Dunmore Hard Rock Quarry Annual Review

1 July 2021 – 30 June 2022

Document Control Sheet

Document Control				
Ref	Prepared by	Approved by	Date	Distribution
v1.0	IEC	Boral Resources	1/09/2022	Initial draft for internal distribution for review
v2.0	IEC	Boral Resources	27/09/2022	• Department of Planning, Industry and Environment • Environmental Protection Agency • Shellharbour City Council • Dunmore Quarry CCC • Online at https://www.boral.com.au/locations/boral-dunmore-operations

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 2020
Annual Review end date	30 June 2021

I, Brodie Bolton , 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 2021 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	Brodie Bolton
Title of authorised reporting officer	Quarry Manager
Signature	Brodie Bolton
Date	30/09/22

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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 Annual Review (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 2022 Financial Year which is 1 July 2021–30 June 2022.

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 2022 Financial Year reporting period (1 July 2021 – 30 June 2022) is contain 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
S4.C60C	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 Review for the development.	Non-compliant Administrative	This options review was due in March 2022. A tender has been circulated with independent consultants and endorsement by the Planning Secretary has been requested by Boral in September 2022. Commissioning of the plan is expected to be completed in late 2022 and an update to the Transport Management Plan is being prepared to incorporate findings of the review.	3.2
S4.C51	Within 3 years of the date of this consent, and every 5 years thereafter unless the Planning Secretary directs otherwise, the Applicant must commission, and pay the full cost of an Independent Audit of the Flora and Fauna Management Plan.	Non-compliant Administrative	Boral has submitted a letter to the portal in September 2022 to confirm from the Secretary that the IEA satisfies the audit requirement in COA 51.	5.7.2

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 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
Geoff Stephens	Dunmore Quarry Manager	Tel: (02) 4237 2000 Email: geoff.stephens@boral.com.au
Angus Shedden	Metropolitan Operations Manager NSW/ACT	(02) 4237 8414 Email: angus.shedden@boral.com.au
Sharon Makin	Environmental Business Partner	Tel: (02) 4237 8414 Email: sharon.makin@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), originally issued on 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.

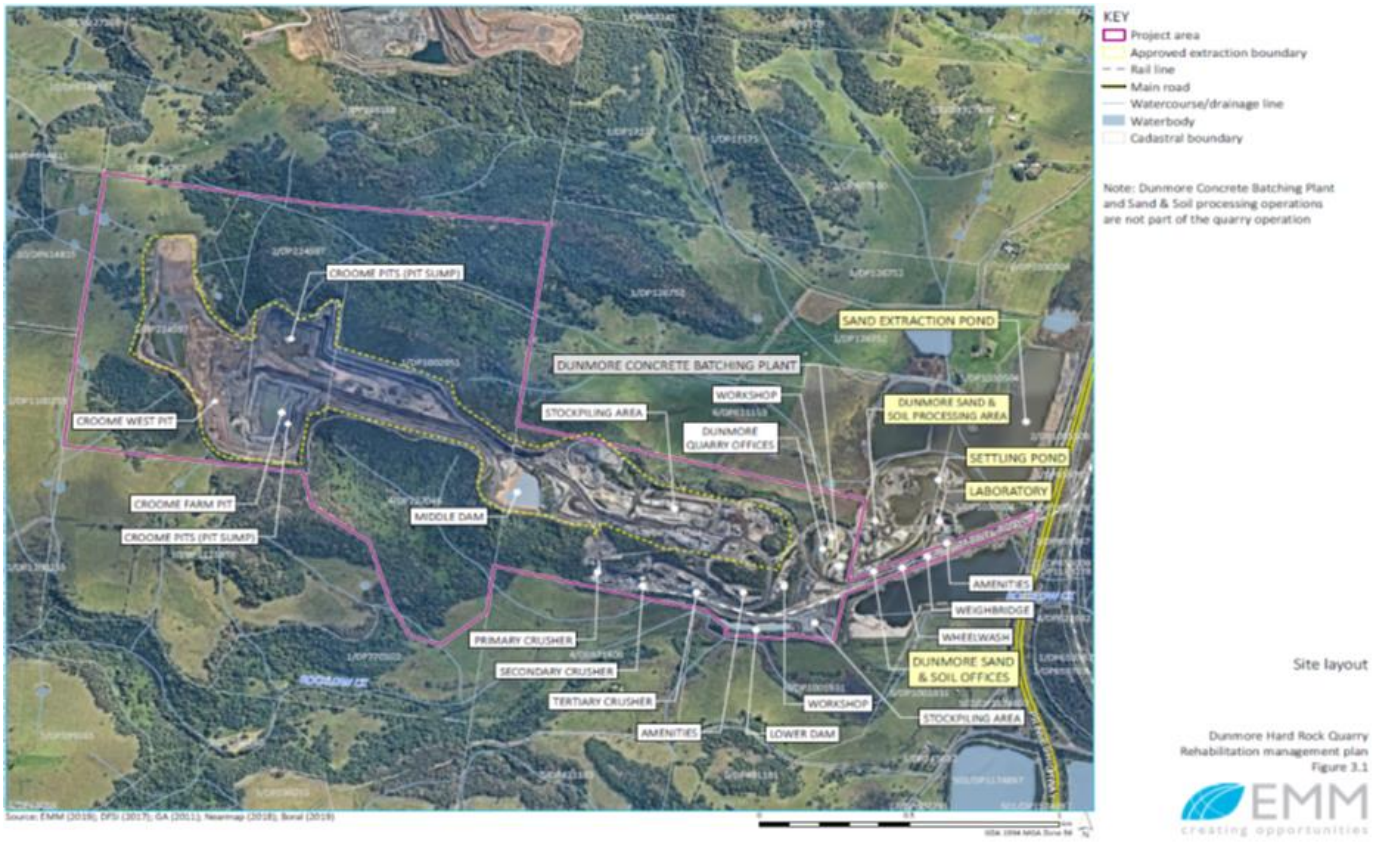

Figure 1 Dunmore Site Layout

2.1. Operations the last 12 months

During the 2022 reporting period, product sales from the quarry reduced to 995,505t while overall production reduced to 1,107,990t. The reductions were largely due to a general decline in demand from the building and construction industry due to the impacts of Covid-19. Concrete aggregate sales slowed but there has been a slight increase in road base sales and construction fill materials.

Over the past 12 months, extraction has focused on the Croome West Pit however the ratio of fresh latite, which is suitable for aggregate production, to the Breccia interburden has been variable. During this time, Boral also changed its strategic intent with the majority of volume for concrete aggregate coming from the Peppertree quarry for logistical reasons.

2.2. Operations the next 12 months

In November 2021, Boral commenced the early consultation process with the Department of Planning and Environment in relation to a proposed quarry pit extension. The extension includes the adjacent 8 ha land parcel acquired from the Rail Infrastructure Corporation (RIC) as well as a proposed deepening of the overall extraction area to maximise resource utilisation. Total production limits will remain at 2.5 Mtpa however the life will be extended to at least 2043. The environmental assessment will be completed in 2024 and once approval is obtained, the ability of Dunmore to supply high quality sealing aggregates will significantly improve to meet anticipated growth in demand over the next 20 years.

Dunmore Quarry is forecast to increase Asphalt aggregates over the coming reporting period with major projects due to commence on the south coast in the early stages of Q2 FY23 and running through the rest of the year. Concrete aggregate demand in the Sydney metropolitan area will be steady and largely supplied through Peppertree Quarry with Dunmore providing top up supply as required.

Sales growth from Dunmore is anticipated in future reporting periods as a result of local highway projects in the Illawarra and engineering fill demand from the Western Sydney Airport construction. It is also expected that railway ballast demand will increase in the 2023 Financial Year.

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	NSW Environmental Protection Authority

	Extractive activities for tonnages up to 2 million tonnes per annum as defined by the EPA anniversary date 01 July.	
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 below FY21 numbers for the FY22 reporting period due to a decrease in concrete aggregate being supplied to the Sydney market offset by a slight increase in product destined for local infrastructure works in the Illawarra.

Disruptions due to the COVID-19 pandemic also affected demand and as a result production was adjusted to reflect uncertainties in demand. Some minor disruptions also occurred as a result of heavy rainfall between February 2022 and May 2022. 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-21	63,366	68,035	4,200
Aug-21	70,870	89,079	15,118
Sep-21	103,807	118,785	6,035
Oct-21	111,255	84,490	6,306
Nov-21	125,105	84,816	4,157
Dec-21	57,385	66,789	3,778
Jan-22	68,977	41,643	0
Feb-22	113,714	67,066	850
Mar-22	88,867	52,072	5,631
Apr-22	97,725	59,872	7,947
May-22	106,909	90,519	3,642
Jun-22	100,010	114,345	52
FY 22 Total	**1,107,990**	**937,511**	**57,716**
		995,227	

Table 7 Sales data for FY22 period

Total Sales/Disposals			
Product	**Type of Material**	**Quantity (Tonnes)**	**$ Value of Sale***
Virgin Materials			
Crushed Coarse Aggregates			
Over 75mm	Latite	30,482	*
Over 30mm to 75mm	Latite	56,927	*
5mm to 30mm	Latite	402,942	*

Total Sales/Disposals			
Product	**Type of Material**	**Quantity (Tonnes)**	**$ Value of Sale***
Under 5mm	Latite	191,813**	*
Natural sand			*
Manufactured Sand	Latite	14,815	*
Construction Sand			*
Prepared Road Base & Sub Base	Latite	291,723	*
Other Unprocessed Materials	Latite	6,803	*
Total		**995,505**	*

Note: This data is an approximation of FY22 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 235.

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. This would correspond to March 2022.

A tender has been circulated with independent consultants and endorsement by the Planning Secretary has been requested by Boral in September 2022.

Commissioning of the plan is expected to be completed in late 2022 and an update to the Transport Management Plan is being prepared to incorporate findings of the review.

4. Actions Required from Previous Annual Review

Table 8 details the actions required from the FY22 Annual review and where each item is discussed.

