB LAeq(15min) <45dB LA1(1min)
12/07/2022 Day	16:33	0.2m/s NE 13°C	55	53	40	0.9	NW	N/A	N/A	N/A	N/A	D	Creek flow 53-45 Birds 53-59 Dog bark 54-59 Aircraft 53-57 Local residential noise 52-69 Quarry inaudible
Quarry Contribution													<40dB LAeq(15min)
12/07/2022 Evening	20:59	0.2m/s N 9°C	53	52	40	2.3	W	9.0	8.1	-0.9	-1.8	F	Creek flow 51-53 Aircraft 51-54 Quarry inaudible
Quarry Contribution													<40dB LAeq(15min)

Note 1: Data from on-site weather station.
Note 2: Calculated from 2m and 50m temperature.

Table 7 NM5 - Attended Noise Monitoring Summary

Date & Period	Time (hrs)	1.5m WS WD Temp	Descriptor LAeq	Descriptor LA90	EPL Limits LAeq (15min)/ LA1 (1min)	Observed Meteorology WS (m/s)[1]	WD[1]	2m Temp°C	50m Temp°C	Delta Temp°C	Lapse Rate °C/100m[2]	Stability Class[1]	Description and SPL, dBA
14/07/2022 Morning Shoulder	06:55	2.5m/s SW 11°C	52	43	40/45	4.8	WSW	N/A	N/A	N/A	N/A	D	Wind in trees 43-45 Birds 40-43 Aircraft 43-45 Traffic 60-81 Quarry inaudible
Quarry Contribution													<33dB LAeq(15min) <45dB LA1(1min)
12/07/2022 Day	16:53	0.1m/s NE 12°C	48	40	40	1.9	W	N/A	N/A	N/A	N/A	G	Birds 38-54 Traffic 37-70 Local residential noise 38-44 Aircraft 39-44 Quarry inaudible
Quarry Contribution													<30dB LAeq(15min)
12/07/2022 Evening	21:18	0.2m/s N 9°C	42	39	40	2.4	W	9.1	8.1	-1.0	-2.0	F	Insects 37-40 Traffic 38-49 Quarry inaudible
Quarry Contribution													<30dB LAeq(15min)

Note 1: Data from on-site weather station.
Note 2: Calculated from 2m and 50m temperature.

5 Discussion and Compliance Assessment

The compliance assessment summary for each monitoring location is presented in **Table 8** for all assessment periods.

5.1 Discussion of Results - Location NM1

The noise monitoring survey identified that the acoustic environment at this location is dominated by road traffic noise from the Princes Highway, approximately 350m to the east. During the survey, quarry emissions were audible during the morning shoulder period. Quarry noise contributions were calculated (during short breaks in traffic) to be at or below the relevant noise criteria for all periods. Extraneous sources audible during the survey included rail noise, insects, traffic and birds.

5.2 Discussion of Results - Location NM2

The noise monitoring survey identified that the acoustic environment at this location is dominated by natural sounds such as insects and bird noise, creek flow and agricultural noise such as livestock. Occasional local traffic on Jamberoo Road, approximately 350m to the west was audible for short periods. During the survey, quarry noise emissions were inaudible. Quarry contributions were calculated to be below the relevant noise criteria for all periods.

5.3 Discussion of Results - Location NM3

The noise monitoring survey identified that the acoustic environment at this location is dominated by natural sounds such as insects, wind in trees, creek flow and bird noise, local traffic and agricultural noise such as livestock. During the survey, quarry noise emissions were inaudible. Quarry contributions were calculated to be below the relevant noise criteria for all periods.

5.4 Discussion of Results - Location NM4

The noise monitoring survey identified that the acoustic environment at these locations is dominated by natural sounds such as insects, creek flow and bird noise and agricultural noise such as livestock. Occasional distant traffic on the East-West Link Road, approximately 2km to the north was audible for short periods. During the survey, quarry noise emissions were inaudible. Quarry contributions were calculated to be below the relevant noise criteria for all periods.

5.5 Discussion of Results - Location NM5

The noise monitoring survey identified that the acoustic environment at these locations is dominated by natural sounds such as insects and bird noise and agricultural noise such as livestock. Occasional distant traffic on the East-West Link Road, approximately 2km to the north was audible for short periods. During the survey, quarry noise emissions were inaudible. Quarry contributions were calculated to be below the relevant noise criteria for all periods.

Table 8 Noise Compliance Assessment Summary

Location	Estimated Quarry Noise Contribution[1]				Noise Limit[1]				Demonstrated Compliance			
	Day	Evening	Morning Shoulder		Day	Evening	Morning Shoulder		Day	Evening	Morning Shoulder	
			LAeq(15min)	LA1(1min)			LAeq(15min)	LA1(1min)			LAeq(15min)	LA1(1min)
NM1	<40	<36	40	47	49	44	47	55	Yes	Yes	Yes	Yes
NM2	<33	<31	<31	<45	37	37	37	45	Yes	Yes	Yes	Yes
NM3	<30	<30	<40	<45	36	36	36	45	Yes	Yes	Yes	Yes
NM4	<40	<40	<40	<45	40	40	40	45	Yes	Yes	Yes	Yes
NM5	<30	<30	<33	<45	40	40	40	45	Yes	Yes	Yes	Yes

Note 1: All levels are dBA.

7 Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has completed a Noise Monitoring Assessment (NMA) on behalf of Boral for Dunmore Quarry (the 'quarry'), Tabbita Road, Dunmore, NSW.

Attended noise monitoring was undertaken between Tuesday 12 July 2022 and Thursday 14 July 2022 at five representative monitoring locations. The assessment has identified that noise emissions generated by Dunmore Quarry were audible on one occasion during the morning shoulder period at NM1. The quarry was inaudible during the remaining periods. Quarry contributed noise emissions were below the relevant noise criteria at all locations during all measurement periods, thus satisfying the relevant noise limits.

Appendix A - Glossary of Terms

Table A1 provides a number of technical terms have been used in this report.

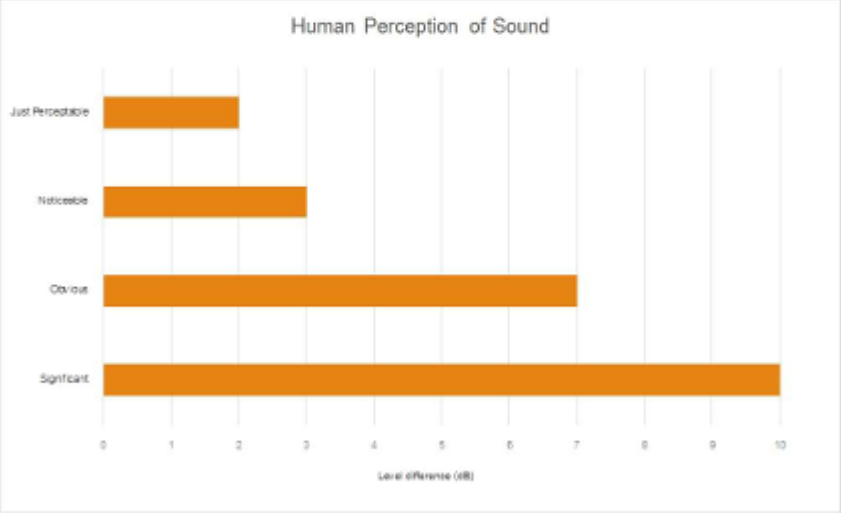
Table A1 Glossary of Terms

Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured LA90 statistical noise levels.
Adverse Weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient Noise	The noise associated with a given environment. Typically a composite of sounds from many sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.
dBA	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(Z), dB(L)	Decibels Linear or decibels Z-weighted.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A noise level which is exceeded 10 % of the time. It is approximately equivalent to the average of maximum noise levels.
LA90	Commonly referred to as the background noise, this is the level exceeded 90 % of the time.
LAeq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period.
LAmax	The maximum root mean squared (rms) sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (LW)	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental location of the source and is independent of the surrounding environment. Or a measure of the energy emitted from a source as sound and is given by : = 10.log10 (W/Wo) Where : W is the sound power in watts and Wo is the sound reference power at 10-12 watts.

Table A2 provides a list of common noise sources and their typical sound level.

Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dBA	
Source	Typical Sound Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



12. Appendix D Blast Monitoring Tables

Table 34 Benny Residence FY23 Compliance Blast Monitoring Results

Date	Time	Airblast Overpressure *dB(Lin Peak)*	100% Airblast Limit *dB(Lin Peak)*	95% Annual Airblast Limit *dB(Lin Peak)*	Ground Vibration *(mm/s)*	95% Annual Vibration Limit *(mm/s)*
1/08/2022	3:12:00 PM	No Trigger	120	115	No Trigger	5
17/08/2022	3:52:00 PM	No Trigger	120	115	No Trigger	5
31/08/2022	4:00:00 PM	No Trigger	120	115	No Trigger	5
19/09/2022	2:53:00 PM	No Trigger	120	115	No Trigger	5
10/10/2022	4:26:00 PM	No Trigger	120	115	No Trigger	5
19/10/2022	2:10:00 PM	No Trigger	120	115	No Trigger	5
14/11/2022	3:15:00 PM	No Trigger	120	115	No Trigger	5
30/11/2022	1:51:00 PM	No Trigger	120	115	No Trigger	5
11/01/2023	12:14:00 PM	109.6	120	115	0.45	5
25/01/2023	2:18:00 PM	108.5	120	115	0.45	5
20/02/2023	3:25:00 PM	108	120	115	1.06	5
9/03/2023	3:01:00 PM	103.6	120	115	1.16	5
20/03/2023	1:23:00 PM	104.6	120	115	0.63	5
14/04/2023	2:26:00 PM	105.6	120	115	0.62	5
28/04/2023	1:00:00 PM	103	120	115	0.09	5
5/05/2023	1:07:00 PM	92.9	120	115	No Trigger	5
12/05/2023	12:35:00 PM	98.6	120	115	0.44	5
19/05/2023	3:59:00 PM	91	120	115	0.31	5
24/05/2023	1:19:00 PM	97.3	120	115	No Trigger	5
26/05/2023	1:20:00 PM	104.3	120	115	1.05	5
31/05/2023	12:42:00 PM	96.6	120	115	0.57	5
9/06/2023	2:37:00 PM	108.1	120	115	0.38	5
16/06/2023	2:21:00 PM	99	120	115	0.45	5
16/06/2023	2:37:00 PM	95.8	120	115	0.18	5
23/06/2023	12:57:00 PM	108	120	115	1.27	5

13. Appendix E EMM Ground Water Monitoring Annual Report

2022 -2023 Annual Groundwater Monitoring Report

Dunmore Quarry

Prepared for Boral Resources (NSW) Pty Ltd

July 2023

2022-2023 Annual Groundwater Monitoring Report

Dunmore Quarry

Boral Resources (NSW) Pty Ltd

J17314 RP6

July 2023

Version	Date	Prepared by	Approved by	Comments
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TABLE OF CONTENTS

1 Introduction 1 1.1 Site operations 1 1.2 Approvals history 1 1.3 Scope of works 1

2 Environmental setting 4

2.1 Site setting 4

2.2 Climate 4

2.3 Surface water 7

2.4 Geology 7

2.5 Hydrogeology 8

3 Groundwater monitoring program 11

3.1 Monitoring network design 11

3.2 Groundwater quality 12

3.3 Sampling methodology 12

3.4 Chemical analysis 12 3.5 Groundwater levels 13 **4 Groundwater levels 14**

4.1 Alluvium 14

4.2 Bumbo Latite 14 **5 Groundwater quality 17**

5.1 Field parameters 17

5.2 Major ions 19

5.3 Dissolved metals 20

5.4 Nutrients 21

6 Conclusions and recommendations 24

6.1 Recommendations 24

References 25

Appendices

Appendix A Groundwater hydrographs A.1

Appendix B Water quality summary tables B.1

Appendix C Laboratory reports C.1

Appendix D Croome West sites – metals timeseries charts D.1

Tables

Table 2.1 Average monthly rainfall and evaporation statistics 4
Table 3.1 Groundwater monitoring bore construction details 11
Table 3.2 Groundwater quality monitoring program 12
Table 3.3 Water quality suite of analysis 12

Figures

Figure 1.1 Site locality and groundwater monitoring bore location 3
Figure 2.1 Cumulative deviation from long-term monthly mean rainfall 6
Figure 2.2 Monthly rainfall for June 2022 to June 2023 compared to average 6
Figure 2.3 Surface geology 10
Figure 4.1 Groundwater levels in the alluvium 15
Figure 4.2 Groundwater levels in the Bumbo Latite 16
Figure 5.1 EC timeseries for all monitoring bores 18
Figure 5.2 pH timeseries for all monitoring bores 18
Figure 5.3 Piper plot for all monitoring bores (2022/2023 monitoring year) 20
Figure 5.4 Dissolved metal concentrations for the 2022/2023 monitoring year 21
Figure 5.5 Nitrate concentration time series 22
Figure 5.6 Total phosphorus concentration time series 23
Figure 5.7 Ammonia concentration time series 23

1 Introduction

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Dunmore Hard Rock Quarry (the quarry) at the end of Tabbita Road, in the Shellharbour local government area. The quarry is approximately 8 kilometres (km) northwest of Kiama (Figure 1.1). The quarry supplies construction hard rock materials to markets in the Illawarra, Southern Highlands and Sydney regions. Quarry operations, comprising hard rock extraction from the Bumbo Latite commenced in the early 20th Century.

EMM Consulting Pty Limited (EMM) was engaged by Boral to conduct groundwater monitoring for the quarry, and to characterise and report on the hydrogeological environment. International Environmental Consultants (IEC) also collect baseline groundwater data which is incorporated in this report. Routine groundwater monitoring is completed to detect any potential impacts to groundwater resources from quarry operations.

This annual groundwater monitoring report has been prepared as a requirement of the *Groundwater Monitoring Program for Dunmore Hard Rock Quarry* (GMP) (EMM 2016) in compliance with condition 44 (c) of the quarry's approved Development Consent (DA 470-11-2003). The

GMP is required to investigate and report on baseline local and regional groundwater levels and quality, groundwater impact assessment criteria, and groundwater inflows.

1.1 Site operations

The quarry comprises one elongated open cut pit with an approved disturbance area of approximately
100 hectares (ha) (Figure 1.1). The extraction area contains four pits: Original Dunmore Quarry, Rail Infrastructure Corporation (RIC) Pit, Croome Farm Pit and Croome West Pit. Site infrastructure includes a crushing and screening plant, product stockpiles, workshop and site offices located to the east of the pit. East of the pit is: the Processing plant, the Dunmore Concrete Batching Plant (CBP), and the Dunmore Sand and Soil Quarry (DSS quarry). The Blending plant is located between the Processing plant and CBP.

Water management at the quarry comprises of a series of dams to control surface water runoff. Captured runoff is directed into dedicated water management dams for storage and subsequent treatment. Stored water is utilised for site operations such as dust suppression. Excess water within the excavated quarry pits is pumped to the Middle Dam, which has a holding capacity of 120 to 150 megalitres (ML) (EMM 2020).

1.2 Approvals history

The quarry is currently under Development Consent DA 470-11-2003. In 2017, approval was granted to expand extractive activities within the Croome West Pit. Due to a lower than expected resource volume, a modification was proposed to extend the life of the quarry and maintain operations. The proposed modification (MOD 13) to the Development Consent includes:

- increasing the approved extraction area by approximately 7.8 ha – the RIC Pit extension
- increasing the depth of approved extraction area
- increasing the approved period for quarry operations from 2034 to 2043.

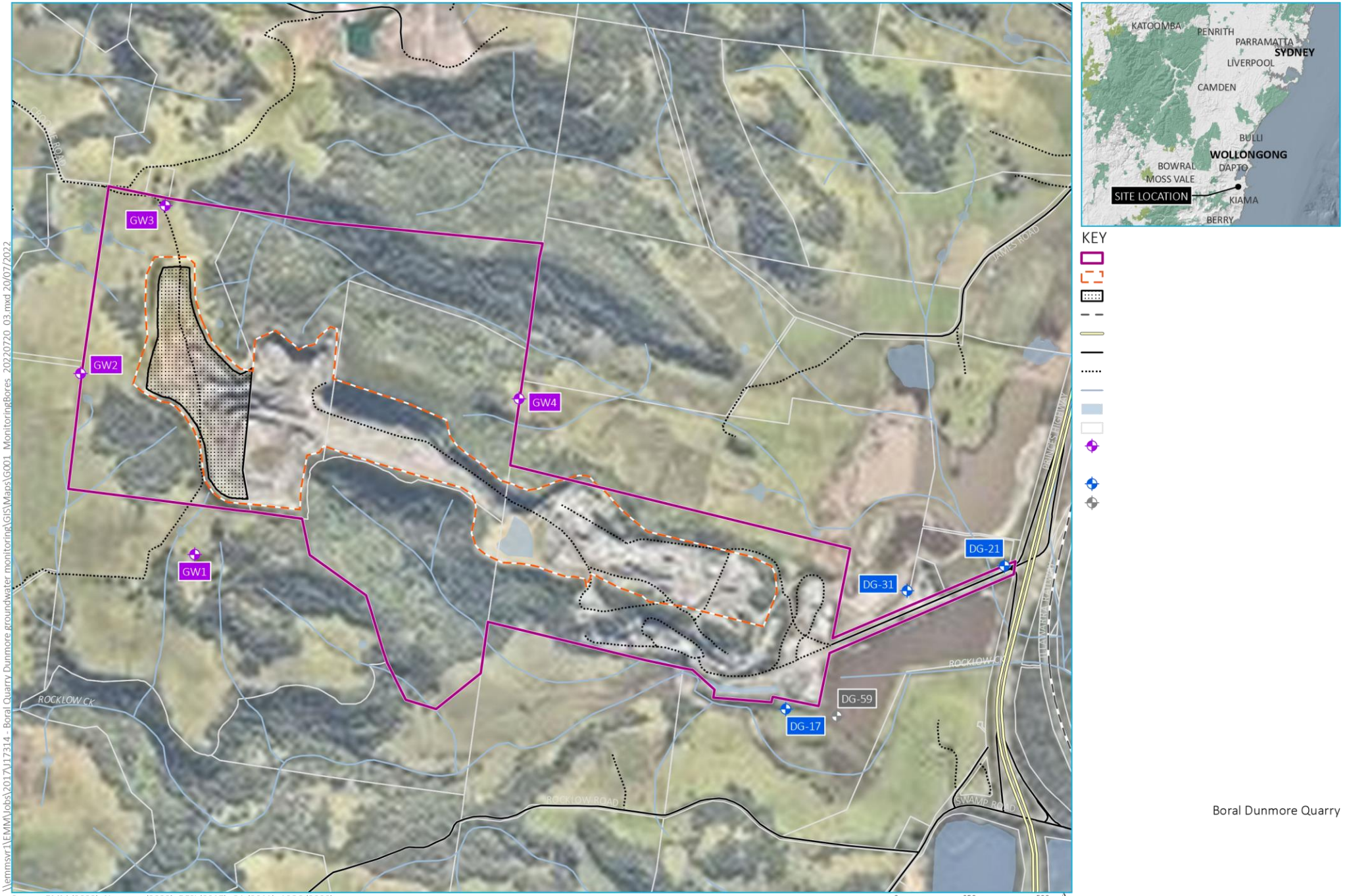
1.3 Scope of works

The monitoring program includes analysis and interpretation of groundwater quality and level data from the groundwater monitoring network. The monitoring network consists of seven groundwater monitoring bores. Four monitoring bores (GW1 – GW4) are installed up gradient within the Bumbo Latite and three are installed down gradient within alluvium (DG-12, DG-21, DG-37).

The scope of works as defined in the GMP are to:

- complete a six-monthly groundwater sampling events at the Bumbo Latite monitoring bores and alluvial monitoring bores
- analyse and interpret groundwater level and water quality data collected.

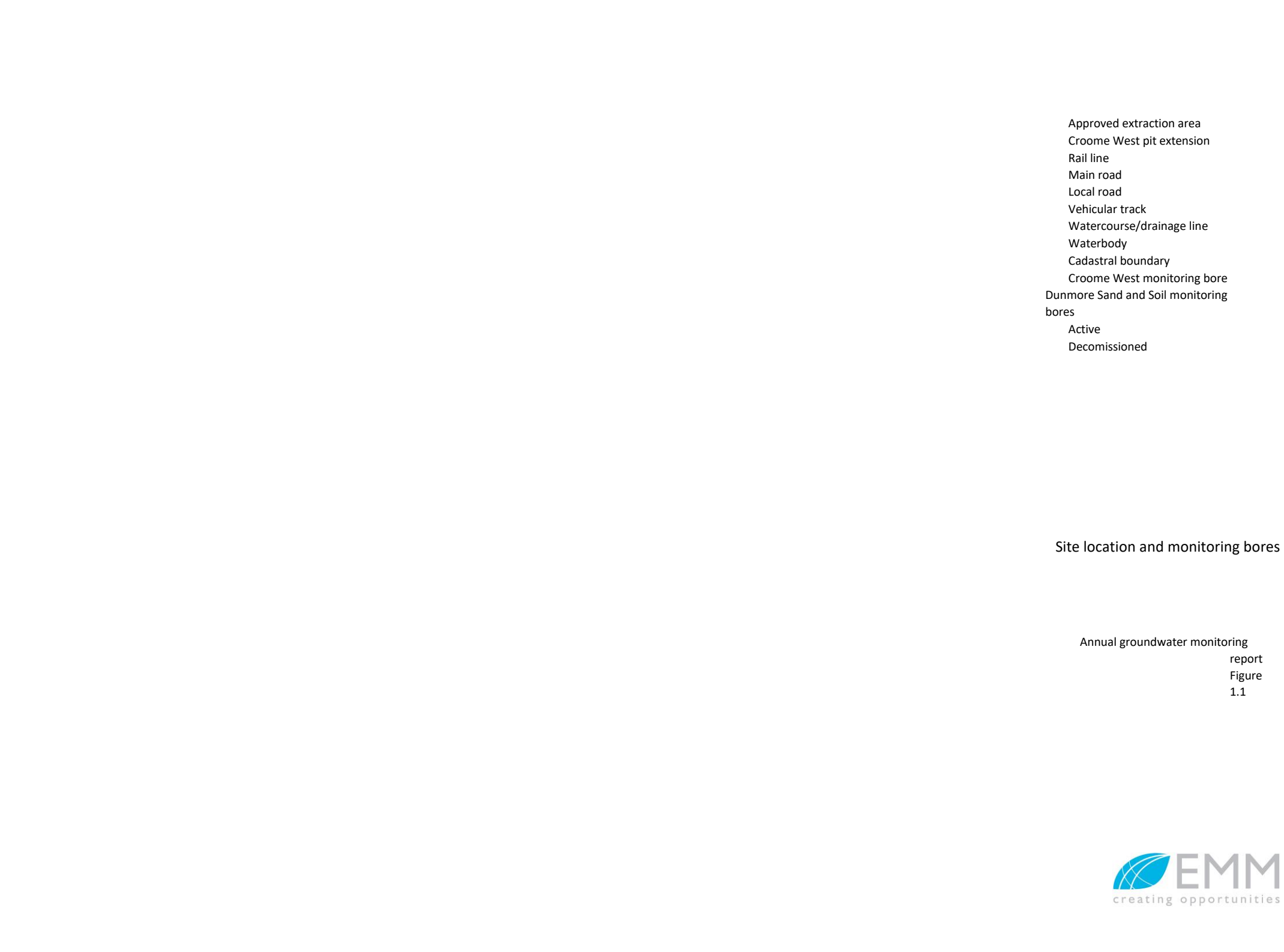
This report also includes a review of the current monitoring network design and provides any recommendations for ongoing monitoring.



\\emmsvr1\EMM\Jobs\2017\J17314 - Boral Quarry Dunmore groundwater monitoring\GIS\Maps\G001_MonitoringBores_20220720_03.mxd 20/07/2022

Source: EMM (2020); Nearmap (2020); DFSI (2017); GA (2011); ASGC (2006)

Boral Dunmore Quarry



Site location and monitoring bores

EMM
creating opportunities

2 Environmental setting

2.1 Site setting

The project area (Figure 1.1) is surrounded by small agricultural plots, with cattle and horse grazing, and rural residential properties. Historically the area has been used for dairy farming. Remnant native vegetation lines the top of the prominent ridge line and persists in isolated pockets in the lower lying areas.

The quarry is set on a north south-west trending range. The peak is named Locking Hill and is partially incised by the existing pit. The ridge extends along the current western quarry highwall and has an elevation of approximately 164 metres Australian Height Datum (mAHD). The elevation of the south-east processing area is 10 mAHD. The DSS quarry and the CBP are east of the quarry. Quaternary alluvial sediments associated with the Minnamurra River system are extracted and processed at the DSS quarry.

Other quarries are located near the project. Approximately 1.5 km to the north is the Cleary Bros Bombo Pty Ltd (Cleary Bros) Albion Park Quarry. The Cleary Bros quarry is approved to produce 900,000 tonnes per annum and has extracted and processed hard rock from the Bumbo Latite since the 1950s (MMJ 2013). Holcim Australia Pty Ltd (Holcim) operates the Readymix Albion Park Quarry immediately west of the Cleary Bros Albion Park Quarry. This quarry also extracts a hard rock resource from the Bumbo Latite.

2.2 Climate

The project area is part of the Illawarra region, which is characterised by a mild/temperate climate described as warm and humid. Rainfall and climate data was downloaded from the SILO Long Paddock database for Albion Park weather station (Bureau of Meteorology (BoM): 068241), which is situated approximately 10 km north of the quarry. Rainfall data has been collected at this monitoring station since 1999. Evaporation data at this site has been interpolated by SILO from nearby weather stations. Climate statistics are summarised in Table 2.1.

The average annual rainfall is 1,011.9 millimetres (mm) (BoM 068241) with the most significant rainfall events generally experienced in autumn (February and March) and the lowest rainfall in winter and spring (August and September).

The average annual evaporation is 1,480.4 mm (BoM 068241) and exceeds rainfall throughout most of the year. Evaporation follows a seasonal trend with the highest rates of evaporation occurring during the hotter months between October to February.

Table 2.1 Average monthly rainfall and evaporation statistics

Time period (month)	Rainfall (mm)			Evaporation (mm)
	Min	Mean	Max	Mean
January	2.6	85.2	178.4	198.9
February	9.8	150.3	356	151.6
March	4.2	142.0	670.6	133.0

April	2.2	76.7	261.2	94.2
May	4.8	63.3	398.6	70.3
June	0	90.0	340.4	53.2
July	1.4	79.6	550.6	61.3
August	1.2	57.7	281.8	86.6

Table 2.1 Average monthly rainfall and evaporation statistics

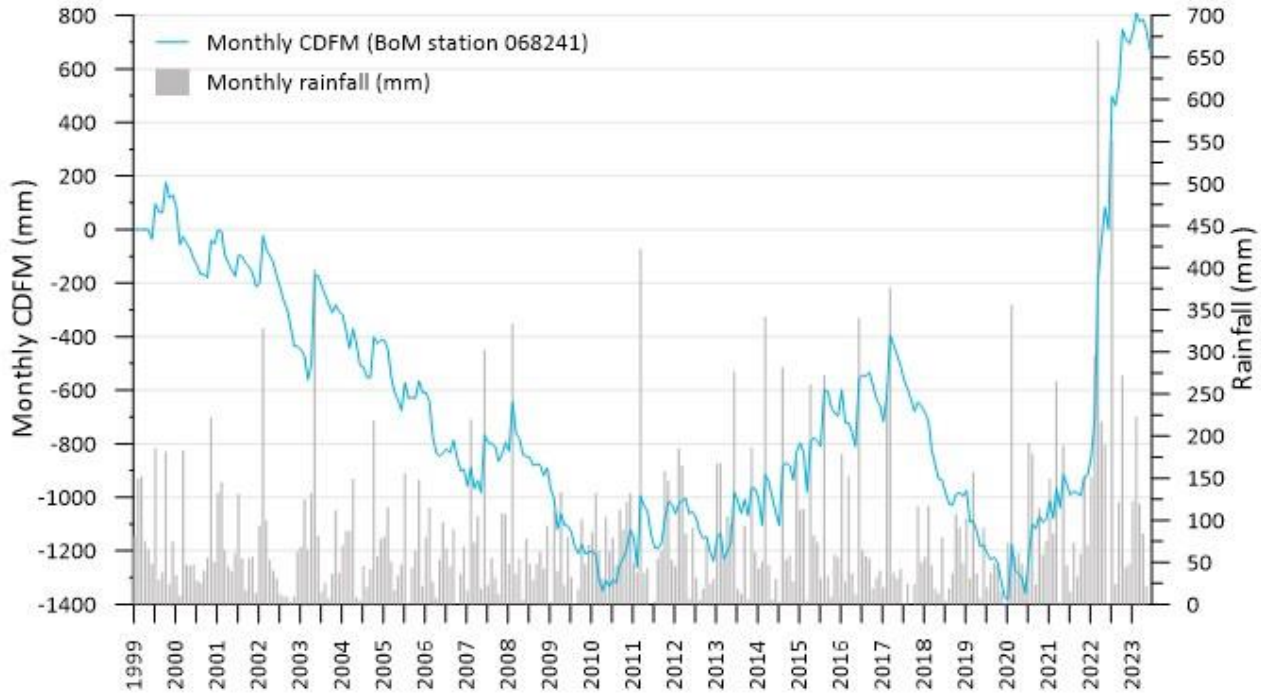
Time period (month)	Rainfall (mm)			Evaporation (mm)
	Min	Mean	Max	Mean
September	0	45.5	122	119.1
October	0.2	76.8	272.2	149.6
November	9.6	80.9	222.0	167.3
December	1.6	64.0	171.8	195.3

Source: Data sourced from SILO at BoM station 068241 (Albion Park – Shellharbour Airport)

The cumulative deviation of monthly rainfall from the mean (CDFM) from 1999 to mid-2023 is presented in Figure 2.1. The long-term CDFM is generated by subtracting the long-term average monthly rainfall for the recorded period from the actual monthly rainfall and then accumulating these residuals over the assessment period. Periods of below average rainfall are represented as downward trending slopes while periods of above average rainfall are represented as upward trending slopes.

The cumulative deviation plot for Albion Park shows a period of predominantly below average or average rainfall from 1999 until 2010, followed by a period of above average rainfall to 2017. Between 2017 and 2020, rainfall was generally below average. From July 2020 to the current reporting period (June 2023) rainfall has been above the long-term average.

The monthly rainfall over the 2022-2023 monitoring period is presented in Figure 2.2. Monthly rainfall was generally around average to below average in most months with exception of July and October 2022 where significantly higher monthly rainfalls were recorded with 551 mm and 272 mm recorded respectively. During the reporting period 1,649 mm of rain was recorded compared to the annual average of 1,012 mm.



Source: Data sourced from SILO at BoM station 068241 (Albion Park – Shellharbour Airport)

Figure 2.1 Cumulative deviation from long-term monthly mean rainfall

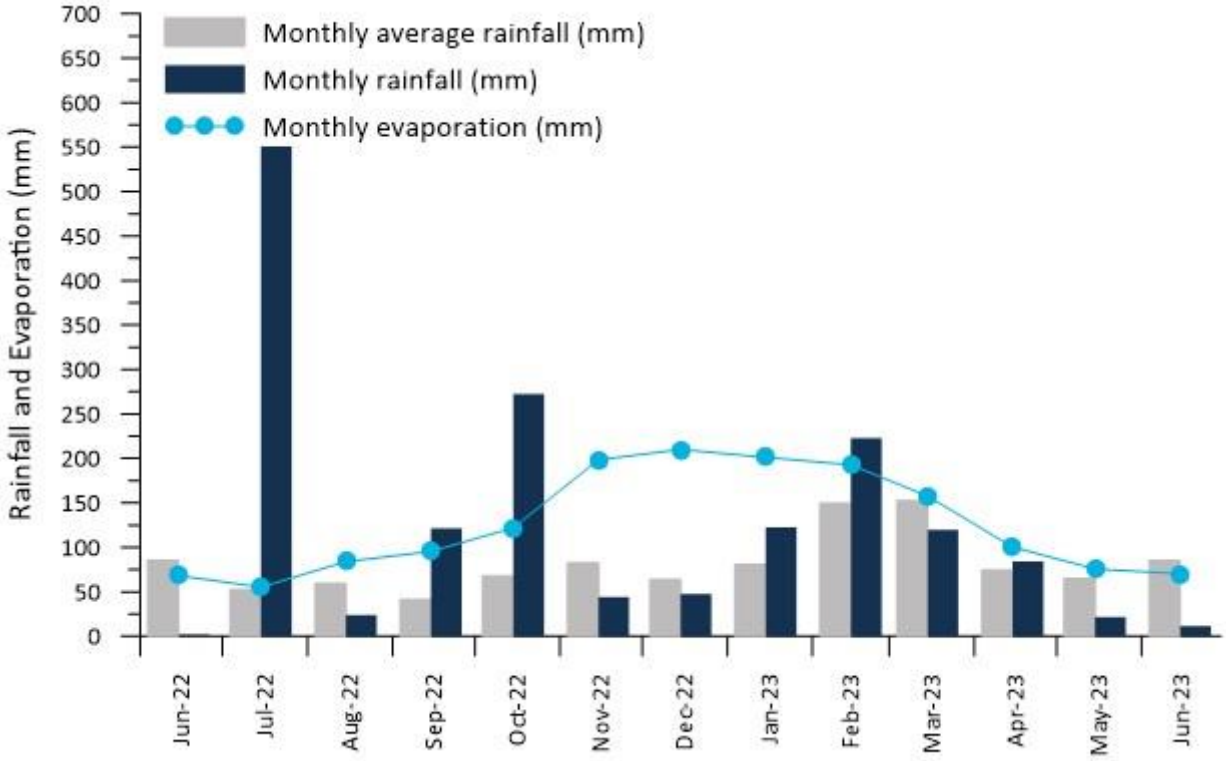


Figure 2.2 Monthly rainfall for June 2022 to June 2023 compared to average

2.3 Surface water

The quarry is located within the Rocklow Creek catchment area, which forms part of the Minnamurra River Catchment. The Minnamurra River discharges into the Pacific Ocean approximately 8 km south-east of the project area (Chapter 2.1).

Rocklow Creek is located to the south of the quarry, flowing to the east and draining to the Minnamurra River. The Rocklow Creek catchment has an area of 21 km^2 and originates in the Illawarra Range, approximately 3 km west of the project area (Arcadis 2016). All clean water runoff from the project area flows into Rocklow Creek. Boral have a current surface water access licence (WAL 25152) to extract up to 227 megalitres (ML) per year of water from Rocklow Creek.

To the north of the project area is the Frasers Creek catchment area which drains to Lake Illawarra. Frasers Creek is an ephemeral system and forms disconnected pools during dry periods.

2.4 Geology

The project area is situated in the south-eastern corner of the Permo-Triassic Sydney Basin. The Sydney Basin predominantly comprises Permian and Triassic aged sedimentary rocks. Near the quarry, the Triassic and Late
Permian sedimentary rocks have been eroded exposing the older early Permian aged Gerringong Volcanics of the Shoalhaven Group (Geology of the Wollongong, Kiama and Robertson 1:50,000 Sheet, Department of Mines 1974). The surface geology across the project area is presented on Figure 2.3.

Volcanic activity in the area has produced a series of flat lying lava flows interspersed with volcaniclastic sandstone members and breccias. The thickness of each successive flow decreases with distance from the volcanic origin, assumed to be off the current coastline to the south (Cohen 2006). At the quarry all geological units exhibit a gentle dip in an easterly direction (Evans and Peck 2006; MMJ 2013).

The Gerringong Volcanics facies comprise nine latite members and three volcanic sandstones or tuff members. The Gerringong Volcanics were deposited in a shallow marine environment, which was then uplifted above sea level. The area has since been eroded via river action to form the present landscape (Cohen 2006).

The Bumbo Latite is the areas greatest and most persistent lava flow and is the predominant geological unit at the quarry and has a maximum thickness of 150 m. The Bumbo Latite Member is divided into three flows: upper, middle, and lower. The Bumbo Latite is a grey to dark grey, very hard dense rock with light coloured phenocrysts of feldspar (Cohen 2006). Weathered latite is generally softer with a brownish, yellow colour. The latite can be jointed and fractured, with the dominant jointing close to vertical, however jointing is not widespread (MMJ 2013). The Bumbo Latite Member overlies the Kiama Sandstone Member which outcrops to the west of the quarry.

A breccia layer was deposited between the middle and lower Bumbo Latite Member flows. This breccia layer, also comprising volcanic material, ranges in thickness between 5 to 22 m (Cohen 2006). It comprises a softer layer of fragmental, angular materials cemented in a fine grained matrix (Department of Mines 1974).

Further east, the low-lying floodplain area is dominated by Quaternary Alluvium, deposited during flooding events associated with the Minnamurra River and its tributaries. This alluvium comprises unconsolidated to loosely consolidated gravels, sands, silts and clays.

2.5 Hydrogeology

2.5.1 Overview

The regional groundwater system, within the Kiama Sandstone aquifer, flows south-east, controlled by the dip of the strata and topography (Cohen 2006). Recharge to the Kiama Sandstone is by rainfall where it outcrops and subcrops and by leakage from overlying sedimentary units to the west of the project area. The Kiama Sandstone aquifer discharges to the Pacific Ocean (Cohen 2006).

Local groundwater systems are present within the Bumbo Latite along the elevated ridgeline (Walker *et al* 2003). These systems are isolated and have limited connection to the regional flow system. The Bumbo Latite is characterised as 'tight' with a low primary and low to moderate secondary porosity (Cohen 2006) controlling groundwater flow. Groundwater flow within the Bumbo Latite is minimal, predominantly occurring along fractures and at contacts between volcanic rock and the underlying sandstone (MMJ 2013).

The local groundwater systems are recharged by rainfall with infiltration higher in areas where the Bumbo Latite outcrops on the ridgelines and hilltops of the landscape (i.e. areas with limited soil profile). Discharge from the local groundwater system occurs in the valleys and includes ephemeral springs.

There is no history of dewatering at the quarry and there is no visual evidence of groundwater seepages to the
Croome Farm pit with the rockface remaining dry throughout the year (Arcadis 2016). Cohen (2006) and Clearly Bros (2019) reports that there is no active mine dewatering at the two Albion Park quarries which also intersect the Bumbo Latite.

Information from Boral suggests that the breccia layer is partially saturated and more permeable than the surrounding Bumbo Latite. Breccia generally exhibits a variable porosity with areas of higher permeability common however they are generally limited in their extent.

The Quaternary alluvial sediments associated with the surface water courses form unconfined groundwater systems of varying storage. These systems are recharged by leakage from surface water courses during wet periods. The alluvial systems are depleted during dry periods and are not recharged by underlying porous and fractured rocks (Cohen 2006).

2.5.2 Conceptual hydrogeological model i

Groundwater flows

Groundwater within the Bumbo Latite flows from areas of high relief towards the valleys and low lying plains where it discharges to the alluvium and surface watercourses. The bulk rock mass has a low primary permeability with groundwater flow occurring primarily through fractures and along the contacts between the latite flows and breccia. Hydraulic testing results indicate an average hydraulic conductivity of 5.5×10^{-7} metres per day (m/day) (EMM 2014) which is comparable to the reported hydraulic conductivity in fractured igneous rocks: 8×10^{-9} to 3×10^{-4} m/day (Domenico & Schwartz 1990).

In the vicinity of the quarry, groundwater flow is generally towards the south-east, discharging to Rocklow Creek and the Minnamurra estuary system. To the north of the quarry the landscape gives way to steep valleys that shed surface water and provide limited potential for groundwater recharge.

The deep groundwater system associated with the Kiama Sandstone typically flow along bedding planes towards the east and are coincident with the dip of the strata.

ii Recharge and discharge

The local groundwater systems within the Bumbo Latite are recharged by rainfall with infiltration in higher areas where the Bumbo Latite outcrops on the ridgelines and hilltops of the landscape (i.e. areas with limited soil profile).

The regional groundwater system is recharged by infiltration from overlying sedimentary units west of the project area and losses from surface watercourses. The steep relief increases runoff with a smaller percentage of rainfall infiltration in this steeper terrain.

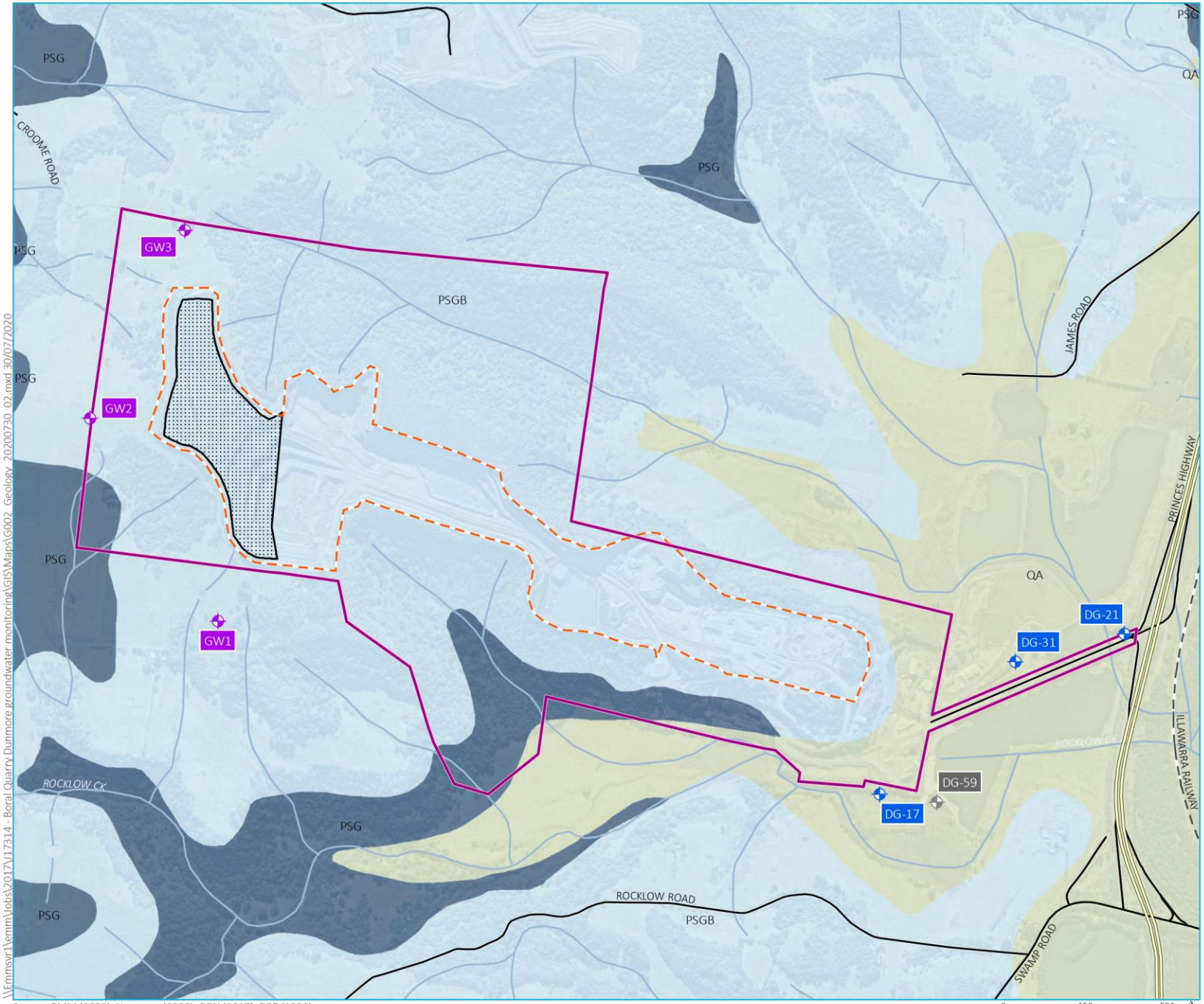
Groundwater from the shallow latite is largely thought to discharge to the Minnamurra River and Rocklow Creek, which form the main drainage systems in the vicinity of the quarry.

iii Groundwater-surface water connection

The surface watercourses in the elevated parts of the landscape are ephemeral in nature with the upper reaches drying out during periods of low rainfall. This ephemeral nature indicates that the surface watercourses are losing streams and are not fed by the underlying fractured rock groundwater systems.

The surface water systems to the east of the quarry in the lower parts of the landscape (Illawarra River, Minnamurra River and Rocklow Creek) are connected to shallow, marginal groundwater systems within surficial alluvial systems. Direct rainfall and surface water runoff recharges these shallow systems during wet periods which rapidly deplete during the drier periods, providing an important temporary source of baseflow for the surface watercourses.

Although groundwater within the shallow Bumbo Latite flows through to the alluvium in the east, the volume of this flux is likely to be insignificant in comparison to the recharge from the overlying rivers, restricted by the groundwater flow properties of the ‘tight’ rock matrix.



KEY

- Dunmore Quarry site boundary
- Approved extraction area
- Croome West pit extension
- Rail line
- Main road
- Local road
- Watercourse/drainage line
- Croome West monitoring bore

Dunmore Sand and Soil monitoring bores

- Active
- Decomissioned

Lithology

- Quaternary Alluvium (Qa)
- Shoalhaven Group, Bumbo Latite (Psgb)
- Shoalhaven Group, undifferentiated siltstone (Psg)

Surface geology

Source: EMM (2020); Nearmap (2020); DFSI (2017); DPE (1996)

0 250 500 m

GDA 1994 MGA Zone 56

\\Emmsvr1\emm\Jobs\2017\U17314 - Boral Quarry Dunmore groundwater monitoring\GIS\Maps\G002_Geology_20200730_02.mxd 30/07/2020

Boral Dunmore Quarry
Annual groundwater monitoring report
Figure 2.3

creating opportunities

3 Groundwater monitoring program

3.1 Monitoring network design

The groundwater monitoring network comprises seven monitoring bores installed at different times since 2014. The groundwater monitoring network has been designed to satisfy the requirements of Condition 40, Schedule 4 of the approved Development Consent. Four groundwater monitoring bores are installed into the fractured rock outside the quarry area, with a further three bores are installed into the alluvium outside the DSS dredge pond (refer Figure 1.1 and Table 3.1). In summary:

- GW4 was installed in February 2022 as part of the proposed northern extension into the RIC area. GW4 is screened across the base of the latite and up gradient of current quarrying activities
- three deep monitoring bores (GW1, GW2 and GW3) targeting the Bumbo Latite (EMM 2014), were installed in July 2014. GW1 is screened across latite and the top of the underlying sandstone, GW2 is screened across latite, and GW3 is screened across latite and breccia. These bores are located up hydraulic gradient from current quarrying activities
- DSS installed and monitor bores as part of their operations. Three shallow monitoring bores (DG-17, DG-31 and DG-21) are screened in the alluvium overlying the regional fractured rock groundwater system
- DG-59, which was part of the 2018/2019 monitoring program, was demolished in August 2019 due to further expansion of the DSS dredge pond. DG-21 has been added to the network as a replacement to DG-59.

Table 3.1 Groundwater monitoring bore construction details

Bore ID	Total depth (mbgl)[1]	Ground level (mAHD)[2]	Total depth (mAHD)[2]	Screened interval (mbgl)[1]	Screened interval (mAHD)[2]	Screened formation	Monitoring duration
GW1	78.0	131.44	53.440	72.0–78.0	59.44–53.44	Bumbo Latite and Kiama Sandstone	July 2014 - present
GW2	86.0	135.69	49.690	79.0–85.0	56.69–48.69	Bumbo Latite	July 2014 - present
GW3	80.0	147.25	67.250	68.0–80.0	79.25–67.25	Bumbo Latite and Breccia	July 2014 - present
GW4	29.0	57	28	20–26	21–27	Bumbo Latite	February 2022 - present
DG-17	6.0	3.49	-2.510	2.8–6.0	0.69–2.51	Alluvium	November 2018 - present
DG-31	5.5	3.05	-2.450	2.5–5.5	0.55–2.45	Alluvium	May 2016 - present
BH-F (decommissioned)	5.2	2.23	3.0	2.1–5.2	0.1–3.0	Alluvium	July 2014 - March 2018
DG-59 (decommissioned)	8.69	1.763	-6.927	unknown	unknown	Alluvium	February 2017 - August 2019
DG-21	5.0	2.12	-2.880	2.0–5.0	0.12–2.88	Alluvium	November 2018 - present

Notes: 1. mbgl = metres below ground level; 2. mAHD = metre Australian Height Datum

3.2 Groundwater quality

In accordance with the GMP, groundwater sampling events were completed as described in Table 3.2.

Table 3.2 Groundwater quality monitoring program

Monitoring bores	Monitoring events (during the 2022/2023 monitoring year)	Monitored by
GW1, GW2, GW3, GW4	December 2022 and May 2023	EMM
DG-17, DG-31, DG-21, GW4	August 2022, November 2022, February 2023, May 2023	IEC

3.3 Sampling methodology

Due to the low permeability of the Bumbo Latite a grab sample was collected (using a decontaminated stainless steel double-check bailer) within the screened interval of monitoring bores GW1 to GW4.

Physicochemical parameters (pH, electrical conductivity (EC), temperature, total dissolved solids (TDS), dissolved oxygen (DO) and oxidation reduction potential (ORP)) were measured for the sampled water using a calibrated hand-held water quality meter.