Table 8 FY22 Annual review actions

Reference	Description of Action	Actions Completed	Section Addressed
DQ1/20	Finalise revised Water Management Plan (WMP).	Comments were provided to Boral from DPIE in October and recommendations will be incorporated into the updated plan to be submitted September 2022.	Section 5.5
DQ2/20	Follow up approval of works required under S4, C38 from DPIE.	A letter was sent requesting approval of works (470-11-2003-PA-14). DPIE have approved the works as complete in accordance with S4.C37 on 9 April 2021. This action is now closed.	N/A
DQ3/20	Determine whether 'regional' monitoring that has been completed is satisfactory and the regional monitoring program can therefore be suspended.	Groundwater monitoring will be continued as part of data collection of the aquifer. This action is now closed.	Section 5.6.3
DQ4/20	Update of WMP to include measures to prevent mud tracking onto public roads from the site.	It was determined that a more appropriate location for the updated WMP includes an Erosion and Sediment Control Plan located in Section 6 of the water management plan. The effectiveness of the controls described in the plan are monitored via the site environmental checklist (monthly checklist and EPP). This action is now closed.	Section 5.5
DQ5/20	Confirm tyre numbers stored on site are less than 500, and if there is a requirement for more than 500 tyres, consult with EPA regarding a licence.	Boral confirms that less than 500 tyres are stored on the premises as waste. The tyre register was completed in 2021. In late 2021 a licenced contractor collected spare tyres and conveyors for recycling at a licenced facility. This action is now closed.	Section 5.9.1
DQ6/20	Finalise revised Bushfire Management Plan and ensure it covers safe storage of tyres in accordance with "Tyre	An updated Bushfire Management Plan has been prepared in consultation with RFS. This action is now closed	Section 5.9.1

Reference	Description of Action	Actions Completed	Section Addressed
	stewardship Australia Best Practice Guidelines for Tyre Storage and Emergency Preparedness (March 2019)" guidelines and "Fire & Rescue NSW Fire Safety Guideline – Guideline for bulk storage of rubber tyres" (December 2014).		
DQ7/20	Ensure all management plans are prepared and reviewed in accordance with the requirements of the conditions of consent It is suggested a review record/register is maintained.	A record was created and attached to the Environmental Permit Planner used by site management. This action is now closed	N/A
DQ8/20	A Traffic Management System should be developed to monitor and control truck dispatch movements in accordance with limitations	A system is currently in place to monitor dispatch. The Transport Management Plan (TMP) will be updated to reflect the monitoring system and updated limits.	Section 3.1, Section 6.2
DQ9/20	If the hourly truck dispatch limitations are not practical for operations, consultation with DPIE should occur to understand if modification of this condition is appropriate.	A modification of consent (MOD 12) has been granted in August 2021. The TMP will be updated as part of MOD 12 post approval documentation post annual review update requirements.	Section 6.2
DQ10/20	Prioritise maintenance checks of bag houses in crushing and screening plans to ensure they are maintained in a proper and efficient condition.	A plant inspection checklist is undertaken daily by staff to ensure that plant components are working correctly, and any corrective actions are completed. This action is now closed	N/A
DQ11/20	Confirm survey plan has been submitted to the Secretary.	Boundary plans were sent 30 December 2017 to DPIE as part of MOD 9 approval. This action is now closed.	N/A
DQ12/20	Implement updated Water Management Plan when approved to reconfigure storage on site and prevent uncontrolled discharge events.	The updated Water Management Plan details the particular dam upgrade works designed to meet this condition. The WMP will be submitted in September 2022.	Section 5.5
DQ13/20	Ensure all future Annual Reviews address the reporting requirements in Schedule 4, Condition 29.	Completed in this Annual Review. This action is now closed.	Section 5.5.4

Reference	Description of Action	Actions Completed	Section Addressed
DQ14/20	Ensure Dam Upgrade Plan is updated or incorporated into the updated approved Water Management Plan.	The dam upgrade plan is included in Appendix G of the updated WMP submitted in September 2022.	Section 5.5.5
DQ15/20	Ensure the approved updated Water Management Plan includes the Lower Dam Transition Plan.	The dam transition plan is included in the Options Assessment (Section 5.3) of the updated WMP submitted in September 2022.	Section 5.5.5
DQ16/20	Bunded fuel drum storage area to be used correctly with all oil drums to be positioned within the bunded area.	Bunded area was cleared of unnecessary containers. An audit from the resource regulator was conducted in the last reporting period. The audit confirmed that the storage is in accordance with AS 1940. This action is now closed.	Section 5.11
DQ17/20	Ensure all fuel, oil and chemical storage areas occurs in appropriately bunded areas.	As above.	Section 5.11
DQ18/20	Condition number references were noted as being incorrect throughout document. Condition numbering to be updated in next review.	Condition references will be amended in the next review of the Flora and Fauna Management Plan document as per the recommendation. This will be completed with the suite of updates for management plans that will be conducted as part of the post MOD 12 approval requirements.	Section 5.7
DQ19/20	Vegetation Clearing Protocol (VCP) to be updated to address collecting seed from site and conserving and reusing topsoil.	As above.	Section 5.7
DQ20/20	Rehabilitation Conservation Bond not lodged within the required timeframe. Boral to ensure timing requirements are met for obligations under this consent.	Rehabilitation Conservation Bond to be recalculated and lodged in accordance with the obligations under the consent. This will be recalculated as part of the updated Rehabilitation Management Plan to be submitted with the suite of updates post Annual Review.	Section 5.7

Reference	Description of Action	Actions Completed	Section Addressed
DQ21/20	It is recommended that sweeping increase to three times per week, the WMP is updated to address this matter, and consideration of further mitigation measures is undertaken.	Sweeping was increased to three days a week with Kiama Council in February 2021. This action is now closed.	N/A
DQ22/20	The document control tables within the all the plans, strategies and programs required under this consent do not reflect the reviews that have occurred. Ensure all documents are reviewed in accordance with this condition of consent. Update the relevant management plans to contain information on timing of review.	Subsequent management plans to include a more accurate description of the document control process, including space to denote when management plans were reviewed. This will be undertaken as part of the updates of subsequent management plans.	N/A
AQMP 1	Alerting system for Real Time Dust Monitors.	A new system is being devised with the subcontractor to provide the alerting system as the old system was discontinued. Alerting has been finalised and the system is now operational.	Section 5.2.6
FFMP1	Continue monitoring Croome West Bund.	Photos of Croome West are provided in Section 5.7.	Section 5.7
FFMP2	Repair fence lines to reduce instances of cattle intrusion in rehab areas, specifically the RVCA.	Contractor engaged to repair fences in early September. COVID related impacts and flooding have limited access required to complete works in the FY22 reporting period. The fencing in the Compensatory Habitat Area has been completed however the Remnant Vegetation Conservation Area has been inaccessible due to flooding.	Section 5.7.3
FFMP3	Continue works in active rehabilitation zones as per FFMP	Contractor (Goodbush) engaged to continue works to meet completion criteria thresholds	Section 5.7.1 and Section 5.7.2

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.

The 2022 reporting period was characterised by heavy rainfall between February and May 2022. This was caused by an intense offshore low pressure system and resulted in widespread flooding. During this time the quarry experienced seven rainfall events which met or exceeded the design capacity of the lower dam (90.7 mm over 5 days): which triggered additional monitoring to be undertaken. The results of this analysis is provided in the following sections.

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 FY22 and historical rainfall data can be found in Appendix A.

5.1.1. Meteorological Monitoring Long Term Analysis and Trends

The FY22 period was wetter than average with 1,977 mm falling over the reporting period. There were seven notable rain events during the reporting period, all of which met or exceeded the design capacity of the lower dam (90.7 mm over 5 days):

- 23-28 February 2022: 204.6mm
- 2-6 March 2022: 255.6mm
- 7-12 March 2022: 196mm
- 25-30 March 2022: 128mm
- 7-12 April 2022: 152.6mm
- 10-15 May 2022 91.4mm
- 23-25 May 2022: 90.6mm

The above events were the result of an intense low pressure system which formed off the south coast of NSW. Importantly, the entire period was characterised by wet weather which increased surface runoff during more intense storm events. The Australian Bureau of Meteorology predicts that the next reporting period may also be wetter than average.

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) and 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.

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

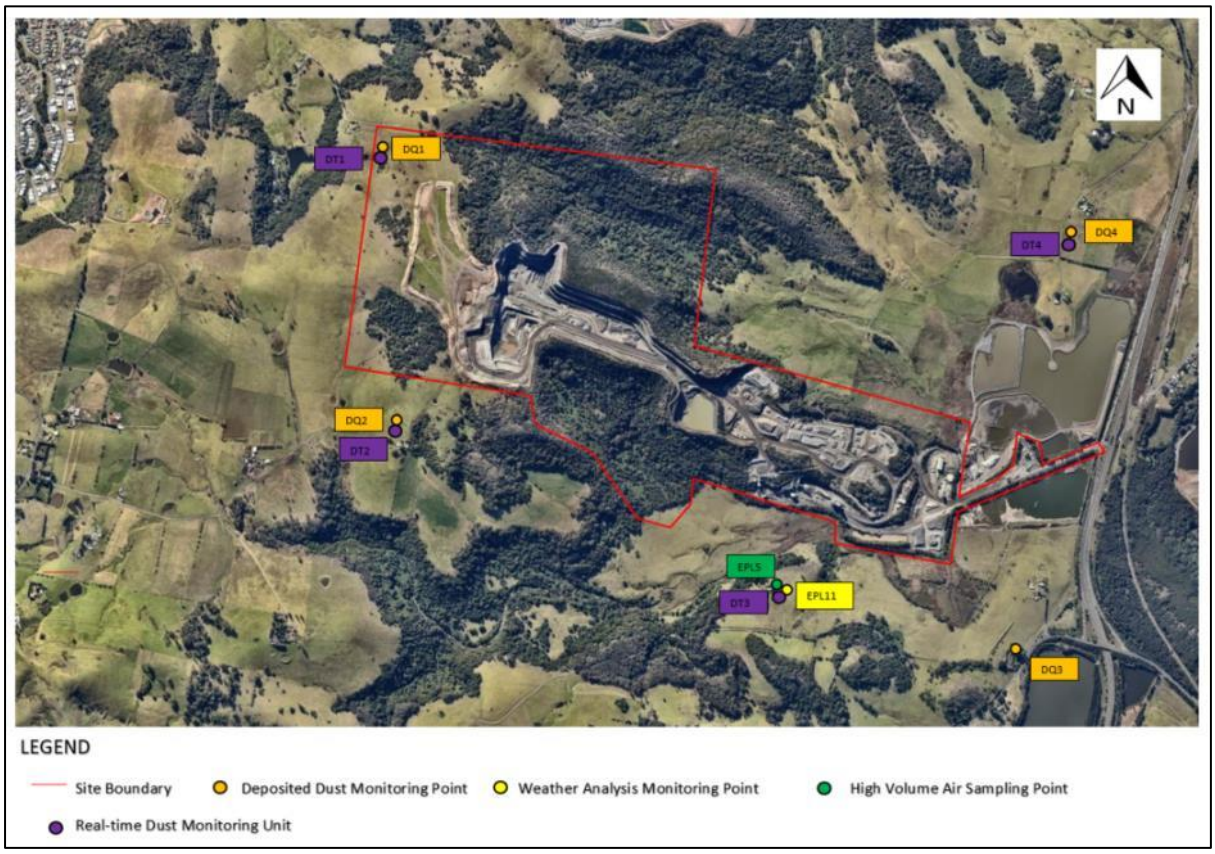

Figure 2 Air Quality Monitoring Locations

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 9 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)			