3.4 Chemical analysis

Water quality samples were analysed for a broad chemical suite. The suite allows groundwater systems to be differentiated by chemical signatures and allows any potential quality impacts from quarry operations to be identified. The analytical suite is provided in Table 3.3.

Table 3.3 Water quality suite of analysis

Grouping	Parameter
Physicochemical parameters (field)	EC, pH, DO, Temperature, TDS, ORP
Major ions	Calcium[1], Magnesium, Sodium, Potassium, Chloride, Total alkalinity, Sulphate[1], Silica[1]
Dissolved metals	Aluminium[1], Arsenic[1], Cadmium[1], Chromium[1], Copper[1], Iron, Manganese[1], Nickel[1], Zinc[1]
Nutrients	Ammonia, Nitrate, Nitrite, Total nitrogen, Total phosphorus

Note: 1. Not analysed in the shallow monitoring bores (DG-17, DG-31 and DG-21).

The samples collected by EMM from GW1, GW2, GW3 and GW4 were analysed by Australian Laboratory Services Limited (ALS). The samples collected from the alluvial bores by IEC were analysed by Sydney Analytical Laboratories in Seven Hills. All laboratories used for analysis are NATA accredited.

All samples were collected in bottles provided by the laboratory, with appropriate preservation where required. Samples undergoing dissolved metal analysis were field filtered using 0.45 micron (µm) filters.

3.4.1 Quality assurance and quality control (QA/QC)

Field sampling procedures conformed to EMM's QA/QC protocols to prevent cross-contamination and preserve sample integrity. The following QA/QC procedures were applied:

- samples were collected in clearly labelled bottles with appropriate preservation solutions
- samples were delivered to the laboratories within the specified holding times
- unstable parameters were analysed in the field (physiochemical parameters).

3.4.2 Laboratory QA/QC

The laboratories conduct their own internal QA/QC program to assess the repeatability of the analytical procedures and instrument accuracy. These programs include analysis of laboratory sample duplicates, spike samples, certified reference standards, surrogate standards/spikes and laboratory blanks. In addition, a duplicate sample is collected in the field for every ten samples collected to assess sampling and laboratory analysis accuracy. A duplicate sample at GW3 was taken during the May 2023 monitoring round.

3.5 Groundwater levels

Following completion of GW1, GW2, GW3 and GW4, pressure transducers (level loggers) were installed to record a groundwater level every six hours. During monitoring events, groundwater levels were also gauged using an electronic dip meter. Groundwater level data for the alluvial bores was supplied to EMM by IEC.

Level loggers were installed by Environmental Earth Sciences (EES) in monitoring bores DG-31, DG-21 and DG-17. These level loggers were programmed to record water levels every hour.

4 Groundwater levels

Hydrographs showing groundwater levels and rainfall from the start of monitoring until May 2023 are presented in Figure 4.1 and Figure 4.2. Individual hydrographs for each monitoring bore are included in Appendix A.

During the 2020/2021 monitoring period, GW1 and GW2 level loggers malfunctioned from December 2020 and June 2020, respectively. Level loggers were replaced in June 2021. The manual groundwater level measurements confirmed no significant changes to long-term groundwater levels at GW1 or GW2.

During the 2022/2023 monitoring period, manual dip recorded at GW2 in May 2023 did not match level logger data. Further monitoring at this location will be necessary to assess and determine if the logger drift is a malfunction.

4.1 Alluvium

Groundwater level trends in the alluvium (DG-17, DG-31 and DG-21) are comparable to the previous monitoring period (Figure 4.1). All shallow alluvial monitoring bores shows a direct and immediate response to rainfall with DG-21 and DG-31 showing the most pronounced responses. The maximum groundwater level rise in these bores is 1.1 m (at DG-31). Short term increases in groundwater levels correspond to above average rainfall observed in January and February 2023, and this groundwater systems immediate and direct response to rainfall recharge.

4.2 Bumbo Latite

Groundwater elevations in the latite monitoring bores at GW1, GW2 and GW3 ranged between 105 and 126 mAHD (Figure 4.2). Groundwater elevations at GW4, screened at the base of the latite, are lower and ranged between 50 and 56 mAHD. Monitoring bore GW4 is also located further down hydraulic gradient than the other fractured rock monitoring bores.

The groundwater levels in monitoring bores GW2, GW3 and GW4, up hydraulic gradient of the quarry show a more muted response to rainfall recharge. The groundwater level at GW1 has historically responded to rainfall recharge during periods of above average rainfall with correlation to the CDFM. GW1 is partially screened within the Kiama Sandstone which responds to regional groundwater recharge. Comparatively, GW2, GW3 and GW4 show little to no response to individual rainfall events or rainfall trends, and groundwater levels are relatively stable.

The groundwater level decline at GW2 observed in the logger data does not align with the manual measurement. Manual measurements show the groundwater level is stable and suggests the logger may be malfunctioning and requires close monitoring.

The monitoring period at GW4 spans approximately 18 months. The groundwater level is trending downwards from July 2022 to February 2023, comprising a decline of 2.2 m over 8 months. This trend is similar to that observed in the alluvium bores, although these bores declined by approximately 1 m. The period of declining groundwater level observed in the Bumbo Latite at GW4 is not believed to be a quarry related impact and is a decline following a period of significantly above average rainfalls (Figure 2.1). The periodic drawdown at GW4 is a result of purging prior to groundwater quality sampling by IEC and is not representative of natural groundwater conditions. Groundwater samples collected at monitoring bores GW1-GW3 (Section 2.5) do not show periodic drawdowns, indicating their higher hydraulic conductivity.

During the 2022/23 reporting period there was no observable groundwater impacts from quarrying activities at the fractured rock monitoring bores.

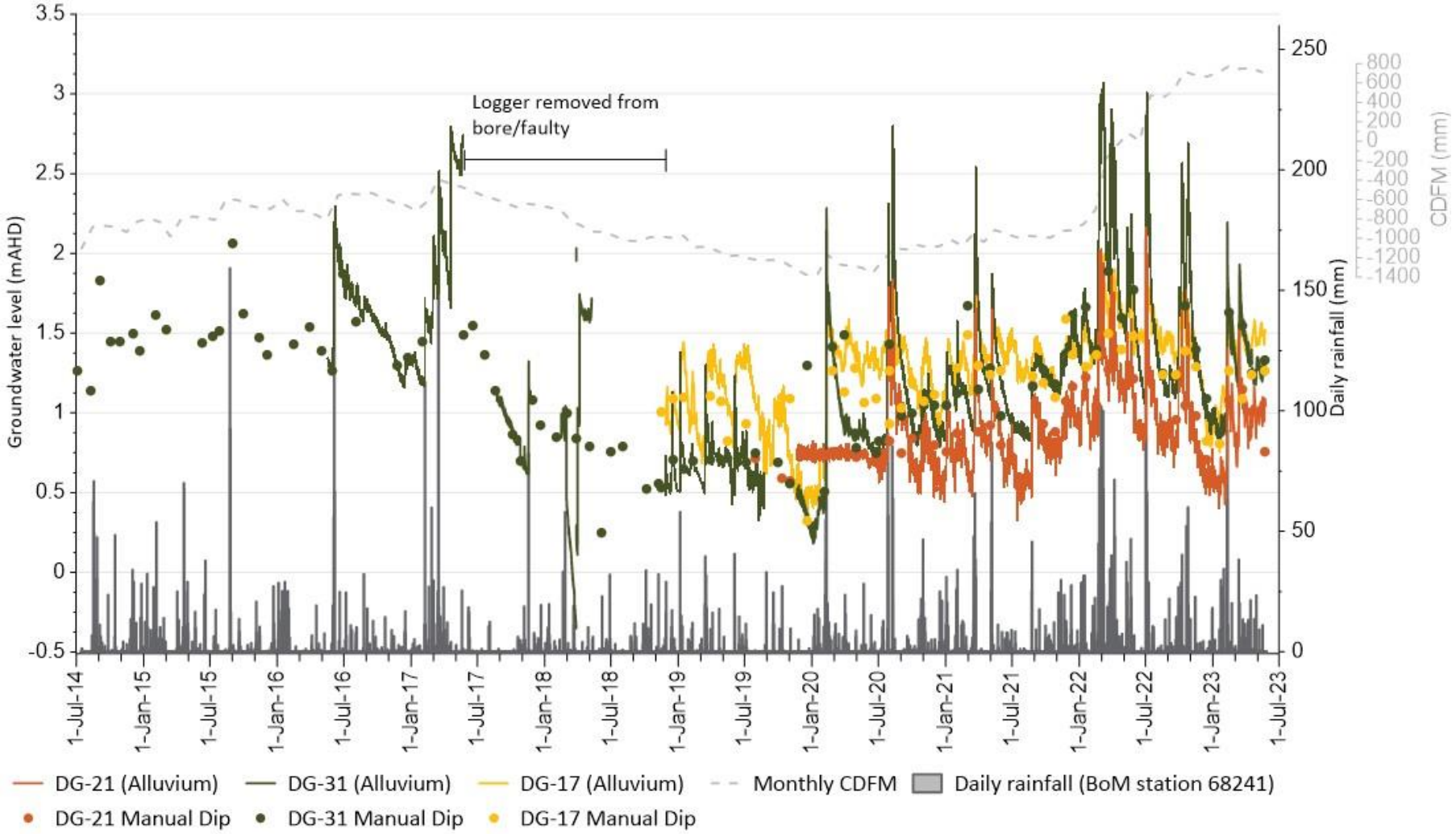


Figure 4.1 Groundwater levels in the alluvium

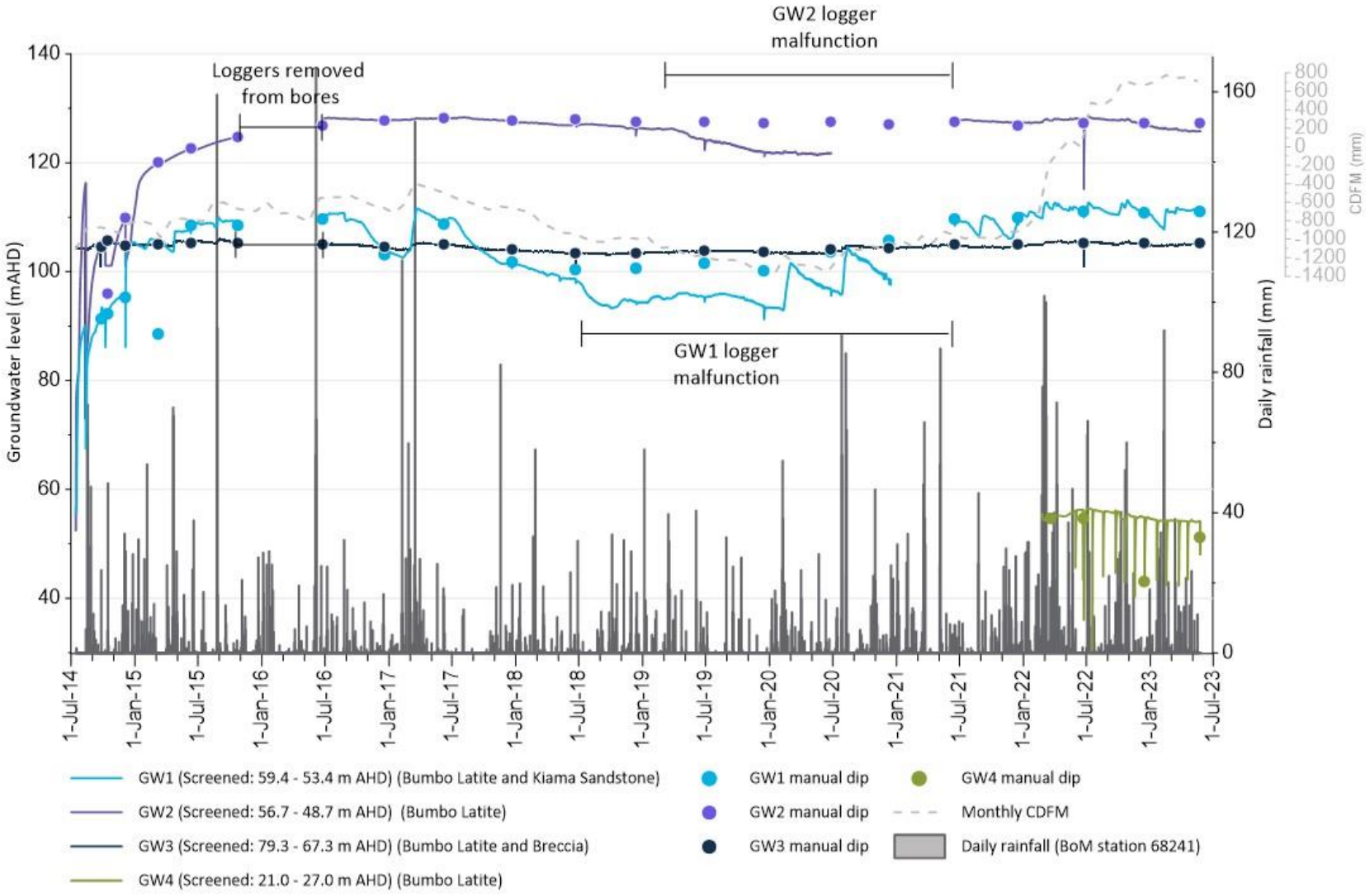


Figure 4.2 Groundwater levels in the Bumbo Latite

5 Groundwater quality

Water quality results for the 2022/2023 monitoring year are summarised below. The full water quality results for the GMP monitoring sites are presented in Appendix B, with laboratory results provided in Appendix C.

5.1 Field parameters

Time series of field EC and pH are presented in Figure 5.1 and Figure 5.2. Groundwater EC and pH from the latite bores, GW1 to GW4, were overall comparable to previous monitoring years. Groundwater EC and pH in the alluvium at DG-17, DG-21, DG-31 were comparable to the previous monitoring years.

Electrical conductivity in the Bumbo Latite was varied, averaging approximately 930 microsiemens per centimetre (µS/cm) at GW3, 1,600 µS/cm at GW2, and 2,400 µS/cm at GW1. The average groundwater EC at GW4, calculated with a smaller dataset (June 2022 – May 2023), was approximately 1,200 µS/cm. Electrical conductivity at GW1 displayed large fluctuation historically ranging from 834 to 4,187 µS/cm. The EC at GW3 showed a decreasing trend with historic minimum recorded in May 2023 at 461 µS/cm. The measured pH at GW1 to GW4 is neutral to slightly alkaline, with an average of approximately pH 7.5. The pH trend at GW1-GW4 was increasing over the reporting period, and rose by approximately 1 pH unit. The more alkaline values are associated with above average rainfall.

Alluvial groundwater is brackish, with an average concentration of approximately 1,700 µS/cm and has a neutral to slightly acidic pH. The EC at DG-31 appears to be variable and potentially influenced by rainfall or other influences; DG-31 is located adjacent to the site carpark while the other alluvial sites are located adjacent to a watercourse where salinity is less likely to accumulate. pH trends in the alluvium were slightly increasing over the reporting period, with more alkaline values associated with above average rainfall. A single spike in pH was recorded at DG-31 in March 2023 (pH 7.95).

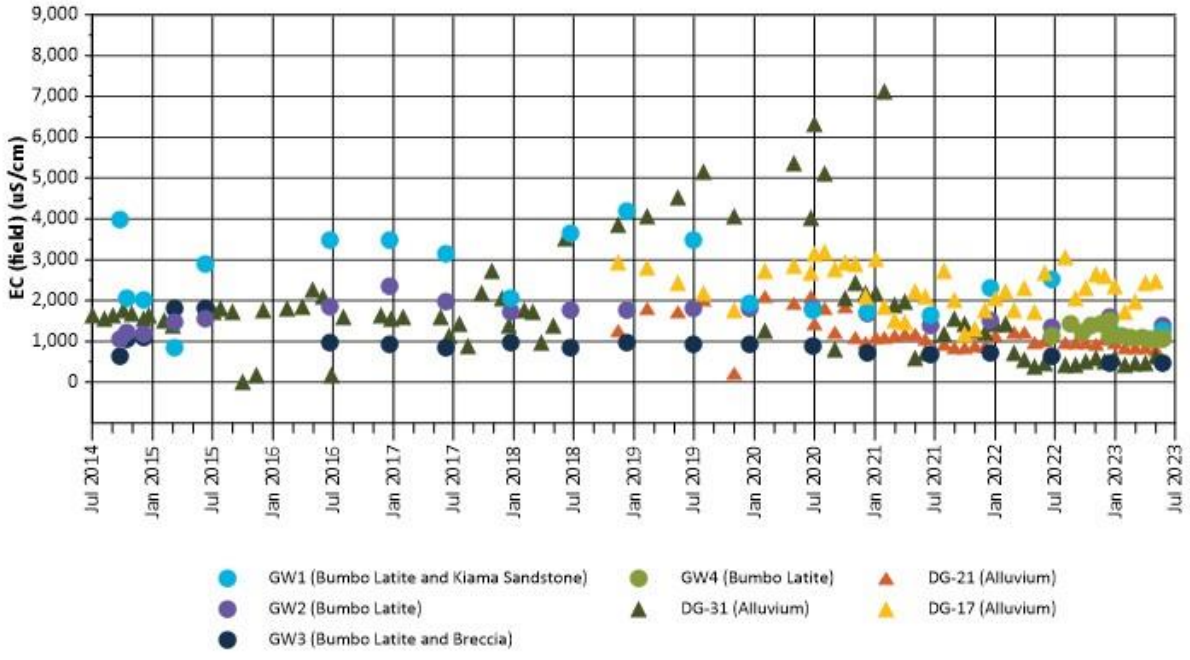


Figure 5.1 EC timeseries for all monitoring bores

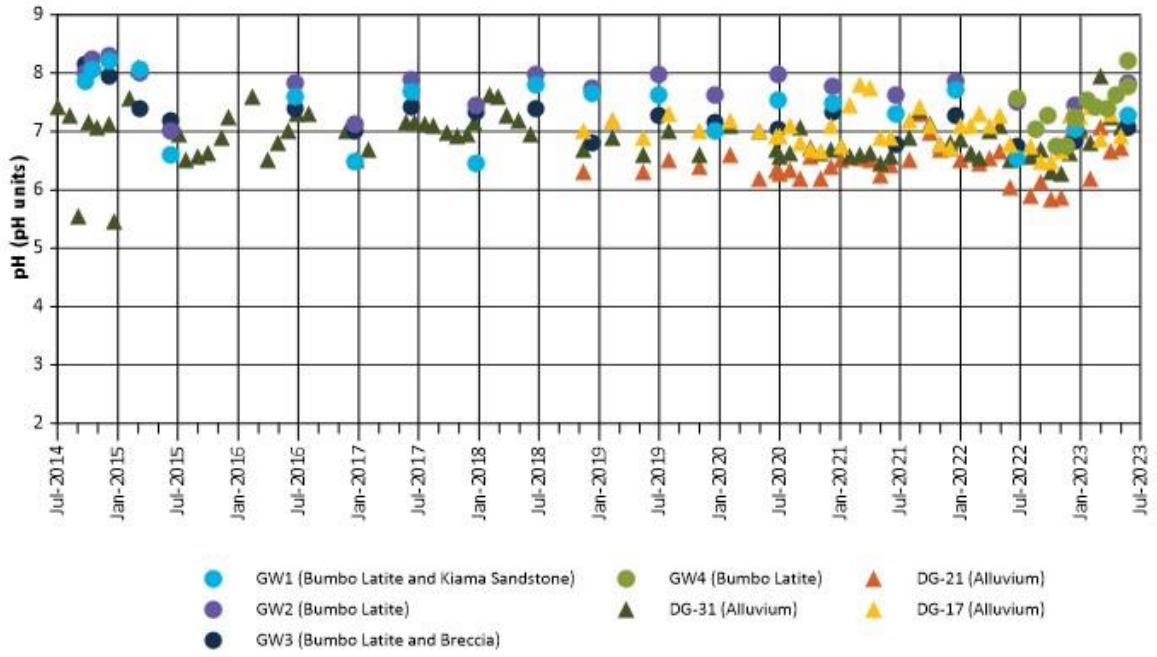


Figure 5.2 pH timeseries for all monitoring bores

5.2 Major ions

The major ion characteristics of groundwater samples for the GMP monitoring sites for the 2022/23 monitoring year are shown in a piper diagram in Figure 5.3. A piper diagram is a graphical representation of the relative concentrations of major ions (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, HCO_3^{-}, CO_3^{2-} and SO_4^{2-}).

Groundwater chemistry from GW1 to GW4 shows some variation in water type. Groundwater quality at GW1,
GW2 and GW4 are interpreted as marginally sodium bicarbonate dominant mixed type. Groundwater quality at GW3 has a magnesium-bicarbonate water type. Major ion concentrations measured at GW1 to GW4 are comparable to previous monitoring years, although a shift towards more bicarbonate type was observed at GW1 indicating increased groundwater mixing.

Groundwater chemistry from DG-17 (alluvial monitoring site) is sodium bicarbonate dominant which is comparable to the previous year. This water type is similar to GW1 and GW2, which is in line with the conceptual understanding where groundwater flows from the latite discharge to the alluvial river systems to the east.

In the reporting period DG-21 and DG-31 has shifted towards a more bicarbonate dominated type. A shift towards more bicarbonate dominant type possibly indicates increased water mixing due to increased discharge towards the east associated with above average rainfalls.

Trends at the DSS sites are regularly monitored by IEC and will be further assessed in the DSS annual report.

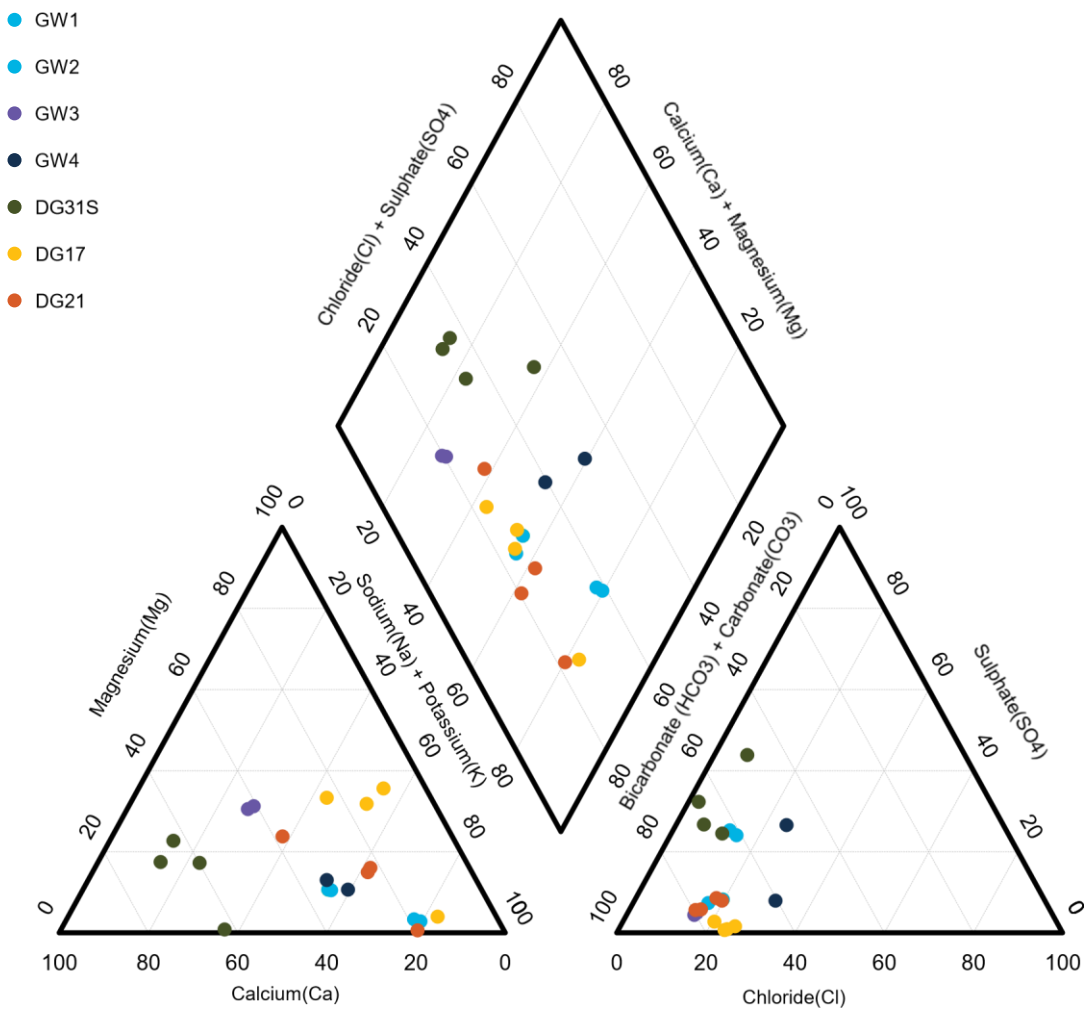


Figure 5.3 Piper plot for all monitoring bores (2022/2023 monitoring year)

5.3 Dissolved metals

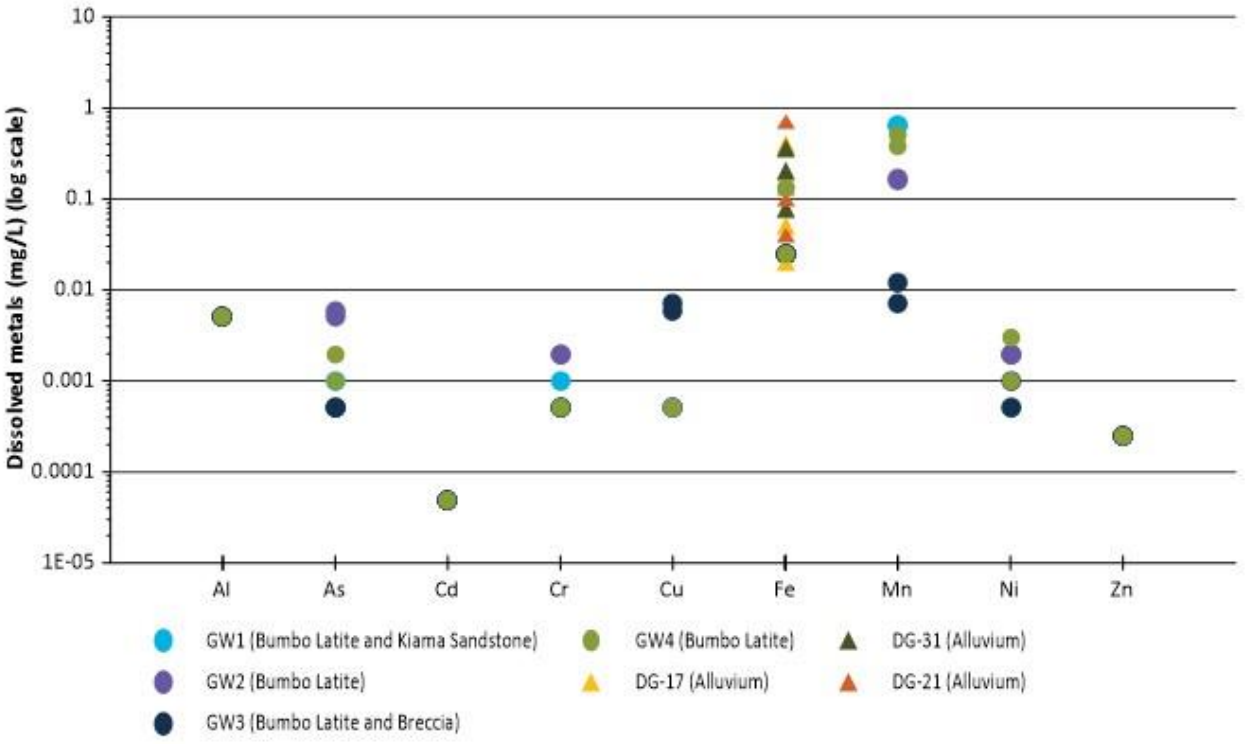
Concentrations of dissolved metals from the groundwater samples collected during the 2022/23 monitoring year are presented in Figure 5.4.

A full suite of metals was analysed for the GW1 to GW4 monitoring sites, with timeseries shown in Appendix D. Only dissolved iron was analysed for the alluvial monitoring sites (DG-17, DG-21 and DG-31).

The main findings for dissolved metals are as follows:

- Dissolved metals at GW1 to GW4 show concentrations within the same order of magnitude as the previous years.
- Iron was detected at all the alluvial monitoring sites (DG-17, DG-21 and DG-31) above the laboratory limits of reporting (LOR).

- Iron was not detected (i.e. was below the laboratory LOR of 0.05 mg/L) at the Bumbo latite bores (GW1 to GW4), except for a concentration of 0.13 mg/L measured at GW4 in December 2022.
- Manganese measurements were an order of magnitude lower at GW3 compared with the other latite groundwater monitoring sites (i.e. GW1, GW2 and GW4).
- Cadmium, zinc and aluminium concentrations were all below the LOR at all sites.



Note: Concentrations below the Estimated Quantitation Limit (EQL) are presented as half the EQL

Figure 5.4 Dissolved metal concentrations for the 2022/2023 monitoring year

5.4 Nutrients

Time series of nitrate, total phosphorus and ammonia concentrations are presented in Figure 5.5, Figure 5.6, and Figure 5.7, respectively. Observations for nutrients are as follows:

- Nutrient concentrations were comparable to the previous monitoring year.
- Nitrate concentrations at most monitoring sites were comparable to previous monitoring year. Overall, nitrate concentrations at DG-17 have increased since February 2022. Nitrate measurements at GW3 were typically an order of magnitude higher than all the other bores (both the Latite and alluvial bores) and continue to fluctuate.
- Total phosphorus concentrations were comparable to previous monitoring years at GW1, GW2 and GW3. GW4 and GW1 displayed a decreasing trend in phosphorous concentrations, after peaking at 2.9 mg/L and 6.7 mg/L, respectively, in June 2022. The total phosphorous concentrations at DG-17 continues to be an order of magnitude higher when compared with DG-21 and DG-31 with the exception in May 2023 when they measured a similar result. The

elevated concentration at DG-17 may be attributed to the nearby water management Middle dam.

- Ammonia concentrations at GW1, GW2 and GW4 remain an order of magnitude higher than at all the other monitoring bores and were comparable to previous monitoring years, except for GW4. Ammonia measured a historical maximum of 0.3 mg/L at GW4 in May 2023. Concentrations at GW2 continues to be an order of magnitude higher than the other monitoring sites.

The elevated and variable nutrient concentrations are not unexpected as these bores are located on or adjacent to farmlands and the groundwater chemistry has likely been altered by land use practices.

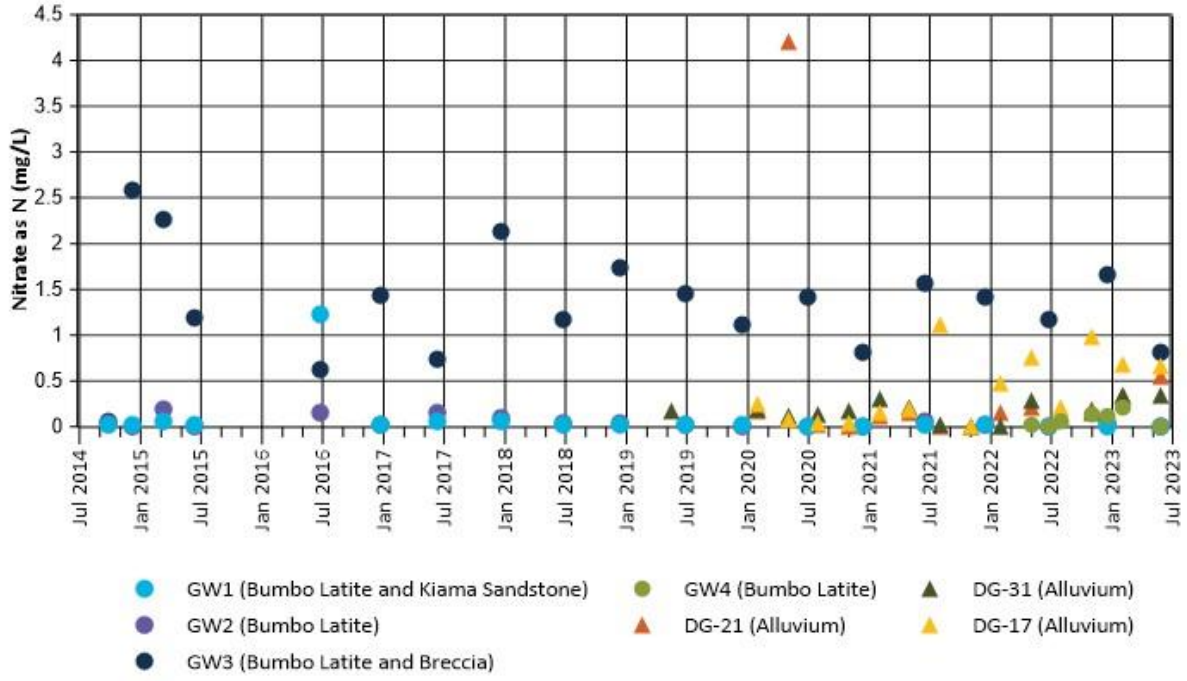
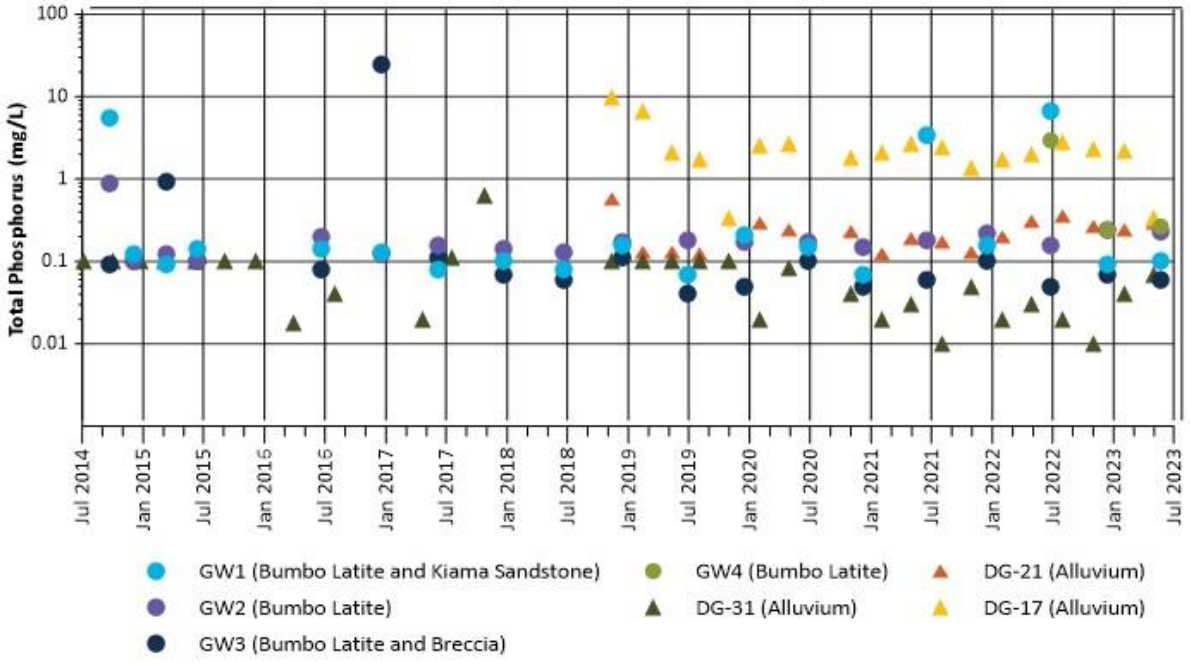


Figure 5.5 Nitrate concentration time series



Note: The figure presents total phosphorus for the alluvium bores and total phosphate as P for the Bumbo Latite bores

Figure 5.6 Total phosphorus concentration time series

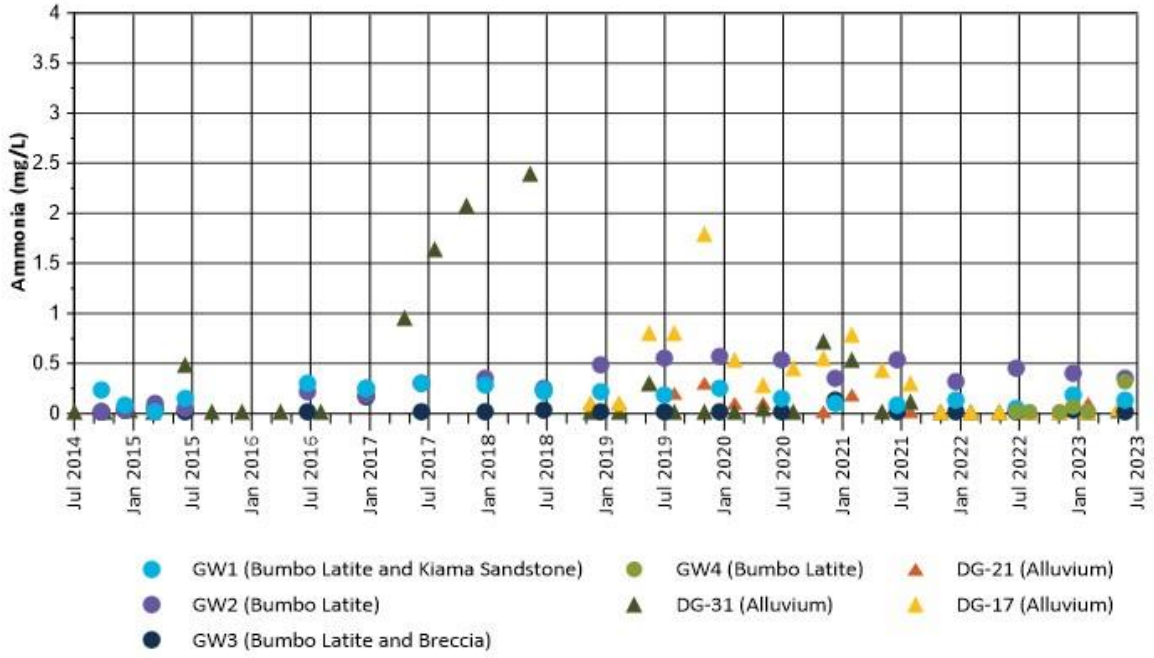


Figure 5.7 Ammonia concentration time series

6 Conclusions and recommendations

The main findings for the 2022/23 monitoring year regarding groundwater levels are:

- no observable groundwater level impacts from quarrying activities associated with groundwater depressurisation were identified at the monitoring bores
- groundwater levels in the alluvium and Kiama Sandstone show a response to rainfall recharge, while the Bumbo Latite shows a more muted rainfall recharge response.

The main findings for the 2022/23 monitoring year regarding groundwater quality are:

- groundwater quality at the monitoring sites was generally consistent with historical data, with the exception of a spike in ammonia at GW4, and a slightly increase pH trend across all bores
- the variable nutrient concentrations are not unexpected as these bores are located on or adjacent to farmlands with livestock and the groundwater chemistry has possibly been altered by land use practices.

The results for the 2022/23 monitoring year are consistent with the hydrogeological conceptual model for the project. There were no changes to groundwater levels or water quality observed in the groundwater monitoring bores during the reporting period that could be associated with the Croome West pit extension activities.

6.1 Recommendations

The Development Consent conditions, issued on 11 March 2019, note: *on the provision of two years of monitoring data that shows negligible impact on the regional groundwater network the Secretary may agree to suspend monitoring of regional groundwater levels and/or quality*. The four year groundwater monitoring period has shown negligible impact to the monitored groundwater system. However, in the interest of collecting additional groundwater site data whilst Boral is extracting in the Croome West pit, it is proposed that monitoring should continue.

Groundwater level monitoring should continue via dataloggers set at six-hourly intervals and groundwater quality monitoring should continue at the six-monthly frequency at GW1, GW2, GW3 and GW4, and at approximately quarterly intervals at DG-17, DG-21 and DG-31 in accordance with the GMP.

Groundwater levels at GW2 should be closely monitored to determine if there is logger drift and to replace the logger if it is necessary.

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Appendix A
Groundwater hydrographs