Pollutant	Averaging Period	Criterion
[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 FY22 Performance Review

Data from all monitoring points shows that deposition levels 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 well 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 10 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	Ash
FY22 Average	1.42	0.61	1.71	0.69	1.25	0.65	1.64	0.93
Criterion	4	-	4	-	4	-	4	-

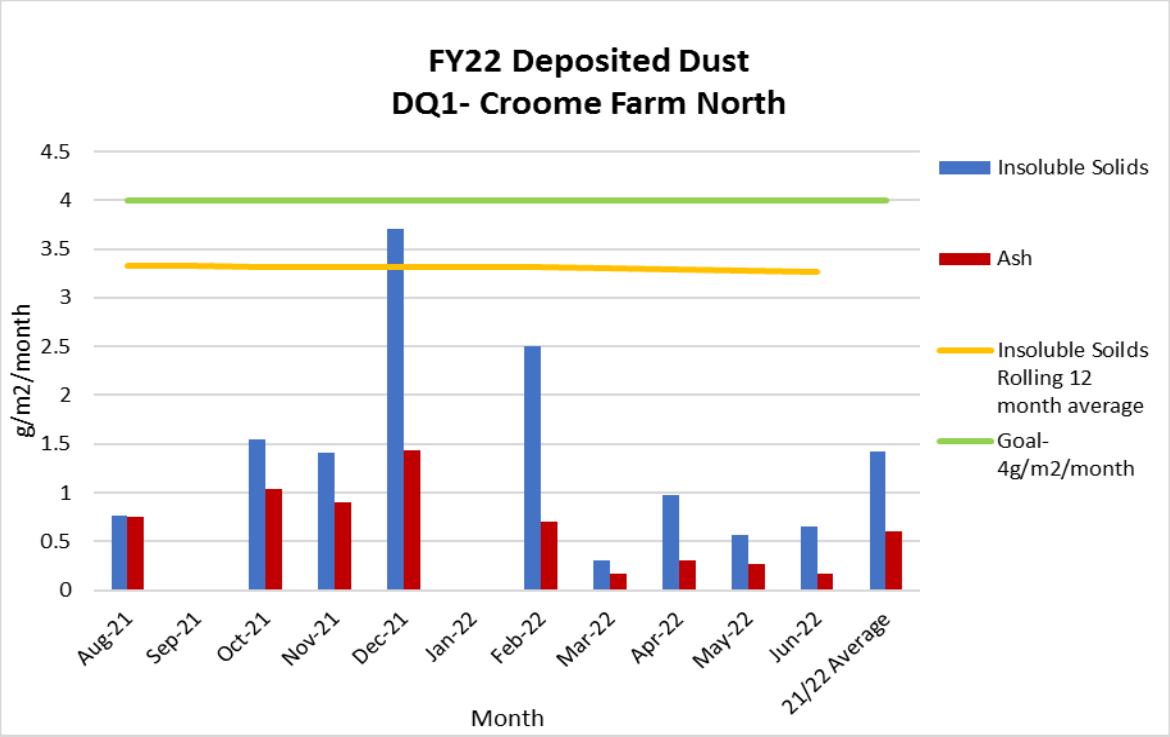

Figure 3 DQ1 Deposited Dust Results

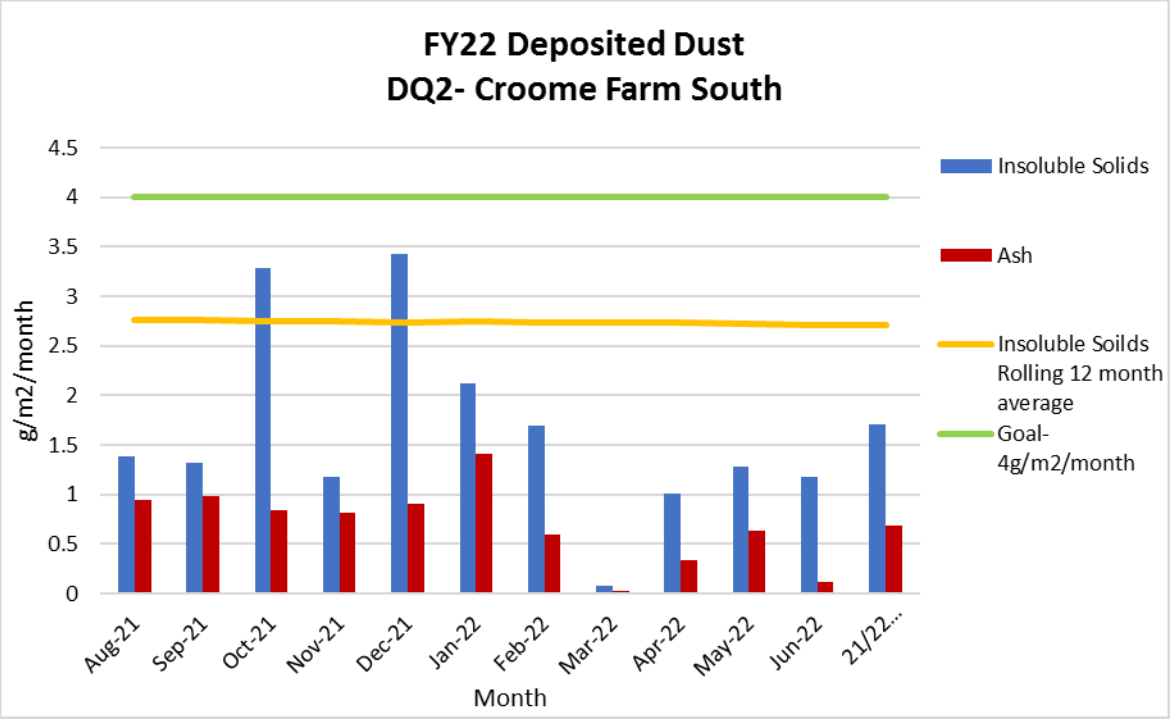

Figure 4 DQ2 Deposited Dust Results

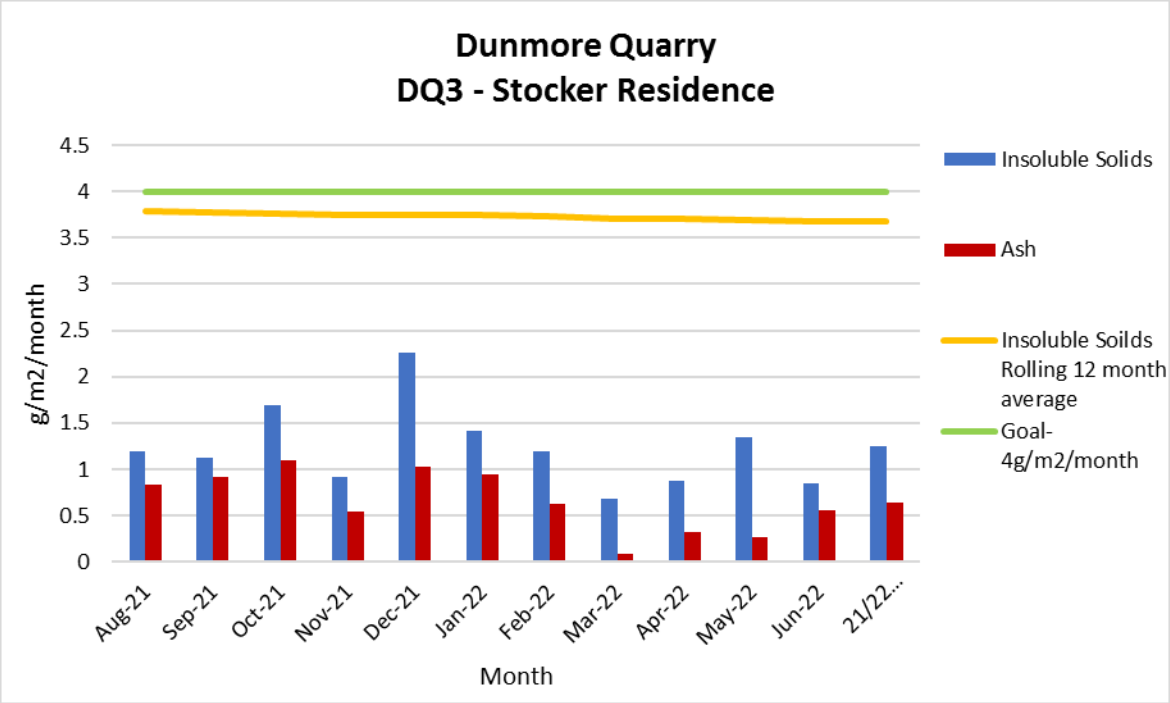

Figure 5 DQ3 Deposited Dust Results

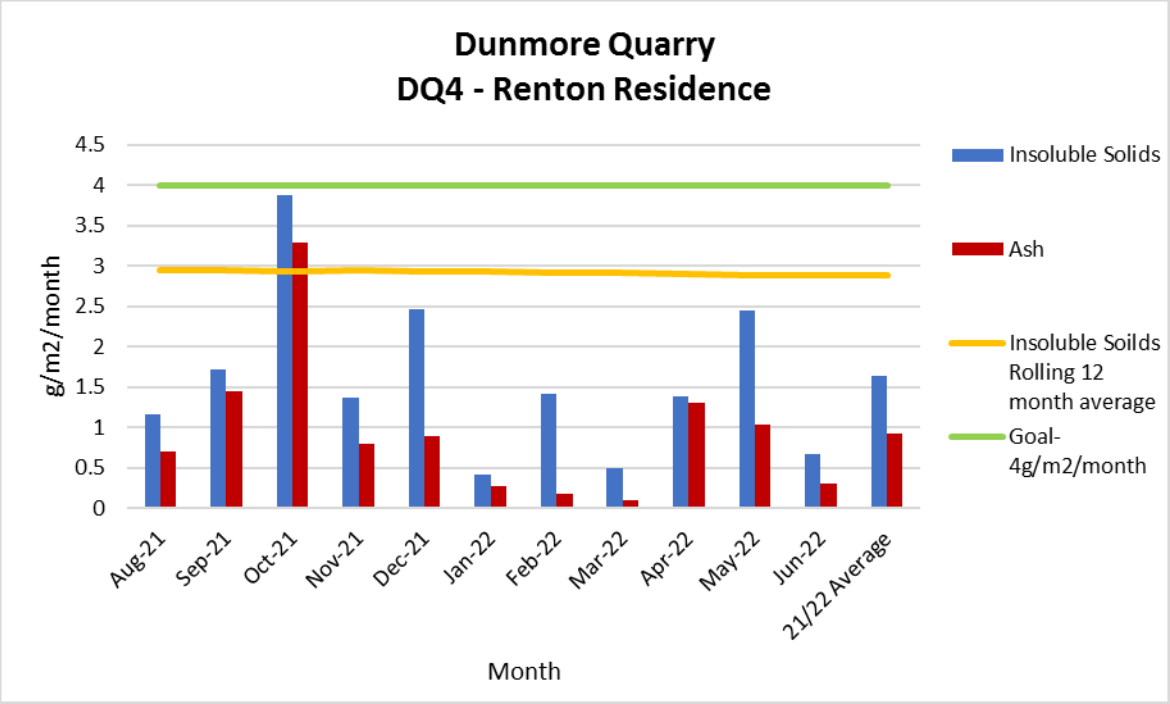

Figure 6 DQ4 Deposited Dust Results

5.2.3. Particulate Monitoring Assessment Criteria

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

Table 11 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 FY22 Performance Review

The PM_{10} readings from FY22 can be seen below in Figure 7.