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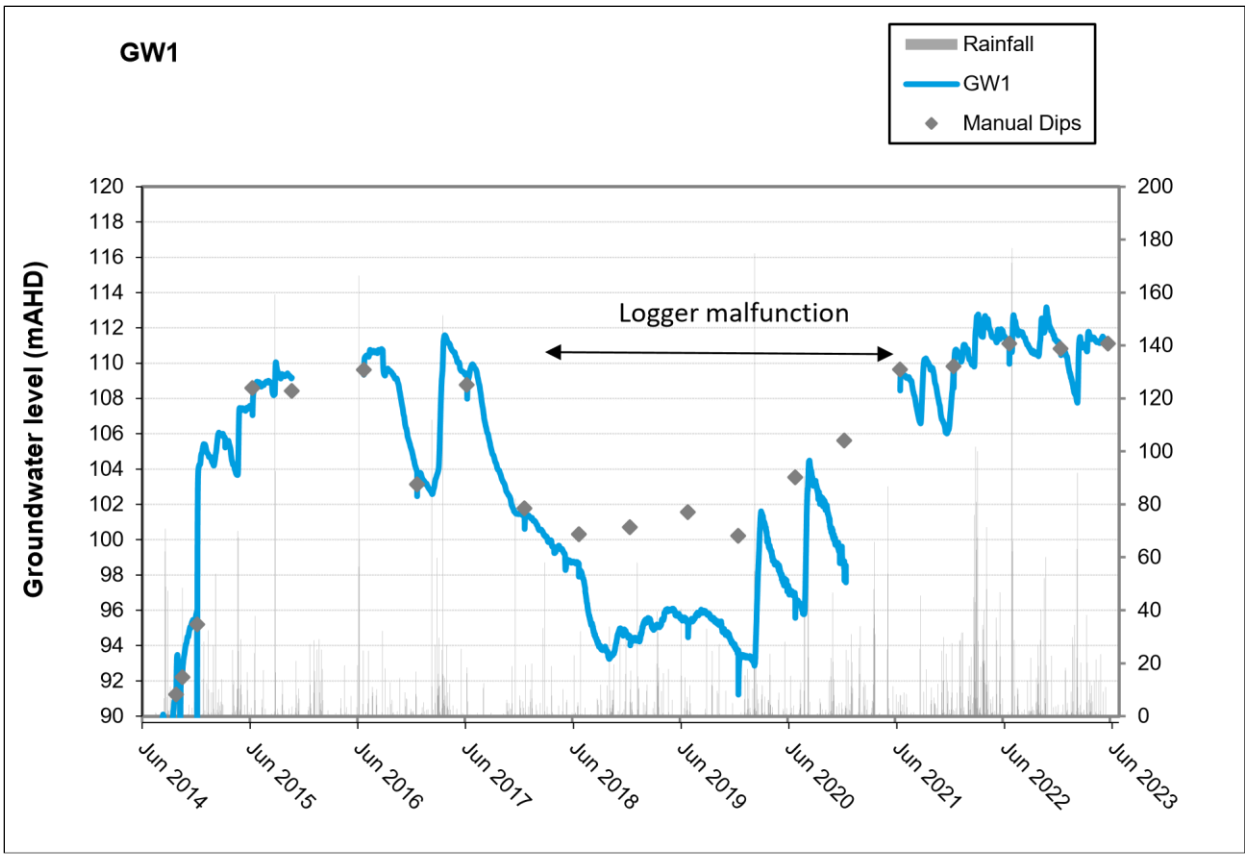
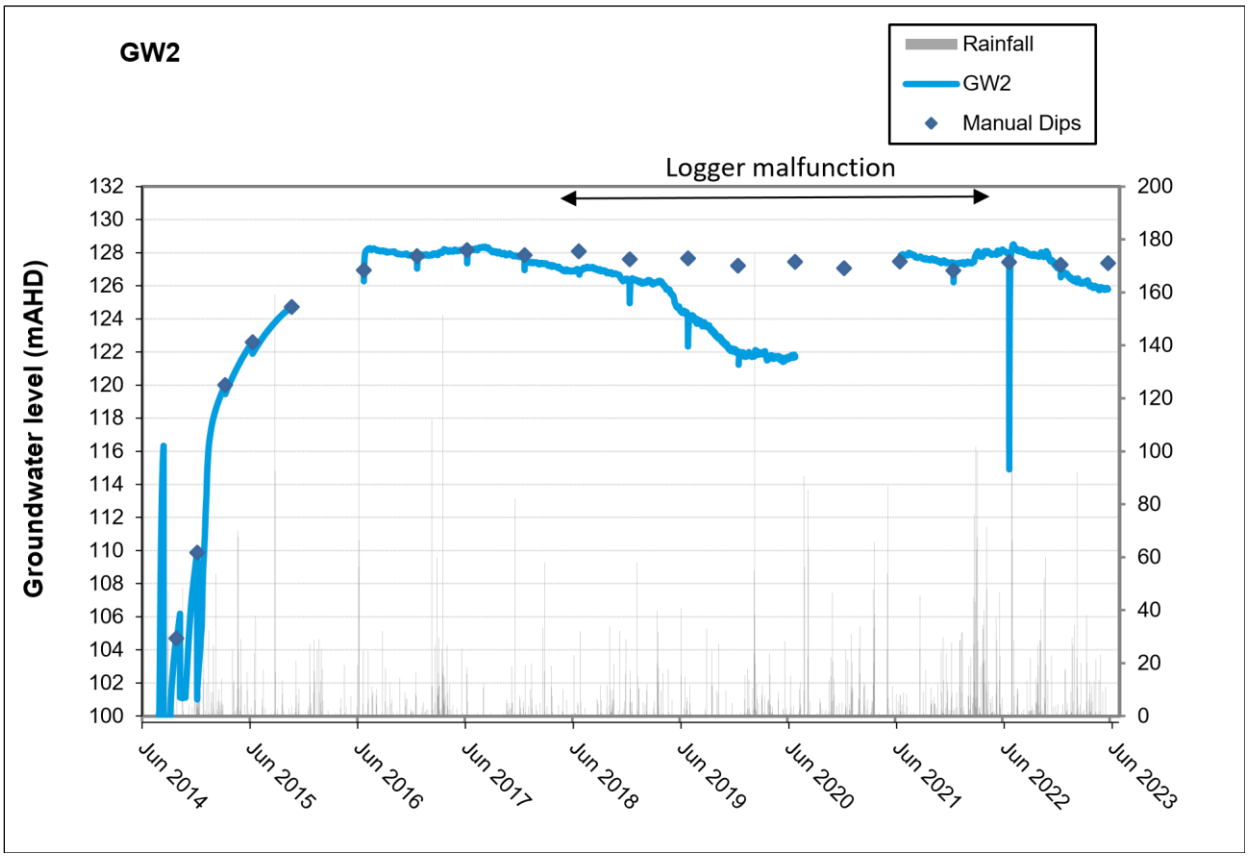
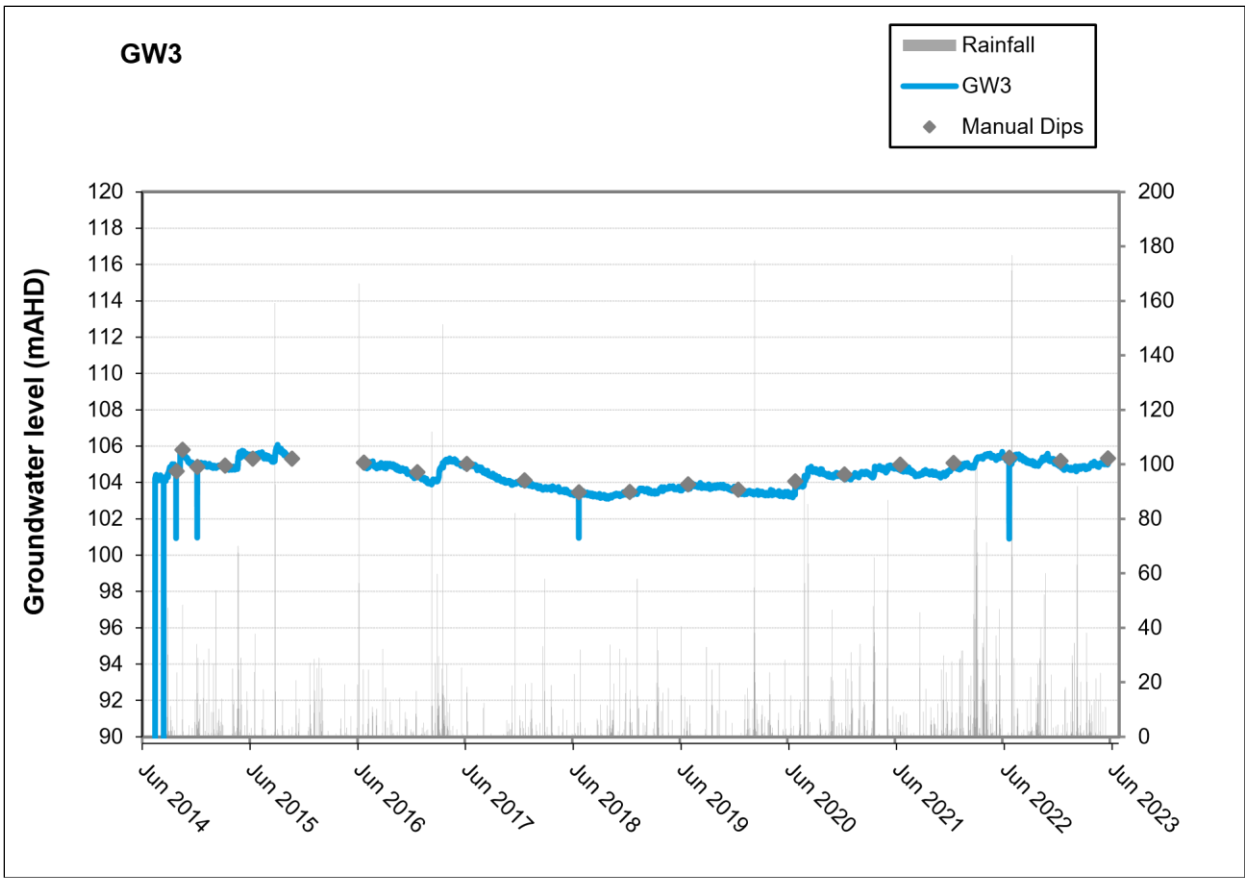
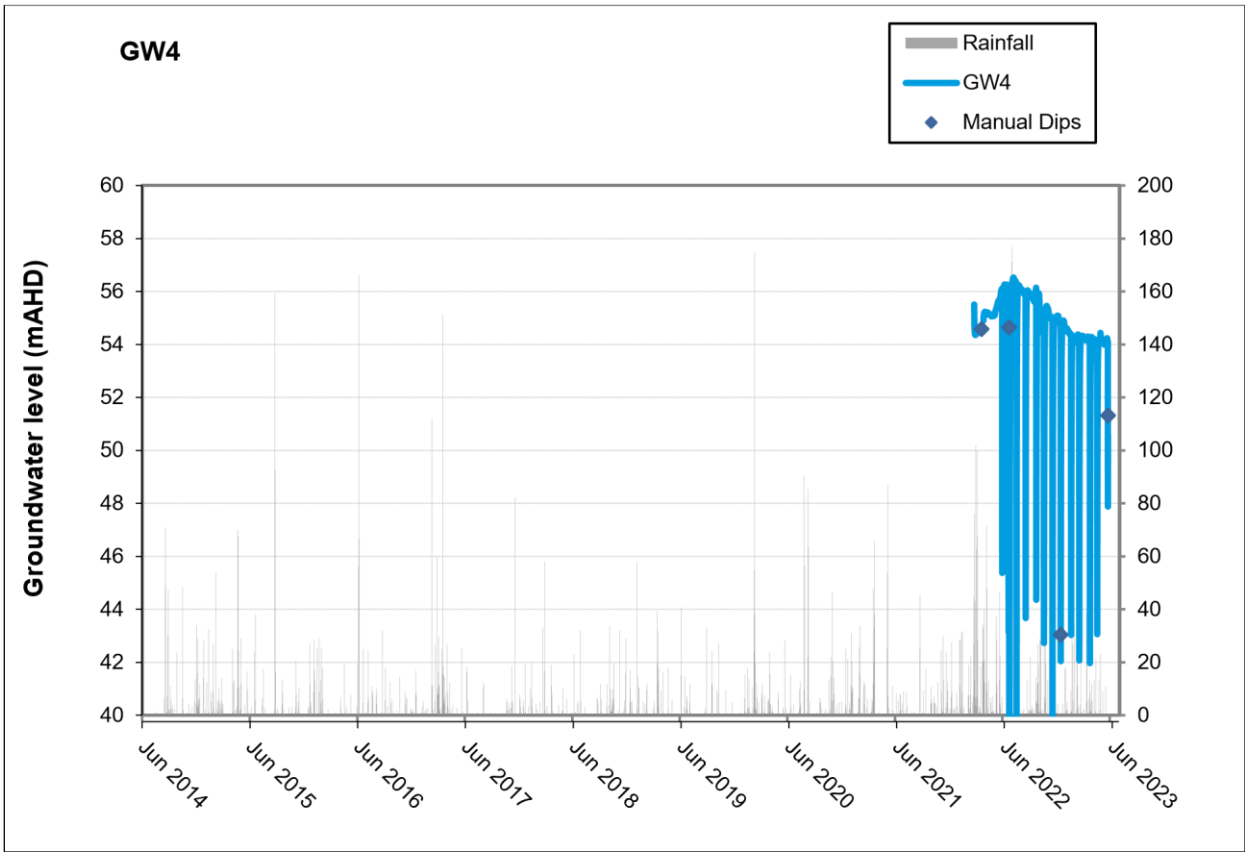
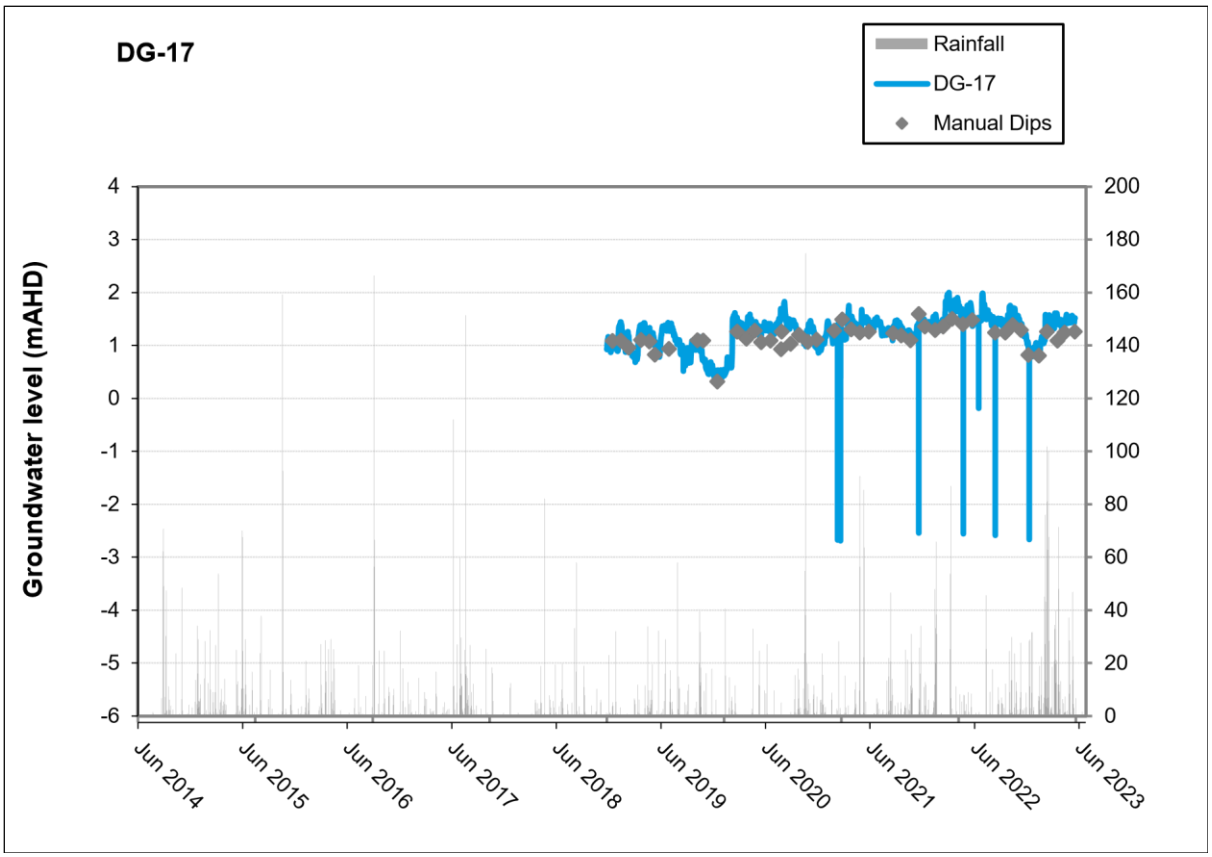
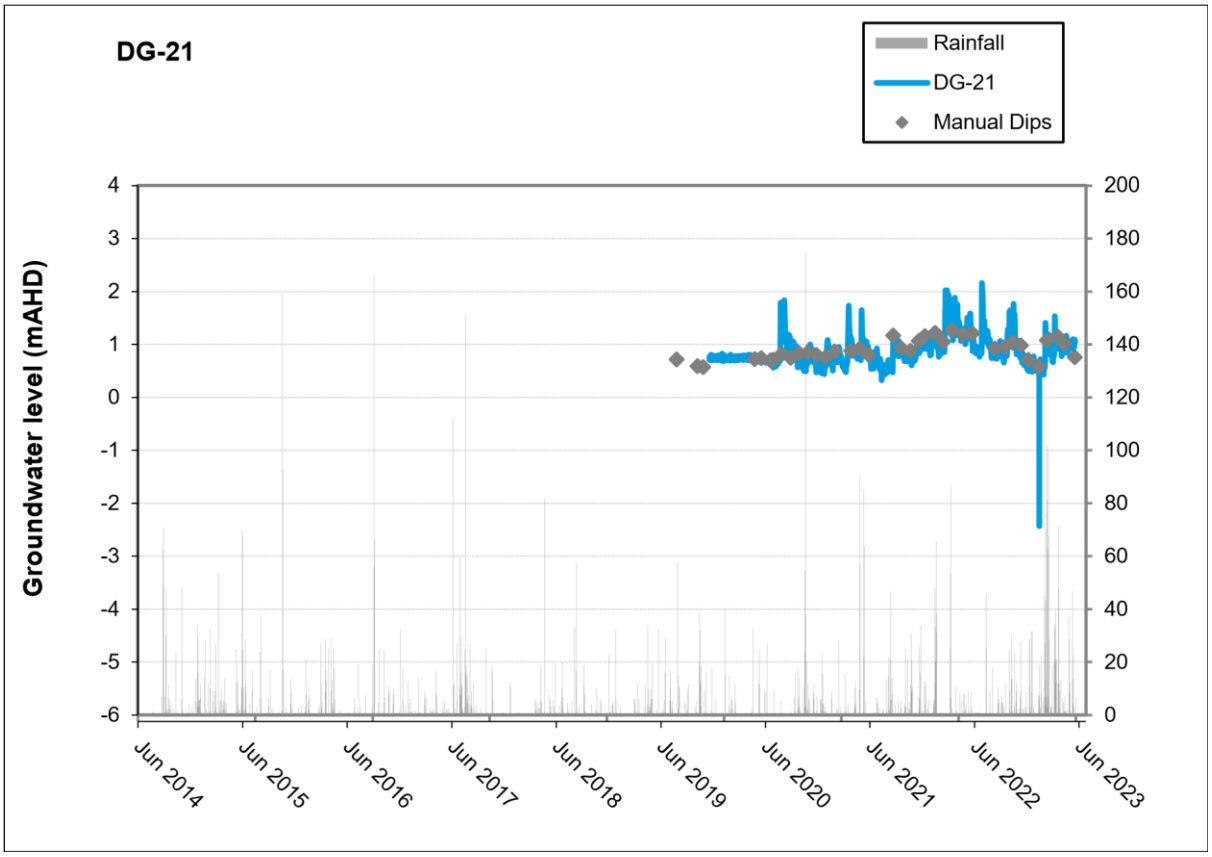

GW1
Rainfall
GW1
Manual Dips
Logger malfunction
Groundwater level (mAHD)
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
200
180
160
140
120
100
80
60
40
20
0
Jun 2014
Jun 2015
Jun 2016
Jun 2017
Jun 2018
Jun 2019
Jun 2020
Jun 2021
Jun 2022
Jun 2023

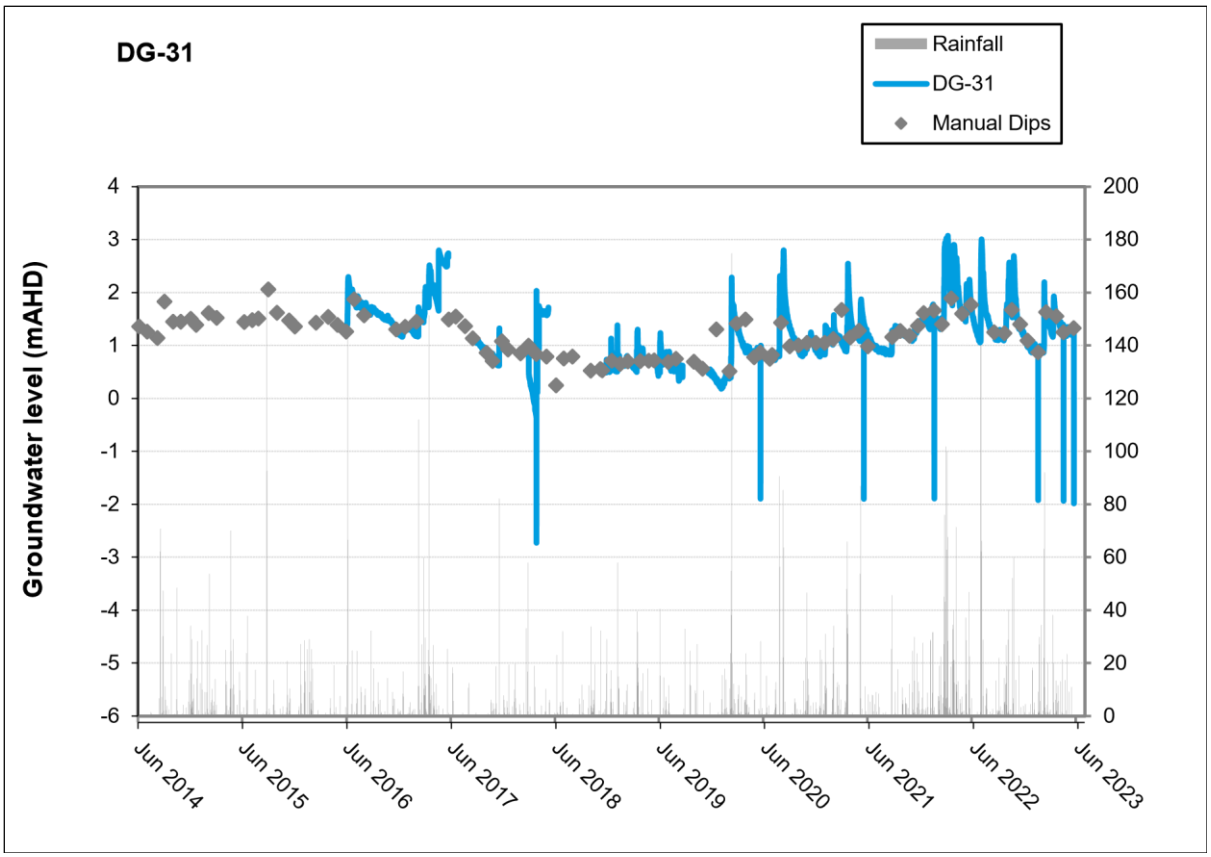

GW2
Rainfall
GW2
Manual Dips
Logger malfunction
Groundwater level (mAHD)
132
130
128
126
124
122
120
118
116
114
112
110
108
106
104
102
100
200
180
160
140
120
100
80
60
40
20
0
Jun 2014
Jun 2015
Jun 2016
Jun 2017
Jun 2018
Jun 2019
Jun 2020
Jun 2021
Jun 2022
Jun 2023


GW3
Rainfall
GW3
Manual Dips
Groundwater level (mAHD)
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
200
180
160
140
120
100
80
60
40
20
0
Jun 2014
Jun 2015
Jun 2016
Jun 2017
Jun 2018
Jun 2019
Jun 2020
Jun 2021
Jun 2022
Jun 2023


GW4
Rainfall
GW4
Manual Dips
Groundwater level (mAHD)
60
58
56
54
52
50
48
46
44
42
40
200
180
160
140
120
100
80
60
40
20
0
Jun 2014
Jun 2015
Jun 2016
Jun 2017
Jun 2018
Jun 2019
Jun 2020
Jun 2021
Jun 2022
Jun 2023


DG-17
Rainfall
DG-17
Manual Dips
Groundwater level (mAHD)
4
3
2
1
0
-1
-2
-3
-4
-5
-6
200
180
160
140
120
100
80
60
40
20
0
Jun 2014
Jun 2015
Jun 2016
Jun 2017
Jun 2018
Jun 2019
Jun 2020
Jun 2021
Jun 2022
Jun 2023


DG-21
Rainfall
DG-21
Manual Dips
Groundwater level (mAHD)
4
3
2
1
0
-1
-2
-3
-4
-5
-6
200
180
160
140
120
100
80
60
40
20
0
Jun 2014
Jun 2015
Jun 2016
Jun 2017
Jun 2018
Jun 2019
Jun 2020
Jun 2021
Jun 2022
Jun 2023


DG-31
Rainfall
DG-31
Manual Dips
Groundwater level (mAHD)
4
3
2
1
0
-1
-2
-3
-4
-5
-6
200
180
160
140
120
100
80
60
40
20
0
Jun 2014
Jun 2015
Jun 2016
Jun 2017
Jun 2018
Jun 2019
Jun 2020
Jun 2021
Jun 2022
Jun 2023

Appendix B
Water quality summary tables

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	Unit	EQL	GW1 15 Dec 2022	GW1 25 May 2023	GW2 15 Dec 2022	GW2 25 May 2023	GW3 15 Dec 2022	GW3 25 May 2023	GW4 15 Dec 2022	GW4 25 May 2023
Field ID / Date										
Analytical results – alkalinity										
Alkalinity (Bicarbonate as $CaCO_3$)	mg/L	1	402	402	338	387	238	227	279	232
Alkalinity (Carbonate as $CaCO_3$)	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (Hydroxide) as $CaCO_3$	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity (total) as $CaCO_3$	mg/L	1	402	402	338	387	238	227	279	232
Analytical results – nutrients										
Ammonia as N	mg/L	0.01	0.19	0.13	0.40	0.36	0.03	0.01	0.07	0.32
Nitrite + Nitrate as N	mg/L	0.01	<0.01	<0.01	0.04	<0.01	1.67	0.81	0.12	0.01
Kjeldahl Nitrogen Total	mg/L	0.1	0.3	0.3	0.6	0.6	0.3	0.5	0.2	0.5
Nitrite (as N)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate (as N)	mg/L	0.01	<0.01	<0.01	0.04	<0.01	1.67	0.81	0.12	0.01
Nitrogen (Total)	mg/L	0.1	0.3	0.3	0.6	0.6	2.0	1.3	0.3	0.5
Inorganics										
Calcium (filtered)	mg/L	1	96	90	61	66	56	55	93	72
Chloride	mg/L	1	156	127	117	113	66	61	202	172
Silicon as SiO2	mg/L	0.1	39.0	-	34.6	-	40.5	-	48.3	-
Silicon as SiO2 (filtered)	mg/L	0.1	-	37.6	-	33.1	-	43.0	-	51.6
Sodium (filtered)	mg/L	1	176	170	317	313	44	40	211	131
Magnesium (filtered)	mg/L	1	18	17	6	7	26	24	20	17
Potassium (filtered)	mg/L	1	1	1	2	2	<1	<1	2	2
Anions Total	meq/L	0.01	14.3	13.2	15.4	17.2	7.20	6.76	17.4	10.7
Ionic Balance	%	0.01	1.10	0.51	6.15	0.94	2.50	2.24	5.59	0.22
Cations Total	meq/L	0.01	14.0	13.3	17.4	17.5	6.85	6.46	15.5	10.7
Sulfate as SO_4 - Turbidimetric (filtered)	mg/L	1	88	75	255	302	28	24	292	58
Metals										
Aluminium (filtered)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic (filtered)	mg/L	0.001	0.001	<0.001	0.006	0.005	<0.001	<0.001	0.001	0.002

Cadmium (filtered)	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium (III+VI) (filtered)	mg/L	0.001	0.001	<0.001	0.002	0.002	<0.001	<0.001	<0.001	<0.001
Copper (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	0.006	0.007	<0.001	<0.001
Iron (filtered)	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.13	<0.05
Manganese (filtered)	mg/L	0.001	0.656	0.648	0.171	0.162	0.007	0.012	0.510	0.380
Nickel (filtered)	mg/L	0.001	<0.001	0.002	0.002	0.002	<0.001	0.001	0.003	0.001
Zinc (filtered)	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
NA										
Phosphate total (as P)	MG/L	0.01	0.09	0.10	0.24	0.23	0.07	0.06	0.24	0.27

Appendix C
Laboratory reports

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Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2245704**	Page	: 1 of 4
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: Quan Bui	Contact	: Cez Bautista
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: 02 9493 9582	Telephone	: +61-2-8784 8555
Project	:	Date Samples Received	: 16-Dec-2022 11:15
Order number	: ----	Date Analysis Commenced	: 17-Dec-2022
C-O-C number	: ----	Issue Date	: 28-Dec-2022 21:02
Sampler	: Quan Bui		
Site	: ----		
Quote number	: EN/112/21		
No. of samples received	: 4		
No. of samples analysed	: 4		

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ISO/IEC 17025 - Testing

J17314

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics, Smithfield, NSW

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J17314

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting ø
= ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Work Order :
Client : EMM CONSULTING PTY LTD
Project : J17314

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				*Sample ID*	**GW1**	**GW2**	**GW3**
				Sampling date / time	15-Dec-2022 00:00	15-Dec-2022 00:00	15-Dec-2022 00:00
Compound	*CAS Number*	*LOR*	*Unit*		**ES2245704-001**	**ES2245704-002**	**ES2245704-003**
					Result	Result	Result

Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**402**	**338**	**238**
Total Alkalinity as CaCO3	----	1	mg/L	**402**	**338**	**238**
Silicon as SiO2	14464-46-1	0.1	mg/L	**39.0**	**34.6**	**40.5**
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**88**	**255**	**28**
Chloride	16887-00-6	1	mg/L	**156**	**117**	**66**
Calcium	7440-70-2	1	mg/L	**96**	**61**	**56**
Magnesium	7439-95-4	1	mg/L	**18**	**6**	**26**
Sodium	7440-23-5	1	mg/L	**176**	**317**	**44**

Potassium	7440-09-7	1	mg/L	**1**	**2**	<1
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	**0.001**	**0.006**	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.000
Chromium	7440-47-3	0.001	mg/L	**0.001**	**0.002**	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	**0.006**
Manganese	7439-96-5	0.001	mg/L	**0.656**	**0.171**	**0.007**
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.002**	<0.001
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05

Ammonia as N	7664-41-7	0.01	mg/L	**0.19**	**0.40**	**0.03**
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	**0.04**	**1.67**
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	**0.04**	**1.67**

J17314

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				*Sample ID*	**GW1**	**GW2**	**GW3**
				Sampling date / time	15-Dec-2022 00:00	15-Dec-2022 00:00	15-Dec-2022 00:00
Compound	*CAS Number*	*LOR*	*Unit*		**ES2245704-001**	**ES2245704-002**	**ES2245704-003**
					Result	Result	Result
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.3**	**0.6**	**0.3**
^ Total Nitrogen as N	----	0.1	mg/L		**0.3**	**0.6**	**2.0**

Total Phosphorus as P	----	0.01	mg/L	**0.09**	**0.24**	**0.07**
ø Total Anions	----	0.01	meq/L	**14.3**	**15.4**	**7.20**
ø Total Cations	----	0.01	meq/L	**14.0**	**17.4**	**6.85**
ø Ionic Balance	----	0.01	%	**1.10**	**6.15**	**2.50**

CERTIFICATE OF ANALYSIS

Work Order	: **ES2317590**	Page	: 1 of 4
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: Quan Bui	Contact	: Customer Services ES
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: 02 9493 9582	Telephone	: +61-2-8784 8555
Project	:	Date Samples Received	: 25-May-2023 16:30
Order number	: J17314	Date Analysis Commenced	: 26-May-2023
C-O-C number	: ----	Issue Date	: 01-Jun-2023 17:41
Sampler	: Quan Bui		
Site	: ----		
Quote number	: EN/112/21		
No. of samples received	: 5		
No. of samples analysed	: 5		

Accreditation No. 825
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Dunmore

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- Analytical Results

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Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

right solutions. right partner.

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting ø
= ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	GW1	GW2	GW3
				Sampling date / time	25-May-2023 13:00	25-May-2023 11:30	25-May-2023 11:00
Compound	CAS Number	LOR	Unit		ES2317590-001	ES2317590-002	ES2317590-00
					Result	Result	Result
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**402**	**387**	**227**
Total Alkalinity as CaCO3	----	1	mg/L		**402**	**387**	**227**

Silicon as SiO2	14464-46-1	0.1	mg/L	**37.6**	**33.1**	**43.0**
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**75**	**302**	**24**
Chloride	16887-00-6	1	mg/L	**127**	**113**	**61**
Calcium	7440-70-2	1	mg/L	**90**	**66**	**55**
Magnesium	7439-95-4	1	mg/L	**17**	**7**	**24**
Sodium	7440-23-5	1	mg/L	**170**	**313**	**40**
Potassium	7440-09-7	1	mg/L	**1**	**2**	<1
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.005**	<0.00
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.000
Chromium	7440-47-3	0.001	mg/L	<0.001	**0.002**	<0.00
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	**0.007**
Manganese	7439-96-5	0.001	mg/L	**0.648**	**0.162**	**0.012**
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.002**	**0.001**
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.00
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05

Ammonia as N	7664-41-7	0.01	mg/L	**0.13**	**0.36**	**0.01**
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	**0.81**
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	**0.81**

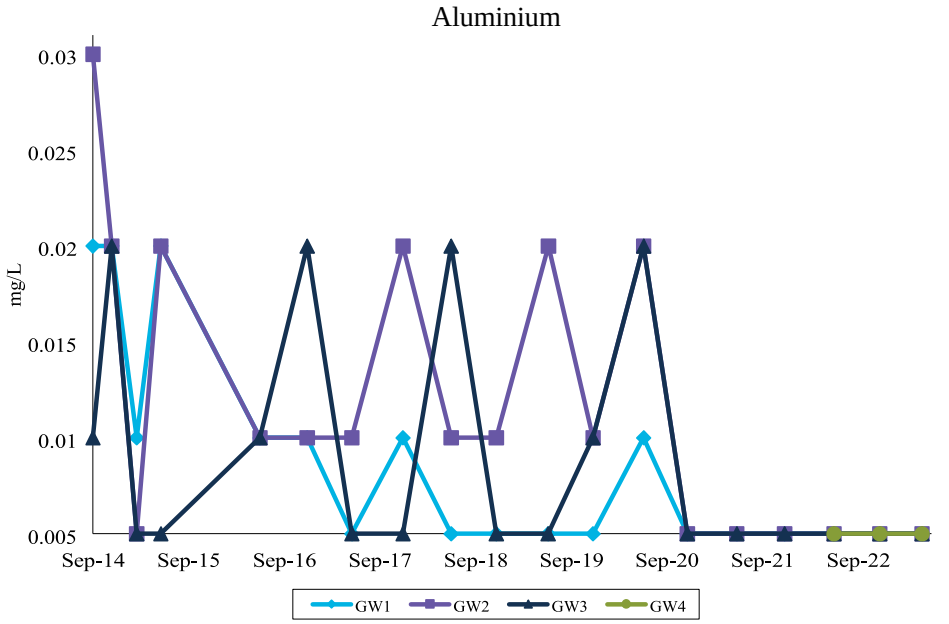
Analytical Results

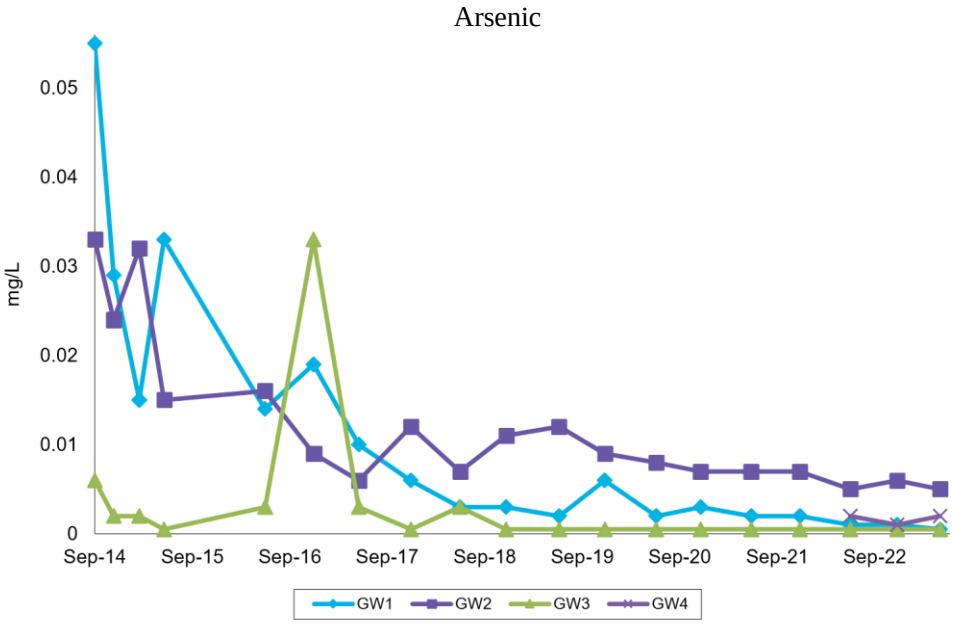
Sub-Matrix: **WATER** (Matrix: **WATER**)				Sample ID	GW1	GW2	GW3	
				Sampling date / time	25-May-2023 13:00	25-May-2023 11:30	25-May-2023 11:00	2
Compound	*CAS Number*	*LOR*	*Unit*		**ES2317590-001**	**ES2317590-002**	**ES2317590-003**	
					Result	Result	Result	
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.3**	**0.6**	**0.5**	
^ Total Nitrogen as N	----	0.1	mg/L		**0.3**	**0.6**	**1.3**	
Total Phosphorus as P	----	0.01	mg/L		**0.10**	**0.23**	**0.06**	
ø Total Anions	----	0.01	meq/L		**13.2**	**17.2**	**6.76**	
ø Total Cations	----	0.01	meq/L		**13.3**	**17.5**	**6.46**	
ø Ionic Balance	----	0.01	%		**0.51**	**0.94**	**2.24**	

Appendix D

Croome West sites metals timeseries charts

EMM
creating opportunities



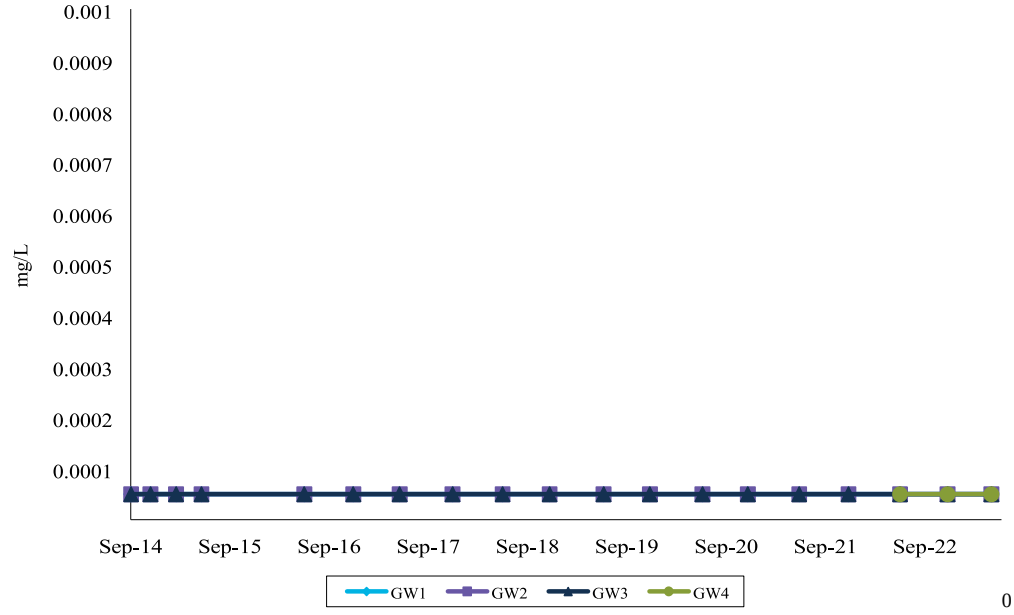


Note: Concentrations below the EQL are presented as half the EQL

Figure D.1

Annual Groundwater Report

Boral Dunmore



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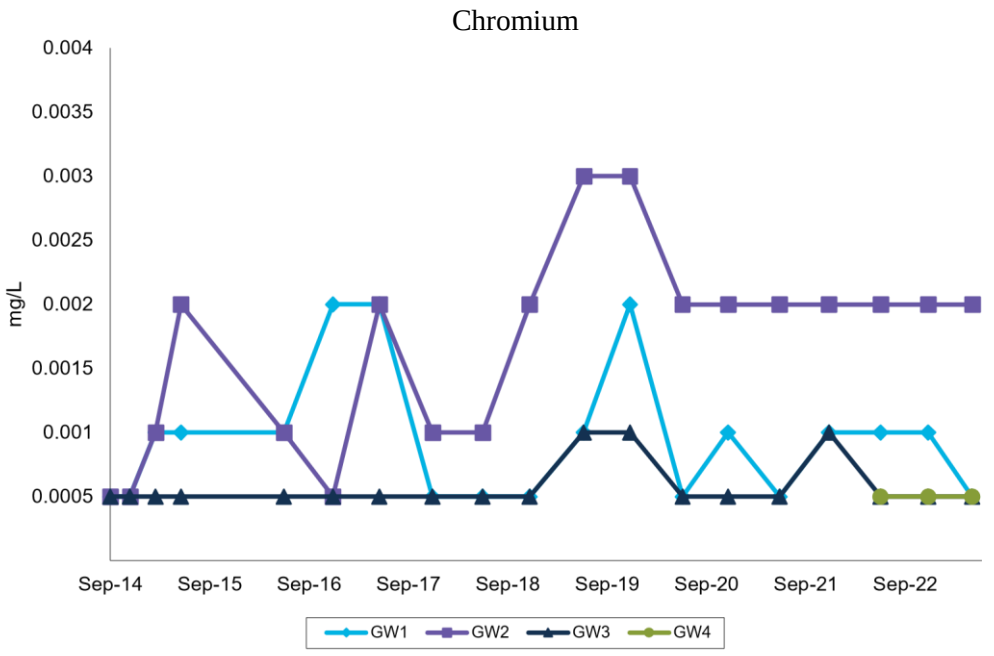

Note: Concentrations below the EQL are presented as half the EQL

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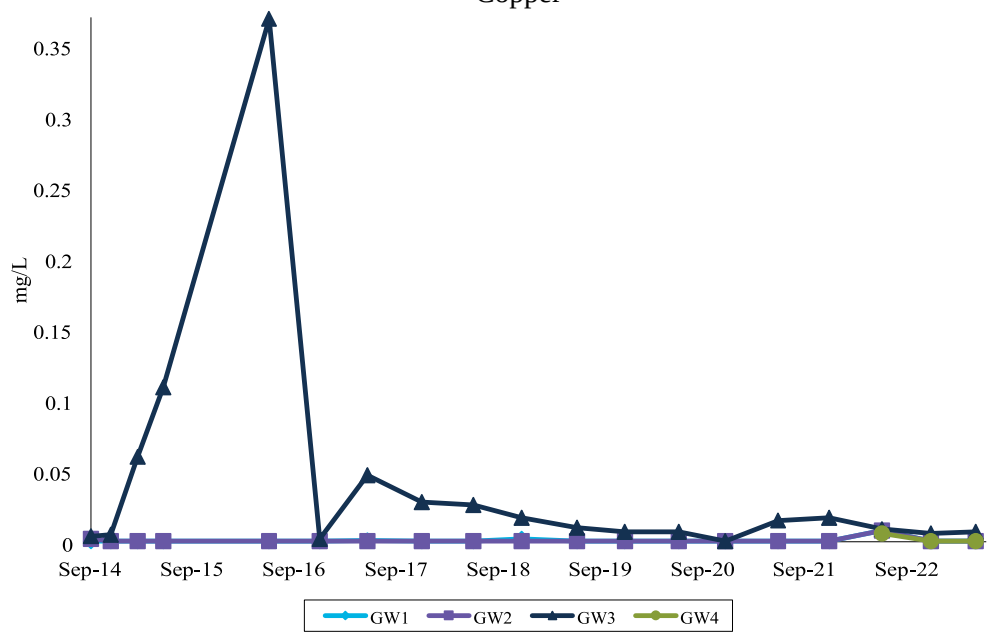
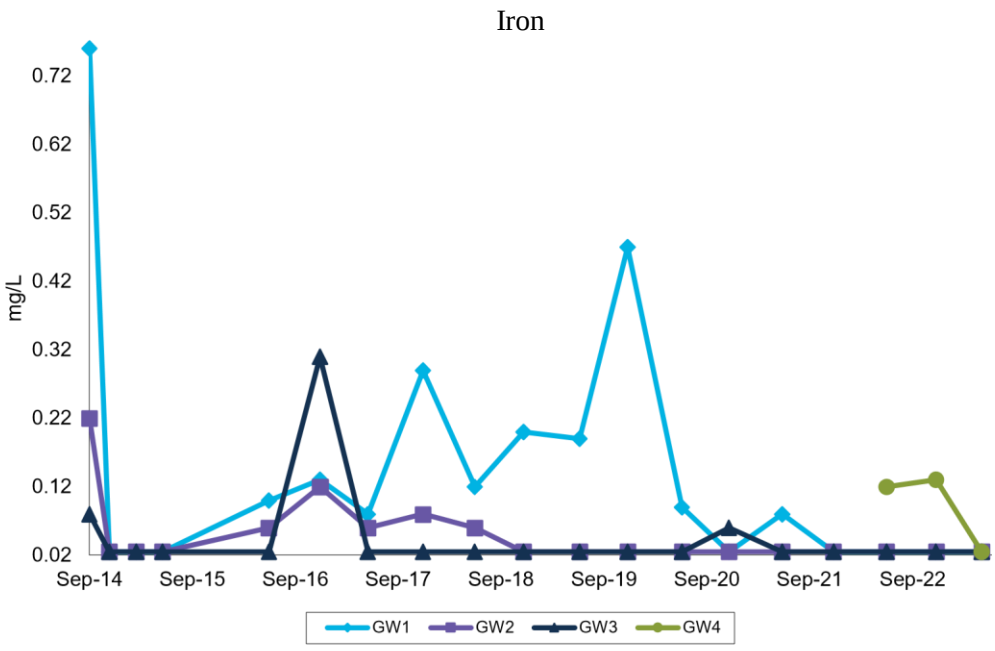
Figure D.2

Annual Groundwater Report Boral

Dunmore





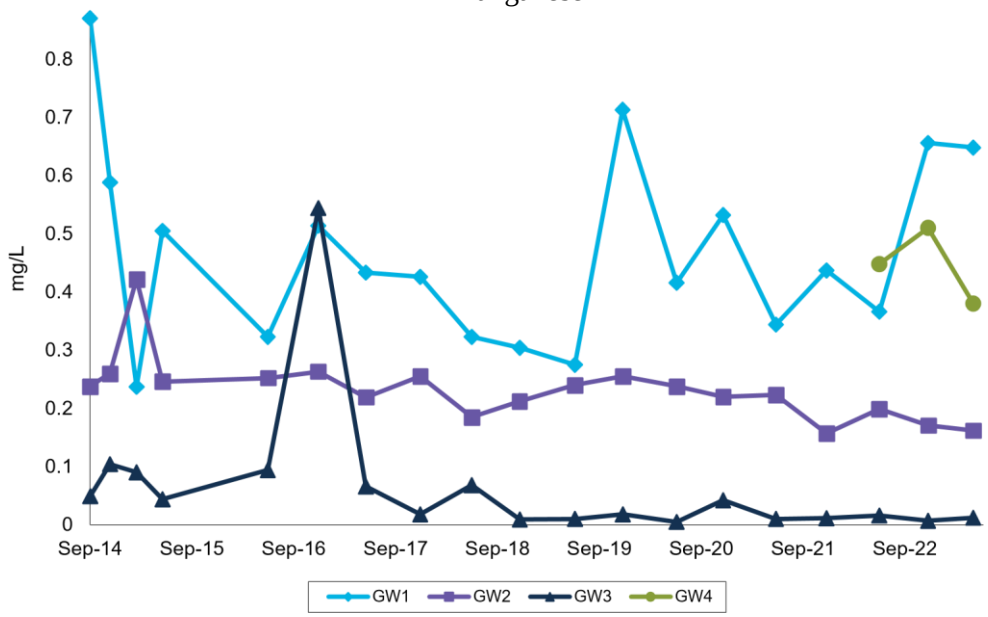
Note: Concentrations below the EQL are presented as half the EQL

Figure D.3

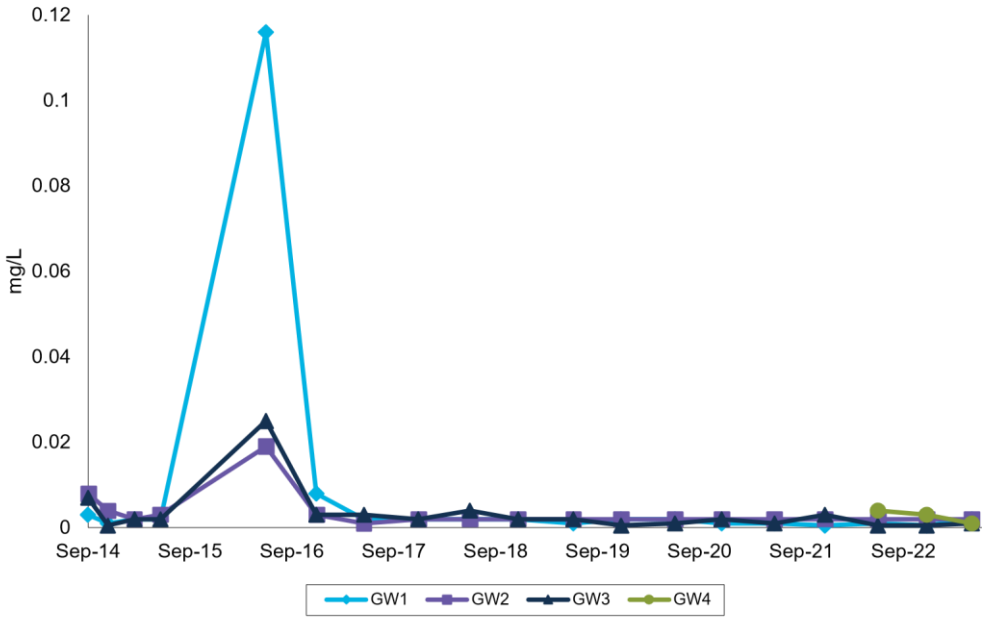
Annual Groundwater Report

Boral Dunmore

Manganese



Nickel

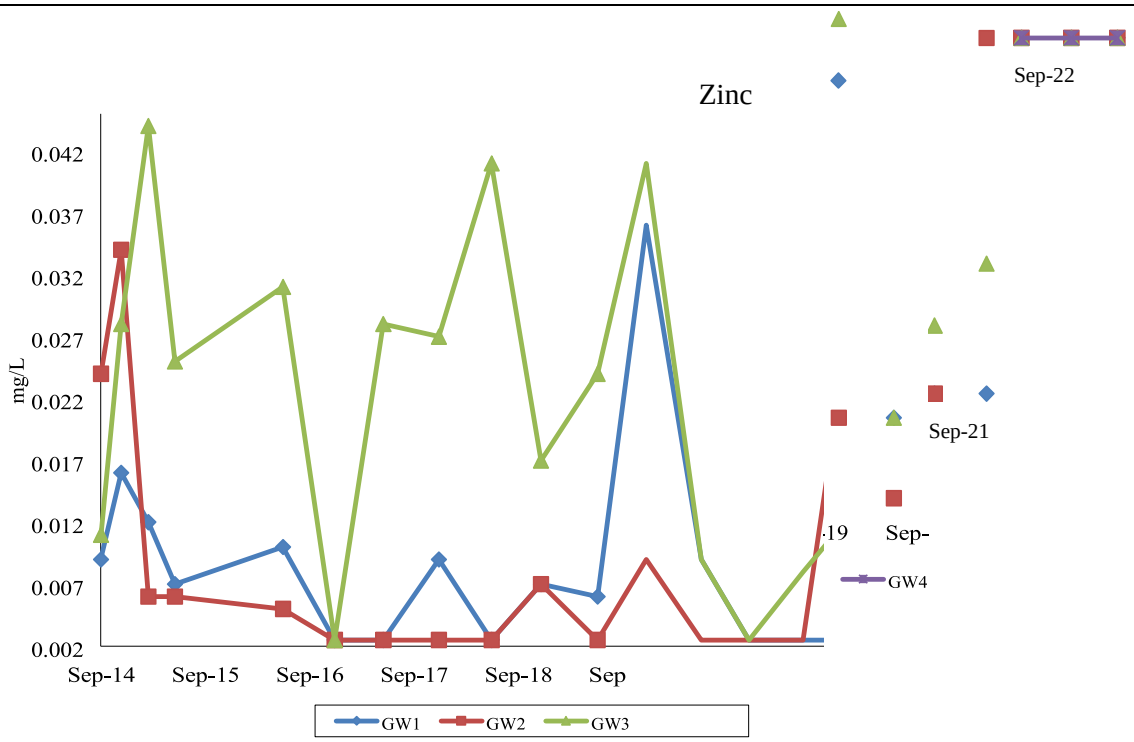


Note: Concentrations below the EQL are presented as half the EQL

Figure D.4

Annual Groundwater Report Boral

Dunmore



Note: Concentrations below the EQL are presented as half the EQL

	Figure D.5 Annual Groundwater Report Boral Dunmore 

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14. Appendix F Goodbush Bushland Restoration Annual Report

Good Bush Pty Ltd
Natural Area Restoration

BORAL METRO QUARRIES: ROCKLOW ROAD, DUNMORE

CONTRACT PERIOD: SEPTEMBER 2022 – AUGUST 2023

REPORT PREPARED BY: MARCUS BURGESS AND TANITA GORDON

DATE COMPLETED: 28th August 2023

Final Report for Bushland Restoration Works at Boral Dunmore Quarry, Rocklow Road, Dunmore

Table of Contents

Objectives 17
Vegetation Assessment Report Outcomes 17
Summary of Works for All Zones 18
Zone 1 Remnant Conservation Area 19
Zone 1 Remnant Vegetation Conservation Area Site Description 19
Summary of Works 20
Description of Works 21
Zone 2 Offset Area Works 21
Zone 2 Offset Area Site Description 21
Summary of Works 22
Work Areas Map 24
Vegetation Condition Assessment 25
Zone 2a: Melaleuca armillaris Tall Shrubland 25
Zone 2b: Illawarra Subtropical Rainforest 26
Zone 2c: Illawarra Grassy Woodland 27
Zone 2 Photographs 28
Zone 3 Compensatory Habitat Area 35
Zone 3 Compensatory Habitat Area Site Description 35
Summary of Works 36
Work Areas Map 39
Vegetation Condition Assessment 40
Zone 3 Photographs 44
Gorse Treatment 48
Appendix 1 Vegetation Monitoring Field Sheets 51
Photo Reference 67

Introduction

This final report is for bushland and riparian restoration works carried out by Good Bush Pty Ltd at Boral Metro Quarries, Rocklow Road, Dunmore from September 2022 to August 2023.

The works carried out at this site are based on the recommendations outlined in the 'Boral Dunmore Vegetation Assessment 29/04/2017'.

15. Objectives

The objective of these works was to undertake bushland restoration works in order to:

- Protect and enhance the remnants of the existing vegetation communities: Illawarra Dry Subtropical Rainforest, Illawarra Grassy Woodland and Melaleuca armillaris Tall Shrubland
- To reduce the area of Boral Dunmore Quarry natural areas impacted by WoNs and environmental invasive weeds
- Treat significant woody weeds throughout establishing 20-year-old revegetation areas to assist development and establishment
- To improve connectivity between local remnant bushland fragments through weed control activities and assisted regeneration
- Assist natural regeneration by removing significant weed species using bush regeneration techniques and methods
- Monitor works, progress and completing using visual based documentation

16. Vegetation Assessment Report Outcomes

The 'Boral Dunmore Vegetation Assessment 29/04/2017' identified three zones surrounding the hard rock quarry at Tabbitta Road and Rocklow Road, Dunmore as priority areas for restoration work. The three zones are as follows:

Zone 1 – Remnant Vegetation Conservation Area
Zone 2 – Offset Area
Zone 3 – Compensatory Habitat Area

17. Summary of Works for All Zones

A total of 804 hours have been carried out within the three zones during the period from September 2022 to August 2023. The following table is a summary of all hours carried out within the three work zones:

Site	Hours Worked
Zone 1 Remnant Vegetation Conservation Zone	0 hours

Zone 2 Offset Area	360 hours
Zone 3 Compensatory Habitat Area	364 hours
Gorse Treatment north of Rocklow Road	84 hours
Total	**808 hours**

Works this year focused on maintain previously worked areas and continuing primary weed control with the Zone 2 and Zone 3 work areas to protect and enhance natural vegetation within the bushland remnants. The following summaries demonstrate the success of these works:

Zone 1 Remnant Vegetation Conservation Zone: No works were carried out within this zone due to inaccessibility of the site during wet periods and cattle accessing the site where fencing is inadequate.