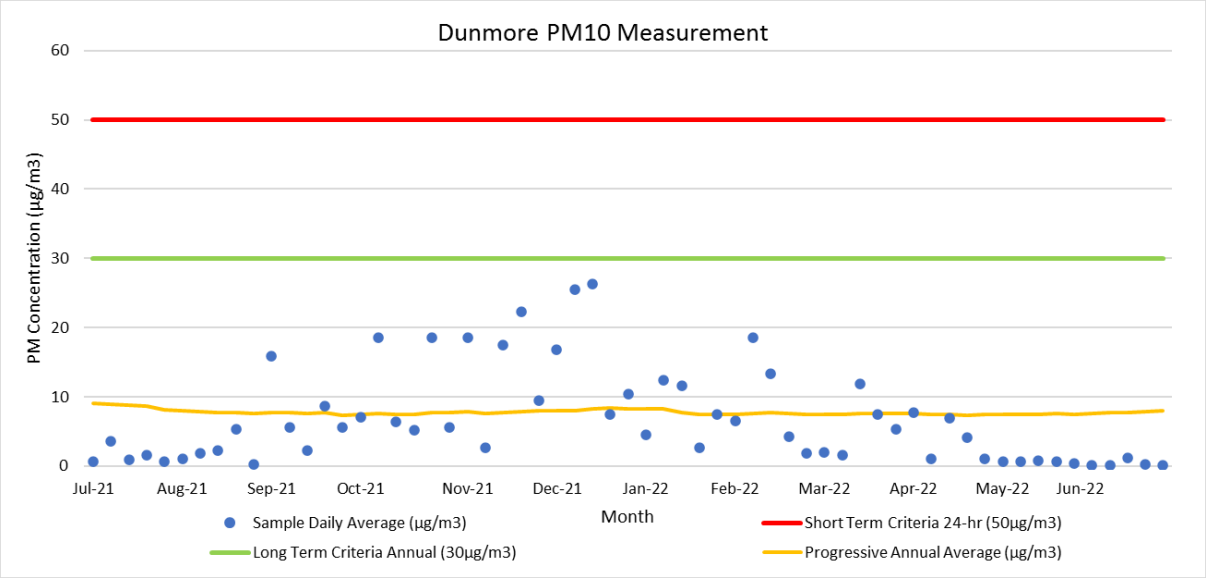

Figure 7 PM_{10} Measurements – FY22

The annual average PM_{10} measurement for the reporting period was below the impact assessment criteria of 25 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 two 24 hour concentrations recorded as occurring above the long-term criteria for PM_{10} during the reporting period, but these were well below the 24m hour average criteria of 50 µg/m³.

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.

The data also shows the effects of wet weather on regional dust levels. During the February 2022 to May 2022 period, dust levels generally were much lower than would typically occur in a rural environment.

Table 12 Summary of Particulate Monitoring Data

Pollutant	Dunmore Quarry FY22 Average (µg/m³)	Albion Park FY22 Average(µg/m³)	Dunmore Quarry Long Term Average (µg/m³)
Measured PM10	6.75	8.29	13.02
Derived TSP	16.88	20.74	32.33
Real time monitor TSP	12.75	-	-
Real time monitor PM10	11.59	-	-
Real time monitor PM2.5	3.02	-	-

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.

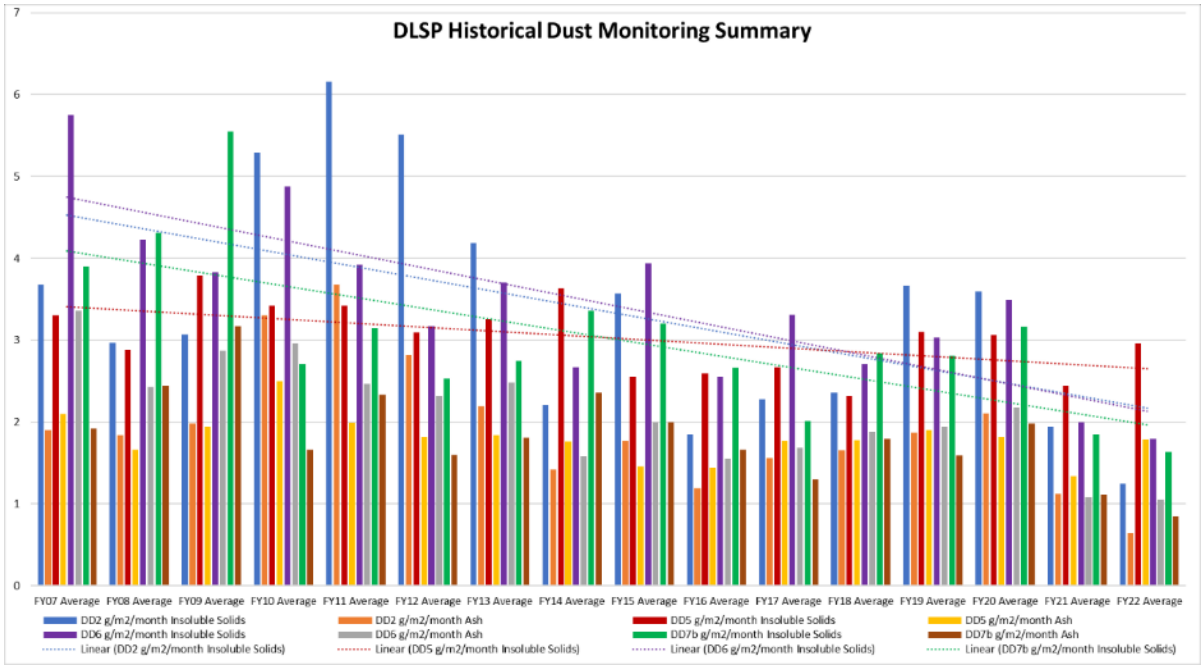

Figure 8 Historical Dust Monitoring Data

There has been a gradual reduction in dust over the past 20 years, however the data also shows that regular seasonal variations occur. Dust is typically higher in dry summer months than winter months, which is also confirmed by the PM_{10} measurements. The data also

shows climatic variations such as the 2018-19 drought and regional sources such as the widespread bushfires in early 2020.

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.

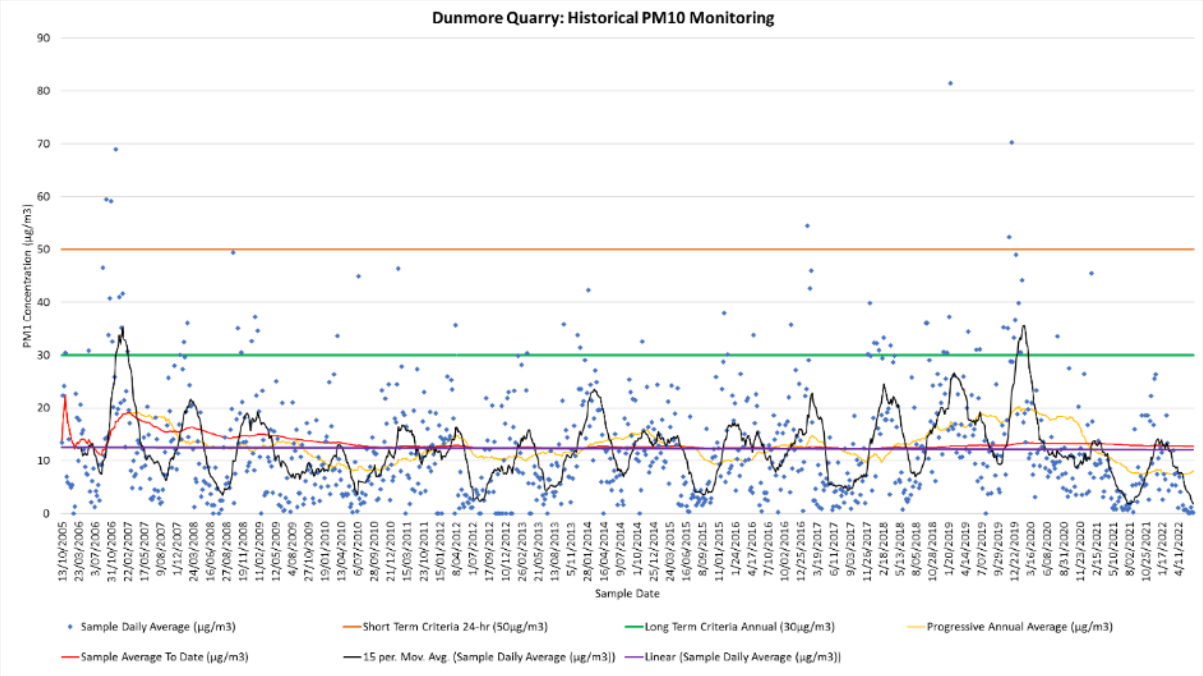

Figure 9 Historical PM_{10} Monitoring Data

5.2.6. Air Quality Monitoring Summary and Opportunities for Improvement

The data shows that overall, the quarry does not appear to be influencing background particulate load with the major influencing factors being climatic conditions, seasonal variations and general surrounding rural sources.

The dust monitoring program has been modified over recent years to better capture data from the quarrying activities. The program will be extended in future to include the new extraction area once approved and will include a real-time dust monitoring system. The system is currently being designed in a web based format to allow greater access to data for operational staff.

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.

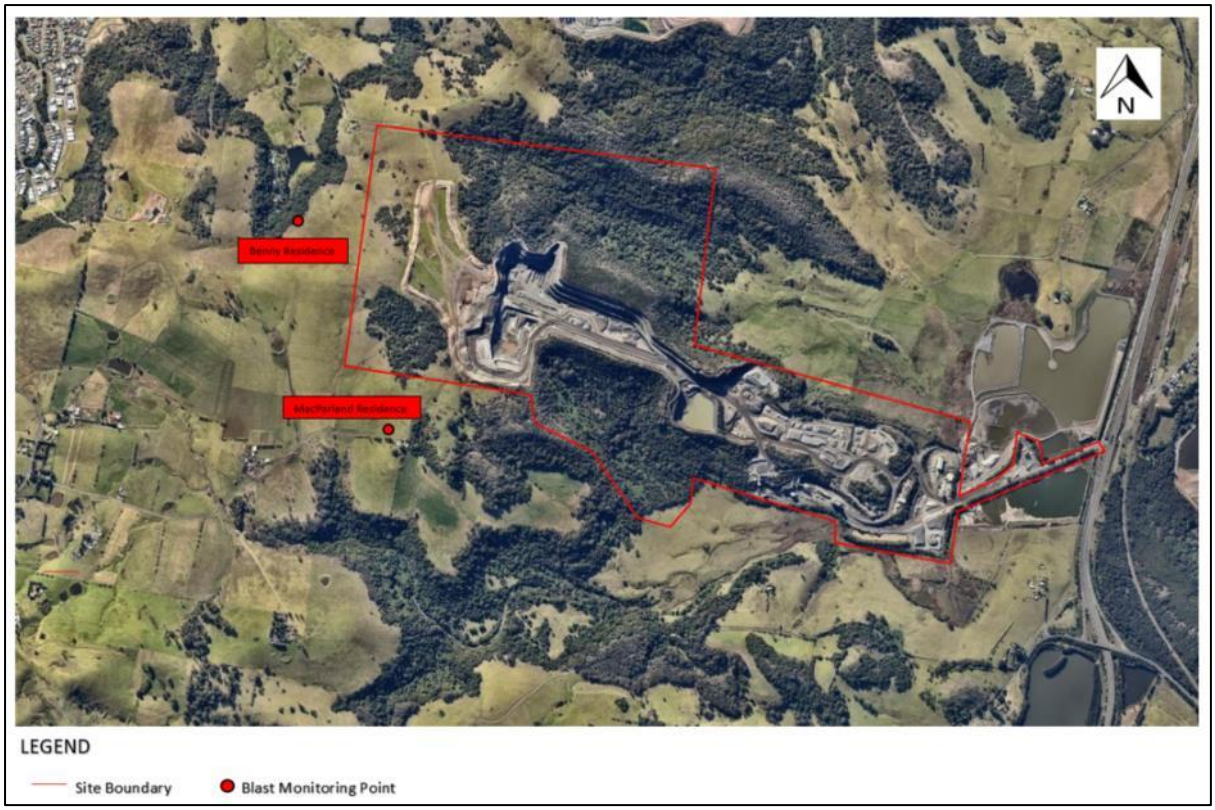

Figure 10 Blast Monitoring Locations

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 13 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 fourteen (14) blasts undertaken during the FY22 reporting period. 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, which is used for compliance reporting as per the approved Blast Management Plan.

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 14 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 FY22 period indicated no change to any of the observed structures on the property.

5.3.2. Blast Monitoring FY22 Performance Review

Table 15 below outlines the blast monitoring in FY22. There were no blasts above the prescribed limits during the FY22 reporting period.

Table 15 Benny Residence FY22 Compliance Blast Monitoring Results

Date	Time	Airblast Overpressure (dB(Lin Peak))	Ground Vibration (mm/s)	EIS Predicted Ground Vibration (100 MIC) (mm/s)	EIS Predicted Ground Vibration (30 MIC) (mm/s)
09-Aug-21	13:04	No Trigger	No Trigger	4.2	3.5
01-Sep-21	13:29	No Trigger	No Trigger	4.2	3.5
20-Sep-21	12:03	No Trigger	No Trigger	4.2	3.5
22-Oct-21	12:11	No Trigger	No Trigger	4.2	3.5
08-Nov-21	14:11	No Trigger	No Trigger	4.2	3.5
17-Nov-21	14:09	No Trigger	No Trigger	4.2	3.5
01-Dec-21	14:41	No Trigger	No Trigger	4.2	3.5
22-Dec-21	13:16	No Trigger	No Trigger	4.2	3.5
21-Feb-22	11:06	No Trigger	No Trigger	4.2	3.5
31-Mar-22	13:05	No Trigger	No Trigger	4.2	3.5
04-May-22	14:37	No Trigger	No Trigger	4.2	3.5
16-May-22	15:20	No Trigger	No Trigger	4.2	3.5
20-May-22	12:17	No Trigger	No Trigger	4.2	3.5
22-Jun-22	12:52	No Trigger	No Trigger	4.2	3.5
29-Jun-22	12:55	No Trigger	No Trigger	4.2	3.5

5.3.3. Blast Monitoring Long Term Analysis and Trends

Historic blasting data is provided in Figures 11 and 12. Where a blast does not trigger the monitor, the data point is represented by a gap in the graph. A “no trigger” reading does not indicate that the blast did not occur or did not result in some vibration or overpressure but rather the level of vibration and overpressure were below pre-set minimum levels. Standard trigger levels for blast monitors are 100 dB(L) for overpressure and 0.5 mm/s for ground vibration, however the unit at Dunmore has been set at 88 dB(L) for overpressure and 0.0 mm/s for ground vibration. The most recent blast in July 2022, which is outside this reporting period, resulted in 98.8 dB(L) for overpressure and 0.508 mm/s for ground vibration. This verifies that the unit is operating correctly and confirms that the results obtained during the reporting period were well below the required assessment criteria.

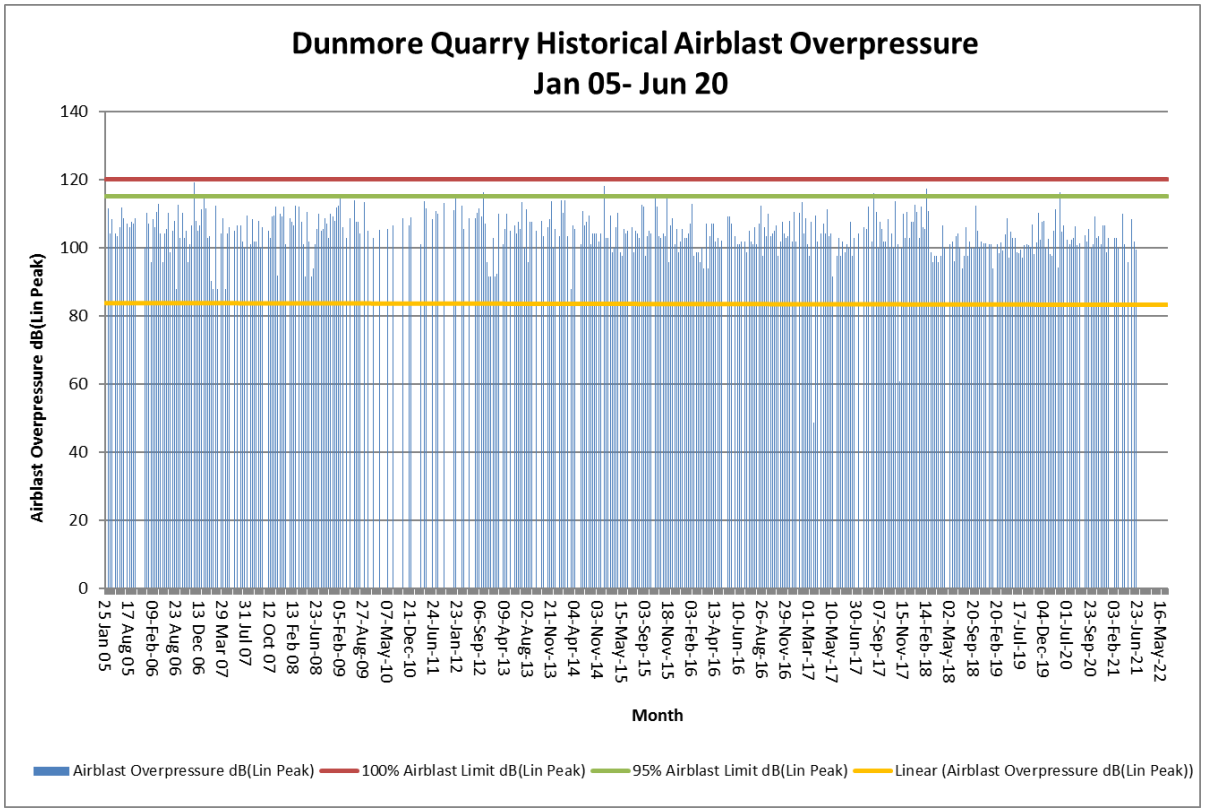

Figure 11 Historical Overpressure Data

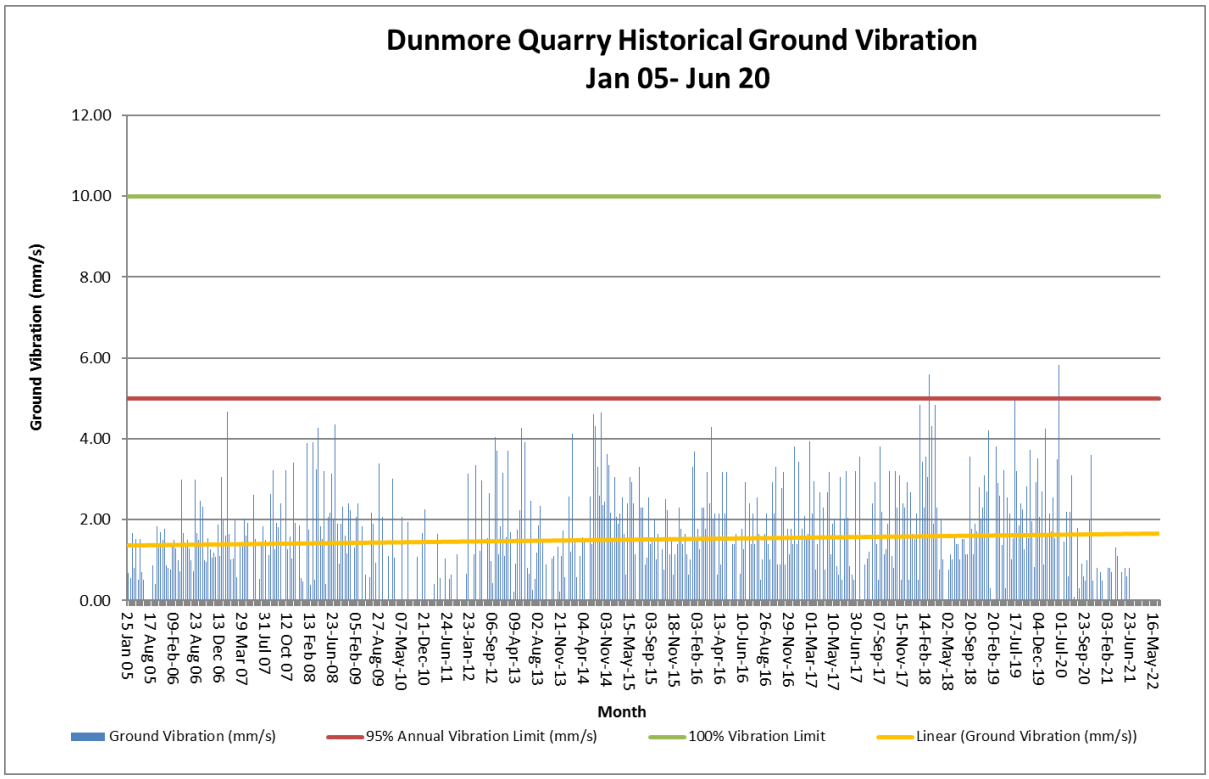

Figure 12 Historical Ground Vibration Data

All measured blasts during the reporting period were below trigger sensitivity.