Zone 2 Offset Area: Works within this zone focused on regeneration of the endangered ecological communities (EEC's) Illawarra Grassy Woodland, Illawarra Subtropical Rainforest and Melaleuca armiallaris Tall Shrubland. Secondary weed control and maintenance works were carried out within this zone throughout all previously worked areas to treat re-growth from woody weeds and invasive vines.
Additional primary weed control was carried out at the eastern extent of this zone covering approximately 2,150m². Additional populations of the threatened species White Wax Flower (*Cynanchum elegans*) were observed at the eastern extent of the work area and bush regeneration works were carried out within this area to protect and enhance the populations of this threatened species.

Zone 3 Compensatory Habitat Area: Works within this zone focused on regeneration of the endangered ecological communities (EEC's) Illawarra Subtropical Rainforest and Melaleuca armiallaris Tall Shrubland. Secondary weed control and maintenance works were carried out within this zone throughout all previously worked areas to treat re-growth from woody weeds and invasive vines. Additional primary weed control was carried out within subtropical rainforest remnants around the populations of the threatened species Illawarra Socketwood (*Daphnandra johnsonii*) and Illawarra Zieria (*Zieria granulata*) with the Melaleuca armiallaris Tall Shrubland remnants covering approximately 2,150m². The latter readily regenerating within areas where weed control works were carried out.

18. Zone 1 Remnant Conservation Area

18.1. Zone 1 Remnant Vegetation Conservation Area Site Description

This site consists of a large gully with a south easterly aspect with a drainage line that forms part of the Rocklow Creek catchment. The total site area of this zone is approximately 15 hectares. The gully is framed by basalt cliffs on the northern and

western boundaries and large basalt boulders dominate the ground layer throughout much of this gully. The south eastern corner at the lower end of the gully has been cleared for pasture and grazing and a waterfall exists at the high end within the north western corner. Immediately west of the waterfall the Dunmore hard rock quarry dominates the landscape.

The basalt at this site erodes to a fine grained highly fertile soil that supports a diverse subtropical rainforest remnant that has remained largely intact despite the clearing of vegetation that was carried out here and within the surrounding areas in the mid 1800's.

The vegetation at this site consists of subtropical rainforest within the deep shaded and wet areas at the top of the gully and planted woodland at the lower end of the gully.

The subtropical rainforest within this zone consists of diverse rainforest remnant that has remained intact due to the rocky nature of the site, difficulty of removing timber species and low value of timber species present. A diverse range of canopy species exists within this gully including Sassafras *(Doryphora sassafras),* Myrtle Ebony *(Diospyros pentamera)* and all five of the local Fig *(Ficus sp.)* species. An abundance of vines exist within this remnant including Round Vine *(Legnephora moorei),* Kangaroo Grape *(Cissus antarctica)* and Milk Vine *(Marsdenia spp.)* and many species of ferns are present as epiphytes, lithophytes and within the ground layer.

Where gaps in the canopy occur, the gully has been invaded by woody weeds and a large percentage of the open areas on the slopes of the gully are dominated by Lantana.

The lower end of the gully has been revegetated within the last ten years using a range of local native tree species, some of which are not entirely relevant to this site. The revegetated areas are also subjected to grazing by cattle and woody weeds have colonised these areas.

18.2. Summary of Works

Works within this zone consisted of primary weed control targeting woody weeds throughout established approximately 20 year old revegetation. Large amounts of Wild Tobacco and Lantana were dominating the revegetation areas on the southern side of the creek while encroachment of Kikuyu was impacting the plantings on the northern side of the creek. A total of 25,000m² of primary weed control was carried out within this zone.

Infill planting was scheduled for this zone but the fencing has fallen into disrepair. Cattle have accessed this site on a number of occasions. The hardwood stakes installed to monitor the photo points were removed and lost and cow pats litter the floor throughout the worked areas.

The following hours worked and square metres covered were carried out within this site:

Date	Hrs	Weed Control	Primary (m²)

* No weed control activity undertaken within this zone due to wet weather restricting access and disruption due to cattle access within the work areas.

18.3. Description of Works

- No works were carried out within this area during this period due to the lack of fencing surrounding the site. Work will recommence within this area once the fencing has been repaired.
- Treatment of Gorse was carried out during July and August 2023 during the flowering period to break the seed cycle

19. Zone 2 Offset Area Works

19.1. Zone 2 Offset Area Site Description

This zone is located south of Rocklow Road and consists of a large bushland remnant with a creek line flowing through the middle. The total site area of this zone covers approximately 18.3 hectares. The majority of this zone is perched on the rocky hillside immediately adjacent to Rocklow Road and supports the 'Melaleuca armillaris tall shrubland' vegetation community. The creekline drops toward the eastern end of the site forming a gully which is well defined by the presence of the rainforest tree species and is identified as the 'Illawarra Subtropical Rainforest' vegetation community. The creek flows close to Rocklow Road at one point where dumping of rubbish and weed material has introduced several highly invasive weed species. Recent improvements to the fencing has been helpful in reducing the rubbish dumping within this area. On the southern side of the gully a tall intact canopy of Forest Red Gum (*Eucalyptus tereticornis*) exists that defines the 'Illawarra Grassy Woodland' vegetation community on site.

The Offset Area has been divided into three zones based on the three different vegetation communities found within this zone. Each of the three vegetation communities have had primary and secondary weed control works targeting woody weeds and invasive vines. The three zones with the Offset Area are as follows:

Zone 2a: Melaleuca armillaris Tall Shrubland
Zone 2b: Illawarra Subtropical Rainforest Zone 2c: Illawarra Grassy Woodland

19.2. Summary of Works

This contract period bush regeneration works focused on secondary and primary weed control within the woodland and rainforest remnants and the rainforest ecotone at the eastern extent of this zone. Regeneration of native canopy species within these areas this year has been rapid and a connected sub-canopy exists within the RF remnant.

Primary weed control was carried out at the eastern extent of this zone during this contract period. Additional populations of the threatened plant species White Wax Flower (*Cynanchum elegans*) were located within the ecotone between the rainforest and woodland remnants. Mass regeneration of Illawarra Zieria (*Zieria granulata*) has been observed within some areas and *Homalanthus stillingiifolius* has emerged within the site and is regenerating naturally and secondary populations of this regionally rare plant can be found throughout the site.

The following hours worked and square metres covered were carried out within the three zones at this site:

Date	Hrs	Weed Control	Primary and Secondary (m^2)

24/11/2022	56 hours	Working from the western extent of the Melaleuca Shrubland towards the rubble creekline connecting into the Lowlands Grassy Woodland extent of Zone 2. Hand removal and or cut and paint of woody weeds and annuals including but not limited to Lantana camara, Olea europaea subsp. cuspidata, Cirsium vulgare, Sida rhombifolia, etc. Hand reeling and rafting of areas of Delairea odorata, large populations of vines cleared to free up native regeneration, particularly Breynia oblongifolia, Enadia spp., Zieria seedlings and Melaleuca armillaris. Solanum maurtianum and Lantana camara removed from the western end of Z2 Lowlands Grassy Woodland. Area of Z2 - MS left to be treated (Cape Ivy) due to proximity to rotting Kangaroo found decapitated on site.	400m²
20/12/2022	52 hours	Continue and consolidate maintenance level sweep from 24/11. (Unable to work around decaying Kangaroo – still in state of decomposition) Continue east through this zone to areas previously treated for Primary level Lantana removal Hand reel and suspension of Cape Ivy. Continue sweep through to lowlands grassy woodlands area where primary level Lantana removal was conducted at the start of the year. Cut and paint Lantana, Tobacco and Olive regrowth.	350m²

23/03/2023	50 hours	Begin secondary sweep through previously worked areas of intensive Moth Vine removal and primary woody weed control. Regeneration of ground covers is successful (see photos attached to bottom of this document) including but not limited to: Oplismenus aemulus Microlaena stipoides Dichondra repens Commelina cyanea Pseuderanthemum variabile Carex spp. High regeneration of pioneer canopy species Hibiscus heterophyllus has popped up throughout this work zone, alongside Breynia, Sand Paper Fig, Maclura and Alectryon species that have doubled in size since last visit. Moth Vine and Cape Ivy regrowth was hand removed, bundled up and secured off ground to prevent vegetative growth. Lantana, Wild Tobacco and Paddy's Lucerne were treated via cut and paint, all woody weed materials were processed on site.	650m²

14/07/2023	56 hours	Sweep through rainforest area near the creek targeting woody weed re-growth from Lantana, Wild Tobacco, small amounts of African Olive hand remove ascending Moth Vine and Cape Ivy and raft materials to dry secondary weed control through the ecotone between the RF and Illawarra Lowlands Grassy Woodland remnant Extensive treatment of Lantana within the woodland remnant covering approximately 1,000m²	1,000m²
27/07/2023	55 hours	Begin maintenance sweep around Ficus targeting all previously worked areas. Cut and paint Wild Tobacco, Lantana, Ink Weed, Gooseberry and Cassia regrowth. Process all woody weed materials onsite. Begin primary weed control on the western edge, covering approx. 350m2 in between Melaleuca armillaris and rainforest gully.	350m²
1/08/2023	91 hours	Continuation of weed control targeting Moth Vine and Paddy's Lucerne as well as occasional woody weeds (Lantana, Wild Tobacco). Cut and paint treatment of woody weeds including Lantana, Wild Tobacco and Paddy's Lucerne. Hand removal of Moth Vine, African Olive, Cape Ivy and White Passionfruit. Propagative plant material was rafted off-ground.	320m²
TOTAL	**360 hours**		**3,070 m²**

19.3. Work Areas Map

The following map identifies the approximate areas worked within the three zones:

19.4. Vegetation Condition Assessment

The vegetation condition assessments are based on a 20m² area surrounding the established photo points within each zone.

19.5. Zone 2a: Melaleuca armillaris Tall Shrubland

Photo Point	**A1, A3**		
Commencement of works date	September 2021		
Monitoring Survey Date	24th August 2023		
Vegetation Condition		**Percentage Cover prior to works**	**Percentage Cover post works**
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of	100% native cover	100% native cover

Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by	80% native cover 20% weed cover	100% native cover 0% weed cover
Shrub layer	The shrub layer surrounding this photo point is dominated by	30% native cover 70% weed cover	100% native cover 0% weed cover
Ground Layer	The ground layer surrounding this photo point is dominated by native and weed grasses as well as a range of annual weeds and woody weed seedlings such as	40% native cover 60% weed cover	95% native cover 5% weed cover

* indicates exotic plant species

19.6. Zone 2b: Illawarra Subtropical Rainforest

Photo Point	**B1**		
Commencement of works date	September 2021		
Monitoring Survey Date	24th August 2023		
Vegetation Condition		**Percentage Cover prior to works**	**Percentage Cover post works**
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of rainforest species such as *Polysias elegans* Pittosporum undulatum Eucalyptus amplifolia	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by rainforest species such as	95% native cover 5% weed cover	100% native cover

Shrub layer	The shrub layer surrounding this photo point is dominated by small regenerating rainforest species and *Solanum mauritianum**	20% native cover 80% weed cover	100% native cover
Ground Layer	The ground layer surrounding this photo point is dominated by regenerating native rainforest trees and ferns as well as a range of annual weeds and invasive vines such as Bidens*, Cape Ivy*, Moth Vine*	40% native cover 60% weed cover	90% native cover 10% weed cover

* indicates exotic plant species

19.7. Zone 2c: Illawarra Grassy Woodland

Photo Point	**A2**		
Commencement of works date	September 2021		
Monitoring Survey Date	24th August 2023		
Vegetation Condition		**Percentage Cover prior to works**	**Percentage Cover post works**
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of *Melaleuca armillaris* *Eucalyptus tereticornis*	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by *Notolea venosa* *Dodonea viscose* *Acaica maidenii* *Olea europaea* subsp. *cuspidata**	80% native cover 20% weed cover	100% native cover 0% weed cover
Shrub layer	The shrub layer surrounding this photo point is dominated by *Lantana camara** *Indigofera australis*	30% native cover 70% weed cover	100% native cover 0% weed cover

Ground Layer	The ground layer surrounding this photo point is dominated by native and weed grasses as well as a range of annual weeds and woody weed seedlings such as *Lantana camara** *Bidens pilosa**	40% native cover 60% weed cover	80% native cover 20% weed cover

* indicates exotic plant species

19.8. Zone 2 Photographs

A1 Photo point prior to commencement of works in 2017

A1 Photo point after primary weed control and maintenance, August 2023

A3 Photo point prior to commencement of works in 2017

A3 Photo point showing regeneration of woodland species and Zieria granualata, August 2022

Mature Forest Red Gum (Eucalyptus tereticornis) surrounded by dense woody weeds such as Lantana prior to commencement of works in 2017

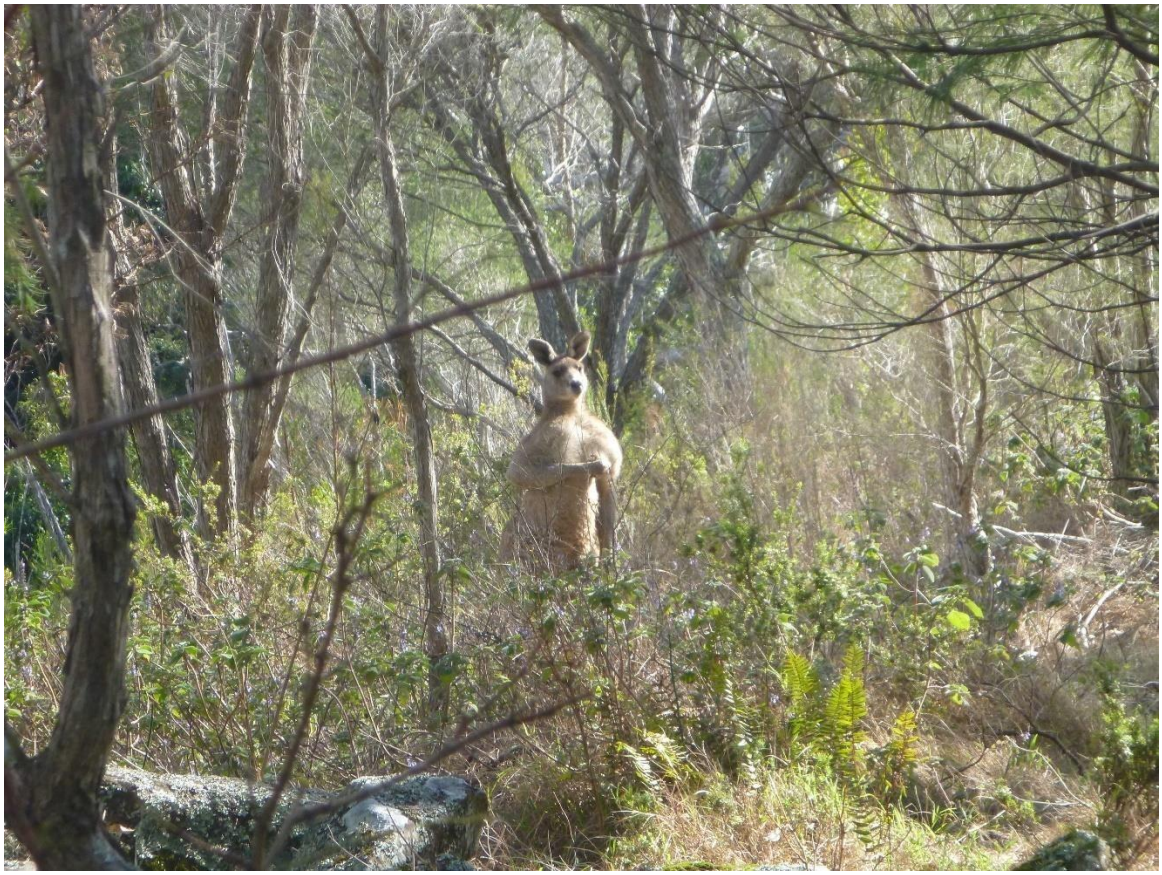
The same view post works demonstrating woodland regeneration after Lantana removal, August 2022

Primary weed control area within the rainforest and woodland ecotone The same view, August 2022

The same view showing native regeneration where Lantana has been removed August 2022

Regeneration of rainforest such as Giant Stinging Tree since Lantana removal was completed, August 2022

The same view August 2023



Big male Kangaroo within the Zone 2 woodland remnant

Native Passionfruit (*Passiflora herbertiana*) particularly abundant within these areas

20. Zone 3 Compensatory Habitat Area

20.1. Zone 3 Compensatory Habitat Area Site Description

This zone is located south of Rocklow Road and consists of a large bushland remnant on a hilltop with a small ephemeral creek line within a gully to the south of the hill. The total site area of this zone covers approximately 23.1 hectares. The majority of this zone is perched on the rocky hillside and supports the Melaleuca armillaris tall shrubland vegetation community. The gully drops at the southern end of the zone which is well defined by the presence of rainforest species and some very impressive land large Moreton Bay Fig (Ficus macrophylla) trees.

Extensive revegetation has been carried out within this zone within the southern gully and on the eastern and western edges of the zone. Hundreds of thousands of trees have been planted within this zone and are now reaching maturity. Many open areas that have been cleared of vegetation also exist within this zone with the majority of these clearings occurring on the rocky hill tops.

Works within this zone have focused on treating woody weeds within the establishing revegetation along the western boundary of the zone.

Vegetation community boundaries within the compensatory habitat zone are as follows:

20.2. Summary of Works

Works within this contract period focused heavily on primary weed control throughout established revegetation areas. Works commenced for the northern fence line that defines this zone and have continued south covering over 2ha. The western fence line defined the boundary of this work area and an old dry-stone wall that divides the revegetation areas from the natural bushland was defining the eastern boundary.

Work continued south focusing on primary weed control within the Melaleuca armillaris Tall Shrubland vegetation community and many individual plants of the threatened species Illawarra Zieria (*Zieria granulata*) were uncovered within this area.

Primary weed control works continued eastward from this point and a large subtropical rainforest remnant was reached that is dominated by several large and very old *Ficus macrophylla*.

The following hours worked and square metres covered were carried out within this site:

Date	Hrs	Weed Control	Primary (m^2)
9/11/2022	42 hours	Begin primary level weed control radiating from the eastern rock wall Cynachum elegans population, heading west. Intensive hand removal of ALL woody weeds (Lantana, Wild Tobacco, Paddy's Lucerne) and ascending vines (Moth Vine, Cape Ivy) ALL weedy vines were carefully identified around the Cynanchum population and hand removed (not skirted) and rafted to prevent vegetative growth and stop the seed cycle. Cover approx. 380m2 primary weed control. HIGH density of native recruitment including ground covers (Basket Grass, Dichondra) understorey shrubs (Einadia nutans) and rainforest tree species (Melicope, Melia, Myrcine, Streblis, Guioa, Alchornea, Dendrochnide exelsa, Alphitonia, Geijera, Ficus coronata to name a few!) were uncovered beneath and within the previously untreated field of Paddy's Lucerne. These trees were carefully isolated and staked out for future maintenance identification.	380m²
10/11/2022	35 hours	Continue intensive hand weed regime from previous day's work. Hand remove Moth Vine and Cape Ivy and raft to prevent vegetative growth. Cut and paint Lantana, Wild Tobacco and previously un treated Paddy's Lucerne. Uncover further amazing natural native recruitment. Stake for future monitoring. Complete approx. 450m 2 primary weed control which ended on the eastern creek bank.	450m²

7/12/2022	49 hours	Continue intensive primary removal of weeds (annuals, vines, grasses) throughout Zone 3 from where we left off last visit (eastern side of creek line) Continue approx. 15m long emu line across to the western side of the creek line.	360m²

		Cut and paint instream woody weeds (Lantana and Wild Tobacco) Hand remove Moth Vine and Cape Ivy, raft or suspend in tree forks to prevent vegetative growth. Cut and paint ALL Paddy's Lucerne within the front belt to stop them outcompeting with excellent native recruitment that has been stunted and shaded out by the woody weeds. Cut and paint Lantana, African Olive and Wild Tobacco on the western side of the creek, heading towards the western fence line where a woody weed buffer will be kept in situ to prevent cattle breaches into the compound. Cover approx.. 360m 2 woody weed control – the Moth Vine infestation on the western side of the creek was very thick and intermingled with juvenile native trees and vines. This will be expanded on next visit.	
8/12/2022	56 hours	Continue with previous day's intensive primary hand weed control. Native recruitment uncovered on the western side of the creek is excellent, including ground coverage of Oplismenus, Plectranthus, Commelina and Microlena. Native vines found amongst the Moth Vine infestation include: Pandorea and Tylophora. Native trees uncovered in the last two days include: Streblus, Melicope, Alectryon, Melia, Alphitonia, Pittosporum, Scolopia. Continue sweep west, hand removing Moth Vine and Cape Ivy, suspending to prevent further growth. Cut and paint woody weeds including Paddy's Lucerne, African Olive, Lantana and Wild Tobacco. Complete approx. 400m2 primary weed control, completing the front belt work area from the eastern rock wall to the western fence line.	400m²

18/08/2023	28 hours	Continuation of weed control targeting populations of Moth Vine (Araujia sericifera) and Paddy's Lucerne (Sida rhombifolia) amongst scattered woody weed regrowth which are affecting site regeneration. Cut and paint treatment of woody weeds including Lantana, Wild Tobacco and Paddy's Lucerne.Hand removal of Moth Vine (Araujia sericifera), woody weed seedlings (as above) and other weeds including African Olive, Purpletop, Cape Ivy and White Passionfruit. All propagative plant material rafted off-ground.	700m²
21/08/2023	35 hours	Continuation of weed control targeting Moth Vine and Paddy's Lucerne as well as occasional woody weeds (Lantana, Wild Tobacco).	
		Cut and paint treatment of woody weeds including Lantana, Wild Tobacco and Paddy's Lucerne. Hand removal of Moth Vine, African Olive, Cape Ivy and White Passionfruit. Propagative plant material was rafted off-ground.	
24/08/2023	56 hours	Secondary weed control within Melaleuca armiallaris Tall Shrubland community at the southern extent of the work site Sweep from Melaleuca armiallaris back toward the entry gate within established revegetation areas target weeding woody weeds such as Lantana and Wild Tobacco and ascending Moth Vine using the cut and paint method	
28/08/2023	63 hours	Sweep from Melaleuca armiallaris back toward the entry gate within established revegetation areas target weeding woody weeds such as Lantana and Wild Tobacco and ascending Moth Vine using the cut and paint method	560m²

TOTAL	**364 hours**		**2850 m²**

20.3. Work Areas Map

The following map identifies the approximate areas worked within this contract period:

20.4. Vegetation Condition Assessment

The vegetation condition assessments are based on a 20m² area surrounding the established photo points within each zone.