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 generally undertaken annually in winter to determine quarry contribution to noise at private residences. Noise monitoring is usually completed in July each year which typically represents the worst-case meteorological conditions for noise propagation.

Due to Covid-19 restrictions affecting the Greater Sydney Region (of which Dunmore was included) this monitoring was delayed and undertaken on 2 and 3 September 2021. Acceptance of this delay and approval of the proposed date in September was received from the EPA and DPE who were notified on the 30/7/21 of the need to delay via a phone meeting.

The current reporting period was the fourth instance where the new monitoring points were assessed post MOD 9 approval. 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 is represented by NM-1 to NM-5 as displayed in Figure 13.

Table 15 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		

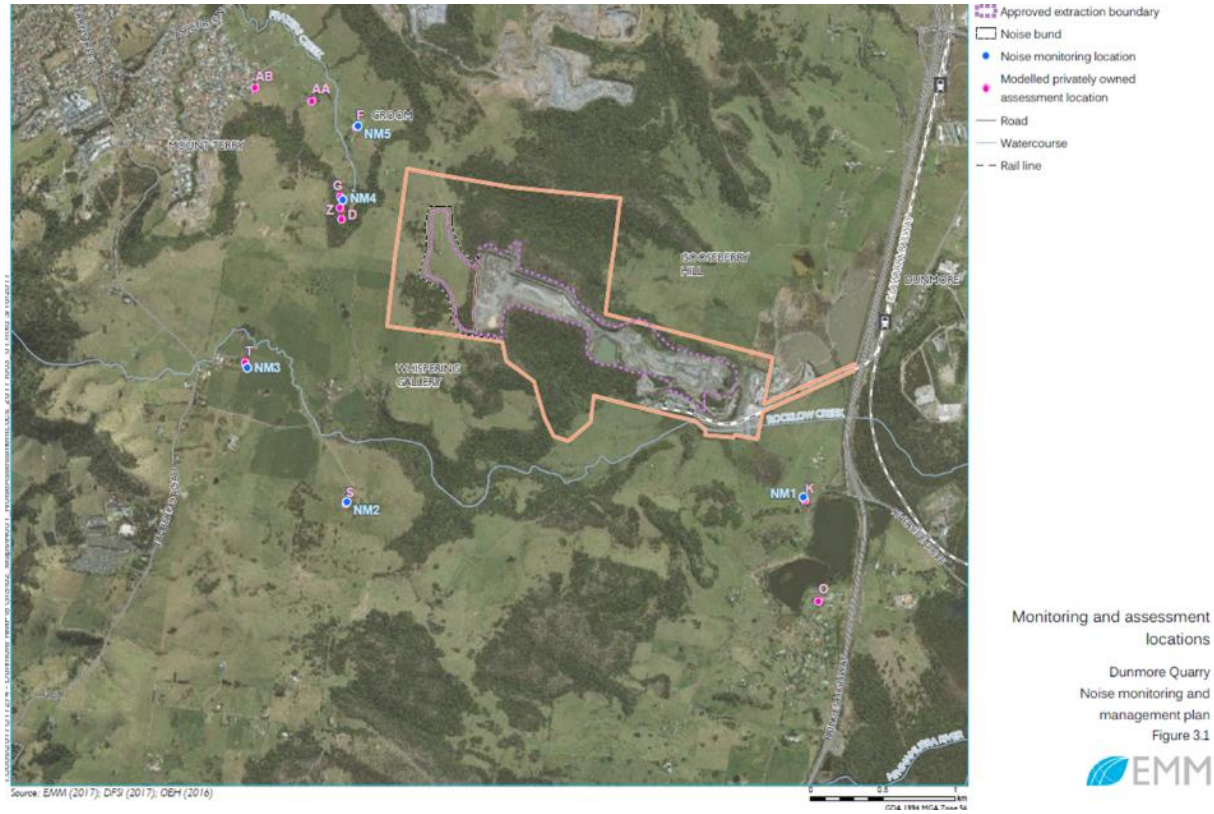

Figure 13 Noise Monitoring Locations

5.4.2. Noise Monitoring FY22 Performance Review

A summary of the attended noise monitoring results against the modelled MOD 9 quarry operations is shown below in Table 16.

Table 16 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
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
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
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
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

During the reporting period monitoring points were 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 now been four years of monitoring under the current monitoring program post MOD 9 operations and minor trends are now becoming apparent. NM-1 has been monitored for a number of years as part of the previously approved monitoring program. The results for NM-1 (also referred to as K) over the last 14 years can be seen below in Figure 14.

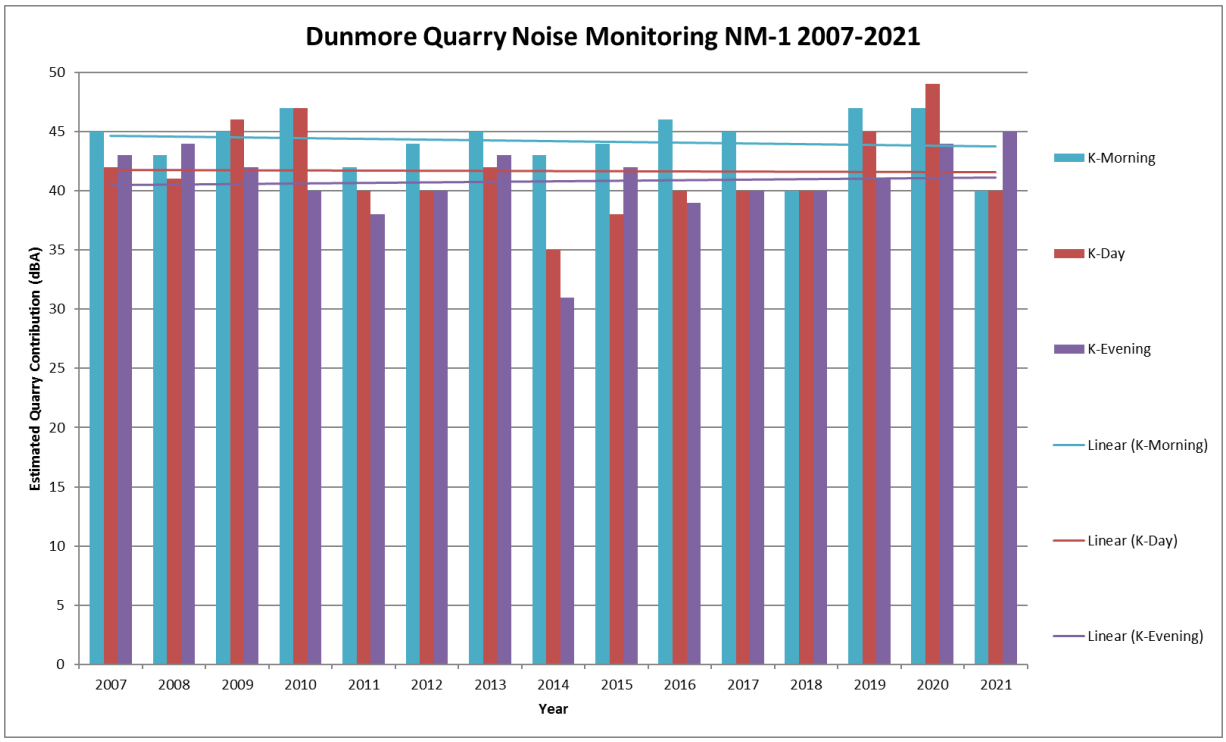

Figure 14 Long term noise monitoring at NM-1 results since 2007

NM1 is located near the Princess Highway and adjacent to Swamp Road which is a local feeder road to Jamberoo. It is also close to the Dunmore Sand & Soil Stage 1 ponds which were completed in 2007. The noise environment at this receptor is heavily influenced by traffic noise and the attended noise survey in September 2021 noted that the quarry operation was inaudible.

A summary of the noise monitoring results post MOD 9 is provided in Figures 15 to 19. The monitoring data, including the annual noise monitoring assessment, which is attached as Appendix C, demonstrates compliance with the noise assessment criteria.

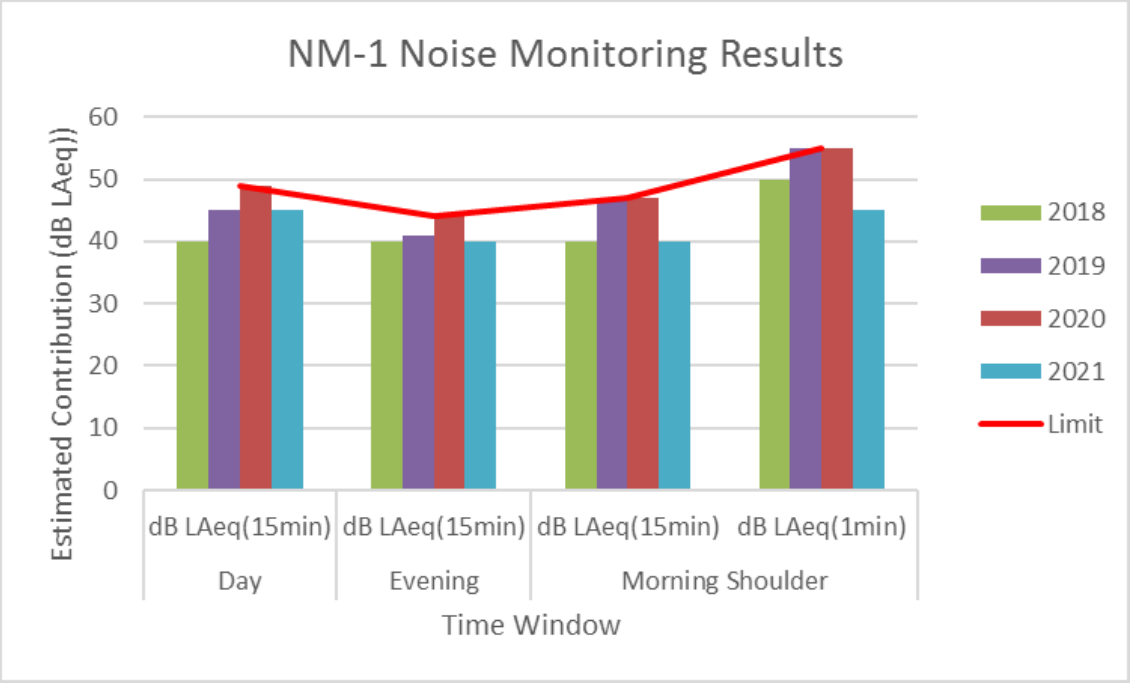

Figure 15 NM-1 Noise monitoring results since MOD-9

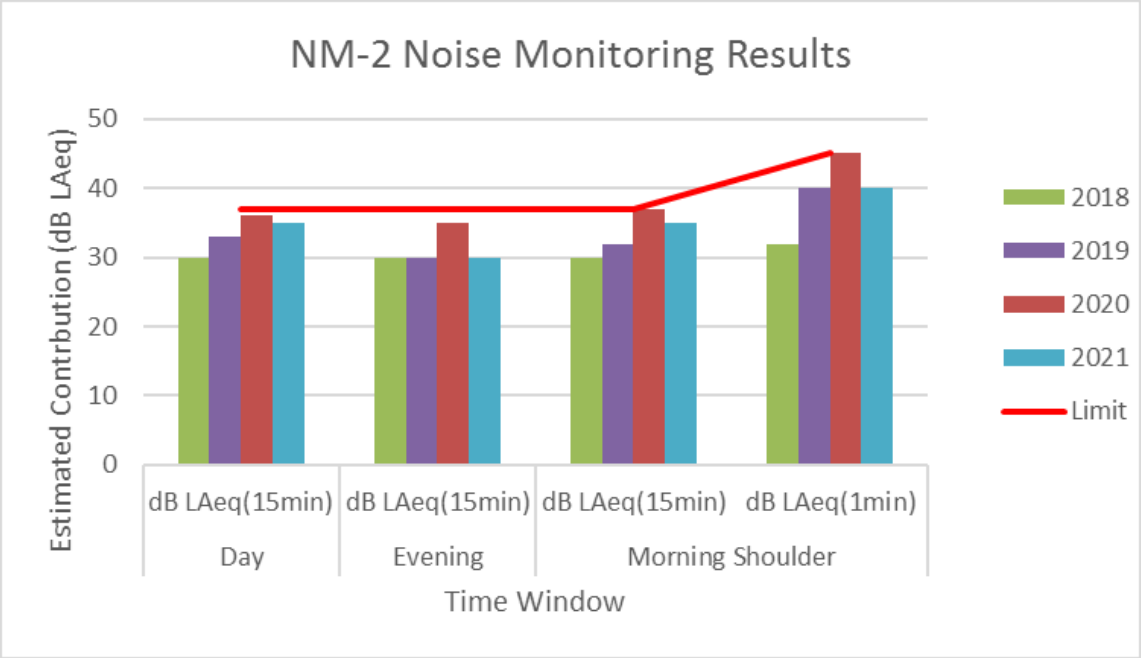

Figure 16 NM-2 Noise monitoring results since MOD-9

The noise environment of NM2 is dominated by surrounding agricultural activities and local traffic on Jamberoo Road. During the attended noise monitoring in September 2021, the quarry was audible on occasions however the contribution of the quarry to the noise environment was calculated to be below the noise assessment criteria.

The data provided separates the morning shoulder (6am to 7am) from the survey period. This captures the first hour of quarry operations and has been divided into L_{Aeq}(15min) and L_{Aeq}(1min) averaging periods. These averaging periods characterise the noise environment by providing information on short but loud noises such as equipment start up and tailgate noise compared with longer duration noise sources such as vehicle movements, pumps and

processing equipment. During the attended noise survey in September 2021, the quarry was only audible during the day, not the morning shoulder.

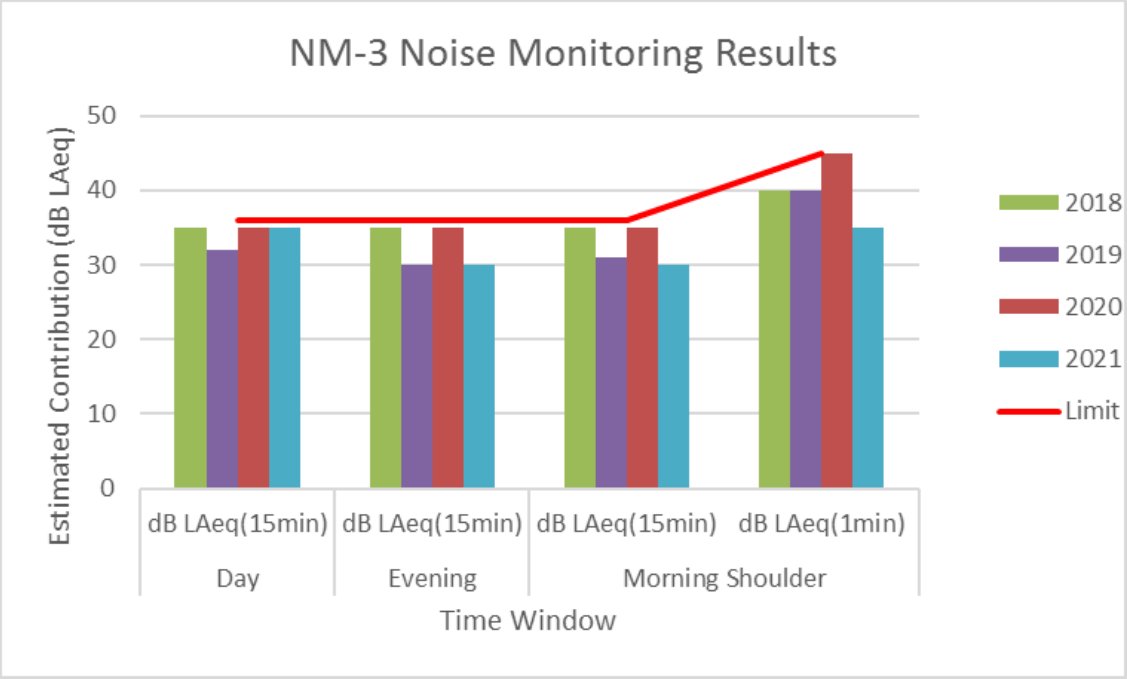

Figure 17 NM-3 Noise monitoring results since MOD-9

NM3 is located to the south west of the quarry extraction area. This site has shown a very minor increase in daytime noise levels over the past 4 years while the evening period has remained steady. The morning shoulder shows the same pattern as the same pattern as the other monitoring sites which shows a general decrease in noise levels over the reporting period compared with past years.

The attended noise survey in September 2021 found that the dominant noise sources were natural but the quarry was audible during the daytime only. The contribution of the quarry to the background noise environment was calculated and found to be well within the assessment criteria.

Sites NM4 and NM5 are located to the west and north west of the quarry. The noise monitoring results shown in Figures 18 and 19 show a slight reduction in noise over the reporting period. The attended noise survey in September 2021 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 emissions were inaudible and the contributions of the quarry activity to the ambient noise environment were calculated to be below the noise criteria for all periods.