Photo Point	**3A**		
Commencement of works date	September 2021		
Monitoring Survey Date	24th August 2023		
Vegetation Condition		**Percentage Cover prior to works**	**Percentage Cover post works**
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of revegetation *Melaleuca armillaris* *Eucalyptus saligna* *Acacia maidenii*	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by *Hakea salicifolia* *Dodonaea viscosa* *Glochidion ferdinandi*	100% native cover 0% weed cover	100% native cover 0% weed cover
Shrub layer	The shrub layer surrounding this photo point is dominated by *Lantana camara** *Solanum mauritianum**	100% native cover 0% weed cover	0% native cover 0% weed cover
Ground Layer	The ground layer surrounding this photo point is dominated by native and weed grasses as well as a range of annual weeds and woody weed seedlings such as *Sida rhombifolia** *Bidens pilosa** *Sigesbeckia orientalis*	40% native cover 60% weed cover	80% native cover 20% weed cover

Photo Point	**3B**

Commencement of works date	September 2021		
Monitoring Survey Date	24th August 2023		
Vegetation Condition		**Percentage Cover prior to works**	**Percentage Cover post works**
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of revegetation *Melaleuca armillaris* *Eucalyptus saligna* *Acacia maidenii*	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by *Hakea salicifolia* *Dodonaea viscosa* *Glochidion ferdinandi*	100% native cover 0% weed cover	100% native cover 0% weed cover
Shrub layer	The shrub layer surrounding this photo point is dominated by *Lantana camara** *Solanum mauritianum**	100% native cover 0% weed cover	0% native cover 0% weed cover
Ground Layer	The ground layer surrounding this photo point is dominated by native and weed grasses as well as a range of annual weeds and woody weed seedlings such as *Sida rhombifolia** *Bidens pilosa** *Sigesbeckia orientalis*	40% native cover 60% weed cover	80% native cover 20% weed cover

Photo Point	**3C**
Commencement of works date	September 2021
Monitoring Survey Date	24th August 2023

Vegetation Condition		Percentage Cover prior to works	Percentage Cover post works
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of *Melaleuca armillaris* *Acacia maidenii*	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by *Clerodendrum tomentosum* *Maclura cochinensis Ehretia accuminata* *Solanum mauritianum**	80% native cover 20% weed cover	100% native cover 0% weed cover
Shrub layer	The shrub layer surrounding this photo point is dominated by *Lantana camara** *Zieria granulata* *Croton verreauxii*	70% native cover 30% weed cover	100% native cover 0% weed cover
Ground Layer	The ground layer surrounding this photo point is dominated by native and weed grasses as well as a range of annual weeds and woody weed seedlings such as *Lantana camara** *Bidens pilosa** *Pellaea falcata* *Ehrharta erecta* is present within this area and will not be treated as resources don't allow for this activity	60% native cover 30% weed cover	80% native cover 20% weed cover

Photo Point	**3D**
Commencement of works date	September 2021
Monitoring Survey Date	24th August 2023

Vegetation Condition	Percentage Cover prior to works	Percentage Cover post works

Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of *Ficus macrophylla*	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by *Elaeodendron australe* *Clerodendrum tomentosum* *Maclura cochinensis*	100% native cover 20% weed cover	100% native cover 0% weed cover
Shrub layer	The shrub layer surrounding this photo point is dominated by *Lantana camara** *Cestrum nocturnum* *Pittosporum multiflorum*	30% native cover 70% weed cover	100% native cover 0% weed cover
Ground Layer	The ground layer surrounding this photo point is dominated by native and weed grasses as well as a range of annual weeds and woody weed seedlings such as *Oplismenus imbecillis Bidens pilosa** *Solanum pseudocapsicuum**	40% native cover 60% weed cover	70% native cover 30% weed cover

20.5. Zone 3 Photographs

3B Photo point prior to commencement of works

The same view after intensive hand removal of weeds, August 2023

3B Photo point prior to commencement of works

The same view after intensive hand removal of weeds, August 2023

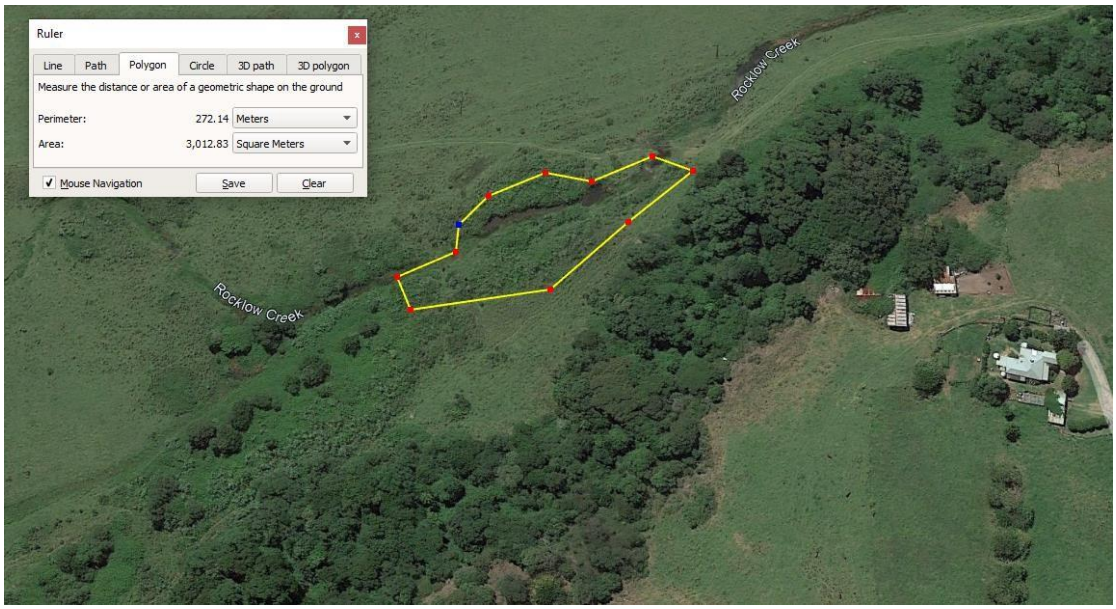
21. Gorse Treatment

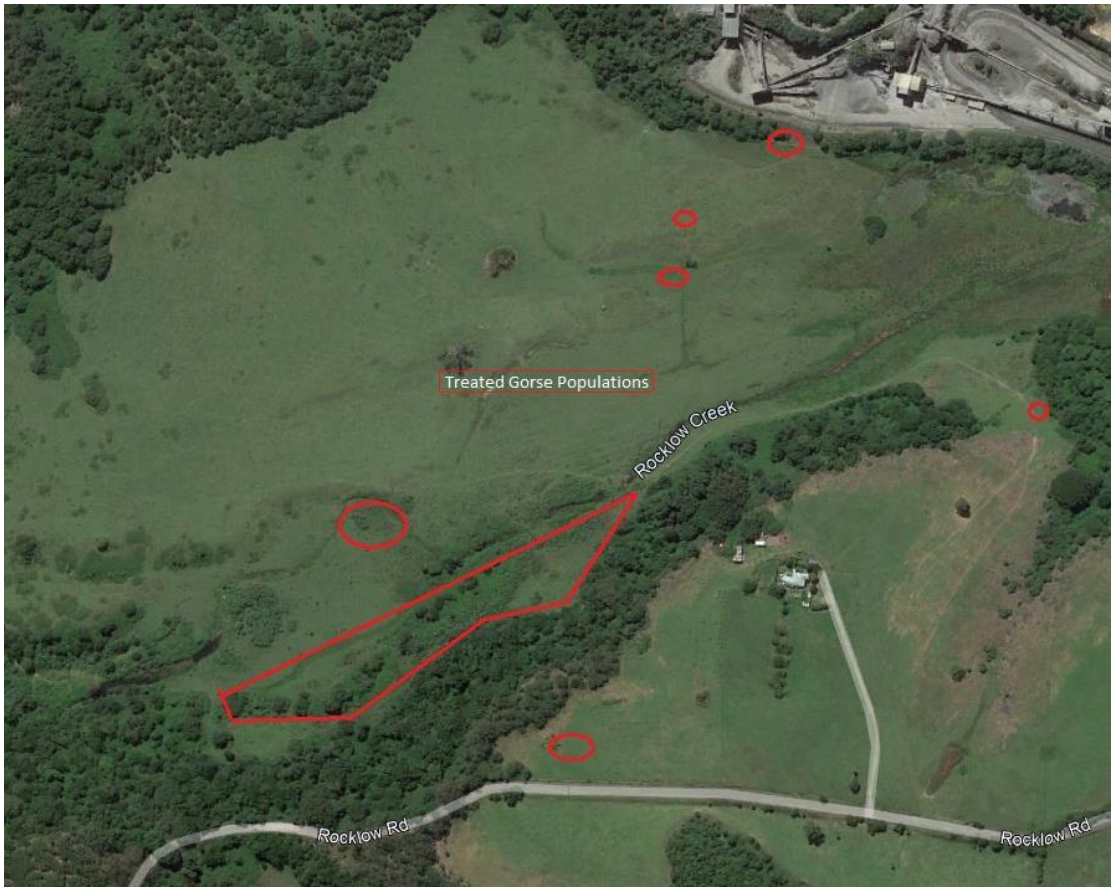
Treatment of the WoNS and NSW reportable weed species Gorse (*Ulex europaeus*) was carried out in July and August 2023. A total of 84 hours was used to treat Gorse within the paddock areas north of Rocklow Road.

These Gorse populations had been treated in previous years by Illawarra District Weeds Authority (IDWA) using spray controls. This treatment method while effective in the initial treatment allowed plants to regrow from the base after a period of four or five months showing the spraying method to be an ineffective treatment method.

All Gorse plants treated during these works used the cut and paint method to ensure success of the weed treatments. Materials were not processed or removed from site as there was no seed present during the treatment period. All Gorse plants treated at this time were in full flower which is the optimum time for treatment to break the seed cycle and ensure no additional seeds were borne this year. Follow work will be required over consecutive years to treat the flush of seed stored in the soil and it is anticipated after a period of approximately five years the Gorse plants should be effectively eradicated form this site.

Work area maps for Gorse treatment below:





Treatment of Gorse using the cut and paint method

Gorse infestation off Rocklow Road prior to treatment

Gorse infestation off Rocklow Road after treatment using the cut and paint method

22. Appendix 1

Vegetation Monitoring Field Sheets

Good Bush Monitoring Survey sheet		Site: Boral Zone 3 (west of creek)	
Date: 24/08/2023		Plot No: 3A Post Assessment	
Recorder: Marcus Burgess		Plot Size: 20 x 20m	
GPS Northing	616694	GPS Easting	0299814
GPS Accuracy	+-7m	GPS Elevation	69m
Vegetation Community: Established Revegetation with Rainforest Understorey			

NATIVE		
Botanical Name	Abundance	% Cover
Accacia maidenii	U	<5%
Acmena smithii	U	<5%
Breynia oblongifolia	C	5%
Carex longibrachiata	U	5%
Celastrus australis	U	<5%
Commelina cyanea	O	10%
Eucalyptus quadrangulata	U	<5%
Eucalyptus saligna	U	5%
Ficus coronata	U	5%
Geitonoplesium cymosum	O	5%
Glycine sp.	U	1%

Guoia semiglauca	U	<5%
Hakea salicifolia	U	5%
Hibbertia scandens	U	5%
Hibiscus heterophyllus	O	7%
Maclura cochinchinensis	U	5%
Melaleuca armilaris	U	5%
Notelaea venosa	O	10%
Oplismenus imbecillis	C	50%
Pandorea pandorana	O	10%
Pittosporum multiflorum	U	10%
Plectranthus parvifolus	U	5%
Sicyos australis	I	<1%
Sigesbeckia orientalis	O	5%
Toona ciliata	I	5%

Vegetation Condition:	Degraded revegetation, annual flush of woody and herbaceous weeds, vines.
Fauna Evidence:	Bandiccot digginds near the Daphnandra population, loads of Kangaroos
Significant Species:	N/A

Good Bush Monitoring Survey sheet		Site: Boral Zone 3 (west of creek)	
Date: 24/08/2023		Plot No: 3A Post Assessment	
Recorder: Marcus Burgess		Plot Size: 20 x 20m	
GPS Northing	616694	GPS Easting	0299814
GPS Accuracy	+-7m	GPS Elevation	69m
Vegetation Community: Established Revegetation with Rainforest Understorey			

NATIVE		
Botanical Name	Abundance	% Cover
Accacia maidenii	U	<5%
Acmena smithii	U	<5%
Aneilema acuminatum	O	<5%
Breynia oblongifolia	C	5%
Carex longibrachiata	U	5%

Celastrus australis	U	<5%
Commelina cyanea	O	10%
Eucalyptus quadrangulata	U	<5%
Eucalyptus saligna	U	5%
Ficus coronata	U	5%
Geitonoplesium cymosum	O	5%
Glycine sp.	U	1%
Guoia semiglauca	U	<5%
Hakea salicifolia	U	5%
Hibbertia scandens	U	5%
Hibiscus heterophyllus	O	7%
Maclura cochinchinensis	U	5%
Melaleuca armilaris	U	5%
Melicope micrococca	I	1%

Vegetation Condition:	Degraded revegetation, annual flush of woody and herbaceous weeds, vines.
Fauna Evidence:	Cows have now been excluded to this site after fencing repairs were carried out
Significant Species:	N/A

Good Bush Monitoring Survey sheet		Site: Boral Zone 3 (east of creek)	
Date: 24/08/2023		Plot No: 3B Post Condition Assessment	
Recorder: Marcus Burgess		Plot Size: 20 x 20m	
GPS Northing	6166983	GPS Easting	
GPS Accuracy	+-7m	GPS Elevation	
Vegetation Community: Established Revegetation with Rainforest Understorey			

NATIVE		
Botanical Name	Abundance	% Cover
Accacia maidenii	U	<5%
Acmena smithii	U	<5%
Breynia oblongifolia	U	<5%
Carex longibrachiata	U	5%
Cayratia clematidea	U	<5%
Geijera salicifolia	U	1%
Dodonea viscosa	U	<5%
Elaeodendron australe	U	5%
Eucalyptus saligna	U	<5%
Ficus coronata	U	<5%
Geitonoplesium cymosum	O	5%
Geranium homeanum	U	<5%

Glochidion ferdinandii	U	<5%
Glycine sp.	U	<1%
Guoia semiglauca	U	<5%
Hakea salicifolia	U	<5%
Hibbertia scandens	U	<5%
Hibiscus heterophyllus	O	7%
Maclura cochinchinensis	U	<5%
Melaleuca armillaris	U	<5%
Melaleuca decora	U	<5%
Myrsine variabilis	U	5%
Oplismenus imbecillis	C	10%
Pandorea pandorana	O	10%
Passiflora herbertiana	U	1%
Pittosporum multiflorum	U	10%
Pittosporum revolutum	U	1%
Planchonella australis	U	1%
Plectranthus parvifolus	U	5%
Streblus brunonianus	U	<5%
Toona ciliata	U	<5%

Vegetation Condition:	15 year old established revegetation, major wind damage
Fauna Evidence:	No more cattle damage
Significant Species:	N/A

Good Bush Monitoring Survey sheet	Site: Boral Zone 3 (east of creek)
Date: 24/08/2023	Plot No: 3B Post Condition Assessment

Recorder: Marcus Burgess		Plot Size: 20 x 20m	
GPS Northing	6166983	GPS Easting	
GPS Accuracy	+-7m	GPS Elevation	
Vegetation Community: Established Revegetation with Rainforest Understorey			

NATIVE		
Botanical Name	Abundance	% Cover
Accacia maidenii	U	<5%
Acmena smithii	U	<5%
Breynia oblongifolia	U	<5%
Carex longibrachiata	U	5%
Cayratia clematidea	U	<5%
Geijera salicifolia	U	1%
Dodonea viscosa	U	<5%
Elaeodendron australe	U	5%
Eucalyptus saligna	U	<5%
Ficus coronata	U	<5%
Geitonoplesium cymosum	O	5%
Geranium homeanum	U	<5%
Glochidion ferdinandii	U	<5%
Glycine sp.	U	<1%
Guoia semiglauca	U	<5%
Hakea salicifolia	U	<5%

Hibbertia scandens	U	<5%
Hibiscus heterophyllus	O	7%
Maclura cochinchinensis	U	<5%
Melaleuca armillaris	U	<5%
Melaleuca decora	U	<5%
Myrsine variabilis	U	5%
Myrsine howittianna	U	<5%

Vegetation Condition:	20-year-old established revegetation, flush of herbaceous annuals weeds
Fauna Evidence:	Deer or goat tracks present within creek line
Significant Species:	N/A

Good Bush Monitoring Survey sheet		Site: Zone 3 Mel armillaris Shrubland	
Date: 24/08/2023		Plot No: 3C Post Assessment	
Recorder: Marcus Burgess		Plot Size: 20 x 20m	
GPS Northing	6166725	GPS Easting	0299
GPS Accuracy	+-8m	GPS Elevation	87m
Vegetation Community: Ecotone Rainforest and Melaleuca armillaris Tall Shrubland			

NATIVE			
Botanical Name	Abundance	% Cover	Botanical Name
Accacia maidenii	U	7 %	*Delairea odorata*
Alphitonia excelsa	U	<5 %	*Erharta erecta*
Aneilema biflorum	U	<5 %	*Modiola caroliniana*
Asplenium flabellifoium	C	<5 %	*Sida rhombifolia*
Breynia oblongifloia	C	<5 %	*Sola*
Carex appressa	U	2 %	*Senecio madagascariensis*
Cheilanthes tenuifolia	U	<5 %	*Oxalis sp.*
Clerodendrum tomentosum	O	<5 %	*Stellaria media*
Commelina cyanea	O	10 %	*Lantana camara*
Croton verreauxii	U	<5 %	
Cryptocarya microneura	I	1 %	
Dichondra repens	U	<5 %	
Ehretia acuminata	U	<5 %	
Einadia hastata	U	<5 %	

Eustrephus latifolius	I	1 %	
Gahnia aspera	I	<5 %	
Geitonoplesium cymosum	O	<5 %	
Guoia semiglauca	U	<5 %	
Gymnostachys anceps	I	1 %	
Hibiscus heterophyllus	U	<5 %	
Maclura cochinchinensis	U	5 %	
Melaleuca armillaris	O	7 %	
Notelaea venosa	U	<5 %	
Oplismenus imbecillis	C	<5 %	
Oplismenus imbecillis	C	10 %	
Pandorea pandorana	U	5 %	
Parsonsia straminea	O	<5 %	
Pellaea falcata	C	<5 %	
Phyllanthus gunnii	U	<5 %	
Pittosporum multiflorum	C	<5 %	
Planchonella australis	I	<5 %	
Plectranthus graveolens	O	10 %	
Poa labillardierei	C	5 %	
Pseudoranthemum var.	C	<5 %	
Sarcopetalum harveyanum	I	1 %	
Streblus brunonianus	O	5 %	
Trophis scandens	U	<5 %	
Xerochrysum bracteatum	I	1 %	
Zieria granulata	U	5 %	

Vegetation Condition:	Disturbed regenerating eco-tone (Rainforest to M. armillaris Woodland)

Fauna Evidence:	
Significant Species:	*Zieria granulata*

Good Bush Monitoring Survey sheet		Site: Zone 3 Mel armillaris Shrubland	
Date: 24/08/2023		Plot No: 3C Post Assessment	
Recorder: Marcus Burgess		Plot Size: 20 x 20m	
GPS Northing	6166725	GPS Easting	0299
GPS Accuracy	+-8m	GPS Elevation	87m
Vegetation Community: Ecotone Rainforest and Melaleuca armillaris Tall Shrubland			

NATIVE

Botanical Name	Abundance	% Cover	Botanical Name
Accacia maidenii	U	7%	*Delairea odo*
Alphitonia excelsa	U	<5%	*Erharta erec*
Aneilema biflorum	U	<5%	*Modiola car*
Asplenium flabellifoium	C	<5%	*Sida rhombif*
Breynia oblongifloia	C	<5%	
Carex appressa	U	2%	*Senecio ma*
Cheilanthes tenuifolia	U	<5%	*Oxalis sp.*
Clerodendrum tomentosum	O	<5%	*Stellaria me*
Commelina cyanea	O	10%	

Croton verreauxii	U	<5%	**Natives conti**
Cryptocarya microneura	I	1%	*Pandorea pan*
Dichondra repens	U	<5%	*Parsonsia stra*
Ehretia acuminata	U	<5%	*Pellaea falcat*
Einadia hastata	U	<5%	*Phyllanthus g*
Eustrephus latifolius	I	1%	*Pittosporum r*
Gahnia aspera	I	<5%	*Planchonella*
Geitonoplesium cymosum	O	<5%	*Plectranthus g*
Glycine sp.	U	<5%	*Plectranthus*
Guoia semiglauca	U	<5%	*Poa labillardie*
Gymnostachys anceps	I	1%	*Pseudoranthem*
Hibiscus heterophyllus	U	<5%	*Sarcopetalum h*
Maclura cochinchinensis	U	5%	*Streblus brunon*
Melaleuca armillaris	O	7%	*Trophis scande*
Notelaea venosa	U	<5%	*Xerochrysum br*
Oplismenus imbecillis	C	<5%	*Zieria granulata*
Oplismenus imbecillis	C	10%	

Vegetation Condition:	Disturbed regenerating eco-tone (Rainforest to M. armillaris Woodland) regeneration of native herbs and woody weeds, maintenance required
Fauna Evidence:	Many Kangaroos, large transient flock of Topknot Pigeons
Significant Species:	*Zieria granulata*

Good Bush Monitoring Survey sheet		Site: Zone 3 Subtropical RF Big Fig Area	
Date: 24/08/2023		Plot No: 3D Post Assessment	
Recorder: Marcus Burgess		Plot Size: 20 x 20m	
GPS Northing	6166719	GPS Easting	0300124
GPS Accuracy	+- 10m	GPS Elevation	55m
Vegetation Community: Remnant Subtropical Rainforest			

NATIVE			
Botanical Name	Abundance	% Cover	Botanical Name
Alchornea ilicifolia	C	20%	*Lantana cama*
Ficus macrophylla	O	90%	*Cestrum parq*
Pittosporum multiflorum	C	5%	*Solanum maru*
Maclura cochinchinensis	C	5%	*Delairea odor*
Alectryon subcinereus	O	<5%	*Passiflora sub*
Claoxylon australe	O	5%	*Araujia sericif*
Notelaea venosa	O	5%	*Bidens pilosa*
Breynea oblongifolia	O	5%	
Diploglottis australis	C	15%	*Ehrharta erec*
Brachychyton acerifolia	O	<5%	*Phytolaca oct*
Streblus brunonianus	C	10%	
Clerodendrum tomentosum	O	<5%	
Elaeodendron austral	O	5%	

Melicytus dentatus	O	<5%	
Geitonoplesium cymosum	C	<5%	
Eustrephus latifloius	C	<5%	
Pandorea pandorana	C	<5%	
Parsonsia straminea	C	<5%	
Nyssanthes erecta	C	<5%	
Wilkea huegliana	O	<5%	
Gymnostachys anceps	I	1%	
Oplismenus imbecillis	C	<5%	
Pseudoranthemum var.	C	<5%	
Pallea falcata	C	<5%	
Asplenium flabelifolium	C	<5%	
Parietarea debelis	O	<5%	
Croton verreauxii	O	5%	
Trophis scandens	C	<5%	
Aneilema biflorum	C	<5%	
Plectranthus parviflorus	C	<5%	
Aphanopetalum resinosum	C	<5%	
Sigesbeckia orientalis	C	<5%	
Sarcomelicope simplicifolia	U	<5%	
Morinda jasminoides	C	<5%	
Cayratia clematidea	O	<5%	
Melia azedarach	U	<5%	
Urtica incisa	O	<5%	
Phylanthus gunnii	O	<5%	
Actephila lindleyi	U	<5%	
Dendrocnide excelsa	U	<5%	

Vegetation Condition:	Heavily degraded, good regeneration
Fauna Evidence:	Kangaroos
Significant Species:	*Actephila lindleyi*

Good Bush Monitoring Survey sheet		Site: Zone 3 Subtropical RF Big Fig Area	
Date: 24/08/2023		Plot No: 3D Post Assessment	
Recorder: Marcus Burgess		Plot Size: 20 x 20m	
GPS Northing	6166719	GPS Easting	030012
GPS Accuracy	+- 10m	GPS Elevation	55m
Vegetation Community: Remnant Su ɔtropical Rainforest			

NATIVE			
Botanical Name	Abundance	% Cover	Botanical Name
Alchornea ilicifolia	C	20%	*Lantana cama*
Ficus macrophylla	O	90%	*Cestrum parq*
Pittosporum multiflorum	C	5%	*Solanum maru*
Maclura cochinchinensis	C	5%	*Delairea odor*
Alectryon subcinereus	O	<5%	*Passiflora sub*
Claoxylon australe	O	5%	*Araujia sericif*
Notelaea venosa	O	5%	

Breynea oblongifolia	O	5%	*Ehrharta erec*
Diploglottis australis	C	15%	
Brachychyton acerifolia	O	<5%	
Streblus brunonianus	C	10%	
Clerodendrum tomentosum	O	<5%	**Natives Contin**
Elaeodendron austral	O	5%	*Croton verreau*
Melicytus dentatus	O	<5%	*Trophis scande*
Geitonoplesium cymosum	C	<5%	*Aneilema biflor*
Eustrephus latifloius	C	<5%	*Plectranthus p*
Pandorea pandorana	C	<5%	*Aphanopetalun*
Parsonsia straminea	C	<5%	*Sigesbeckia ori*
Nyssanthes erecta	C	<5%	*Sarcomelicope*
Wilkea huegliana	O	<5%	*Morinda jasmi*
Gymnostachys anceps	I	1%	*Cayratia clemati*
Oplismenus imbecillis	C	<5%	*Melia azedarach*
Pseudoranthemum var.	C	<5%	*Urtica incisa*
Pallea falcata	C	<5%	*Phylanthus gunn*
Asplenium flabelifolium	C	<5%	*Actephila lindley*
Parietarea debelis	O	<5%	*Dendrocnide exc*

Vegetation Condition:	Heavily degraded, good regeneration
Fauna Evidence:	Kangaroo on site, Cow scat present, tracks and deep rutting on some trees.
Significant Species:	*Actephila lindleyi*

23. Photo Reference

Cover Image:
Greenhood Orchid (*Pterostylis curta*) within Zone 1, August 2023

All Image of checkpoint photos:
Taken on September 2nd 2021 and August 24th 2023 by Marcus Burgess.