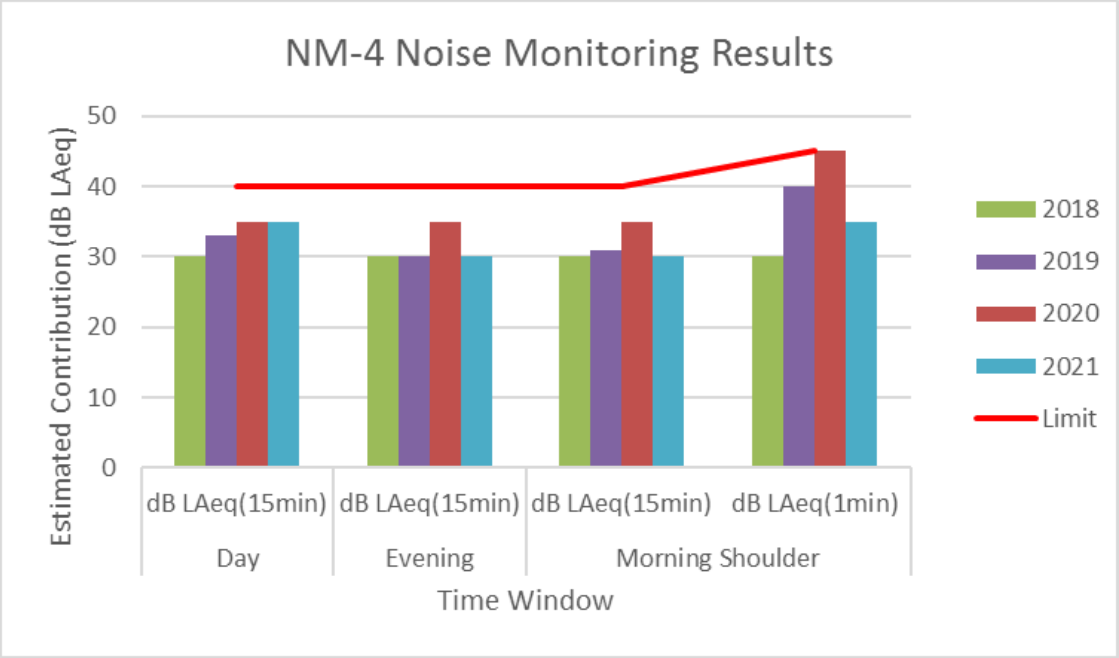

Figure 18 NM-4 Noise monitoring results since MOD-9

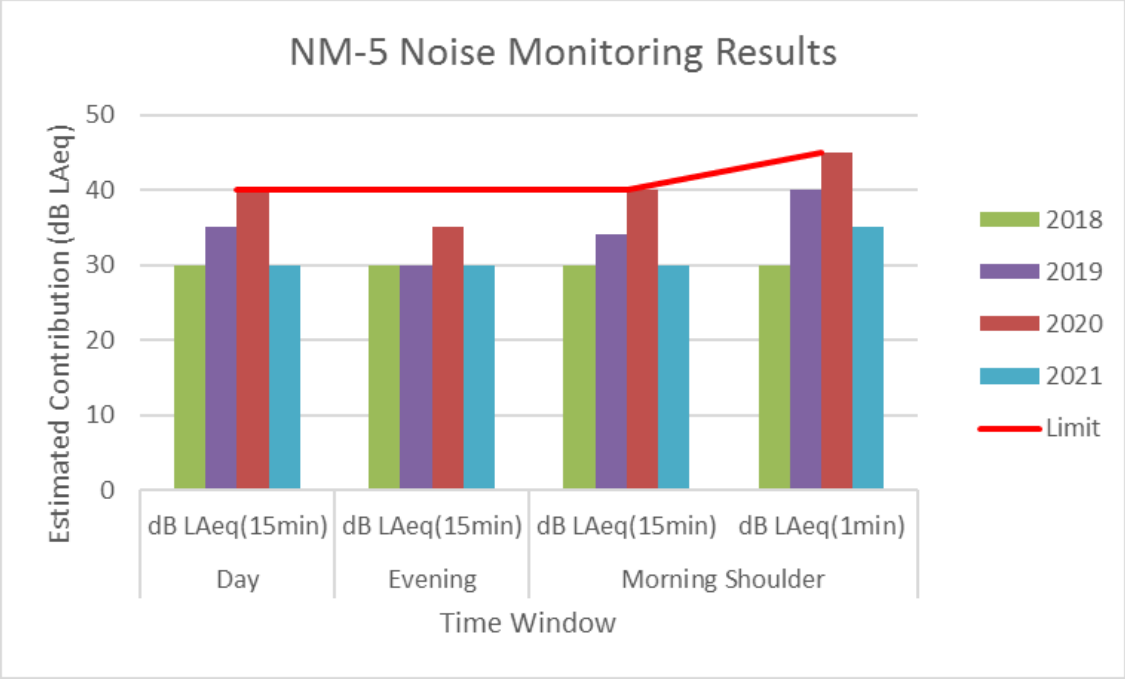

Figure 19 NM-5 Noise monitoring results since MOD-9

5.4.4. Noise Monitoring Summary and Opportunities for Improvement

As previously discussed, noise monitoring results at all receptor locations were well within the noise assessment criteria listed in Condition 7 of Schedule 4 of the consent. Noise monitoring will continue at these locations for the coming reporting period. It is expected that as operations deepen that measured noise will decrease for the western monitoring points due to the buffering effect.

At this stage it is not considered necessary to implement any additional noise mitigation measures to the operation however access to real time weather data will continue to assist and inform site operations of when prevailing weather conditions could exacerbate noise emissions from the operation.

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 20 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.

Between February 2022 and May 2022, an intense low pressure system of the NSW South Coast caused widespread rainfall and localised flooding. Several intense storm events also occurred which triggered a total of seven discharge events from EPL7. These events also triggered periods of associated daily monitoring of receiving waters. The results of this monitoring work is provided in Section 5.7.2.

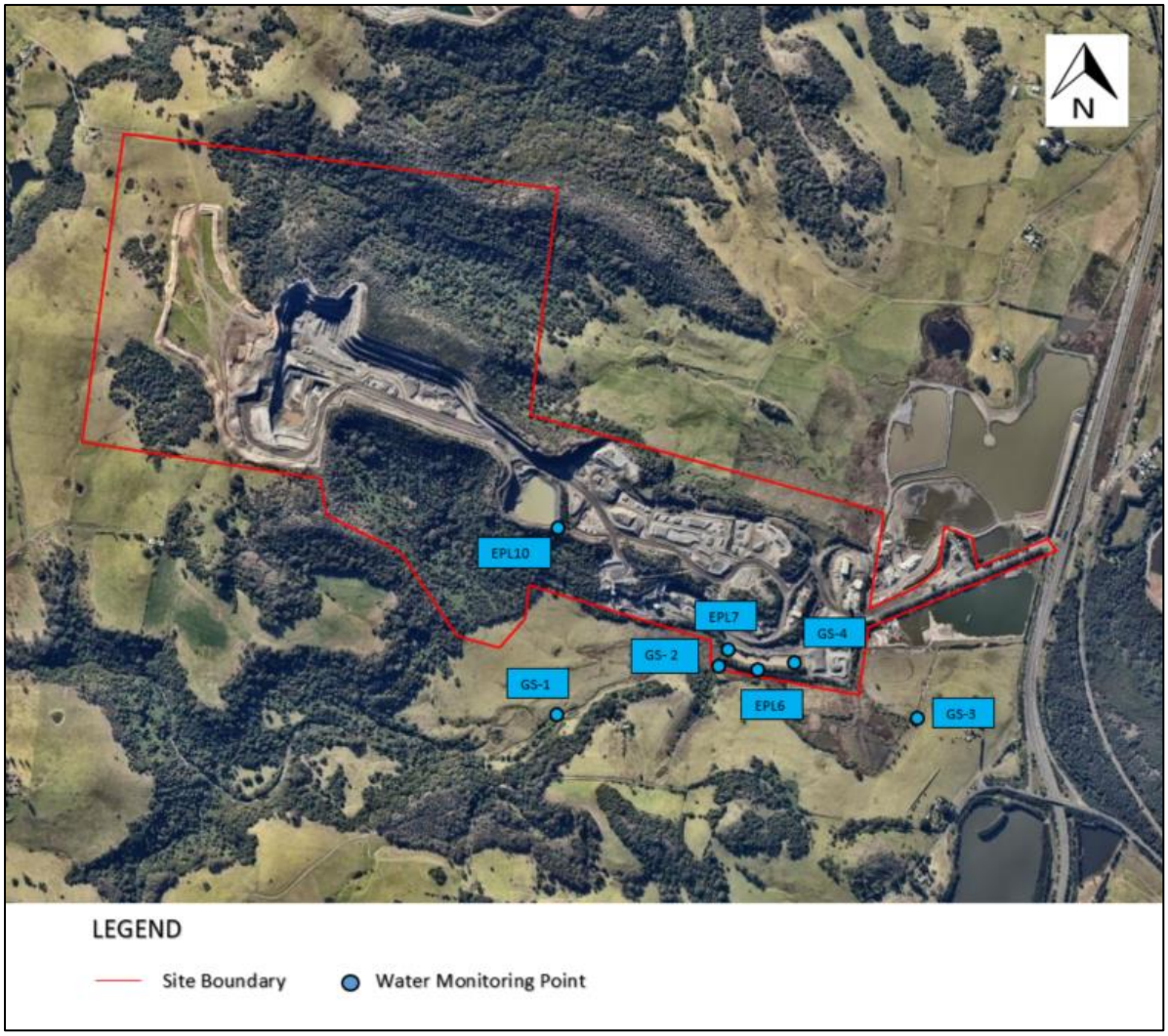

Figure 20 Surface water monitoring points

5.5.1. Surface Water Quality Impact Assessment

S4.C28 of the consent refers to discharge 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 GS1 and GS3 are also sampled to determine if any impacts to water quality have occurred.

5.5.2. Surface Water Quality FY22 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. 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 17 Water quality monitoring results at GS-1, GS-4/EPL#8, GS-2/EPL#7 and GS-3/EPL#9 over the reporting period.

	GS-1 Upstream of Rocklow Creek				EPL#8 Lower Dam			
Month	pH	Turbidity (NTU)	EC (µS/cm)	TSS (mg/L)	pH	Turbidity (NTU)	EC (µS/cm)	TSS (mg/L)
Jul-21	7.7	13	353	10	8.1	30	645	20
Aug-21	6.6	18	273	20	8	650	383	464
Sep-21	6.8	100	351	1	8.1	36	580	40
Oct-21	6.9	9.5	379	10	8.1	80	664	34
Nov-21	7.2	3	411	9	8.2	140	533	83
Dec-21	7.6	30	452	53	8.1	230	529	215
Jan-22	7.2	2.2	337	<0.1	8.1	110	508	51
Feb-22	7.1	12	197	7	7.9	218	375	103
Mar-22	6.6	37	166	38	7	24	229	47
Apr-22	7.2	6.3	294	2	7.7	110	511	12
May-22	7.1	28	190	18	8	230	339	252
Jun-22	7	3.8	300	4	8.2	75	483	62
FY22 Ave	7.08	21.90	308.58	15.64	7.96	161.08	481.58	115.25

	GS-2 Downstream of Rocklow Mixing Zone				GS-3 EPL#9 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-21	8.2	24	600	22	6.8	40	3250	49
Aug-21*	6.6	65	257	65	6.5	21	267	25
Sep-21	6.9	1.8	417	9	7.4	36	459	47
Oct-21	6.8	5	491	3	7.3	24	597	23
Nov-21	6.9	3.5	413	9	7.4	6.2	456	6
Dec-21	7.2	190	405	137	7.3	9.9	418	21
Jan-22	7.4	130	478	118	7.3	6.24	390	10
Feb-22	7.5	171	317	77	6.7	15.1	294	26
Mar-22*	7.6	245	353	164	6.9	8.25	269	15
Apr-22*	7.1	30	368	12	7.3	18	392	15
May-22*	7	40	209	35	7	34	185	33
Jun-22	7.2	20	304	15	6.9	95	407	104
FY22 Ave	7.20	77.11	384.33	55.50	7.07	26.14	615.33	31.17

Note *GS-2 inaccessible due to high water flow, sampled at EPL#7 instead

Prolonged rainfall between February and May 2022 led to discharge from Middle Dam to Lower Dam. The capacity of the Middle Dam is 120ML with an additional allowance of 12ML for accumulation of sediment in the dam base. Discharge from Middle Dam is directed into Lower Dam which is designed to hold water up to the 95th percentile 5 day rainfall event of 90.7mm. This was exceeded on several occasions as detailed in the following sections. During normal operations and rainfall conditions, the Lower Dam is kept offline to Rocklow Creek however in the case of high rainfall there is potential for floodwaters to back up around the narrow bend of the creek and inundate the Lower Dam, causing it to fill and create a mixing zone with waters from Lower Dam, compromising its storage capacity.

Overall there were seven (7) rainfall events which led to extended period of discharge from Middle Dam to the Lower Dam and from the Lower Dam via the spillway at EPL7 into Rocklow Creek. All of these rainfall events were outside the 95th percentile 5 day rainfall design capacity of the Lower Dam (90.7mm). Sampling had to be delayed until safe to do so for three (3) of these events. The EPA was notified of the delay as per condition M2.4. These seven events are summarised below.

Rainfall Event 1: 23rd February 2022

Between 23rd February and 28th February 2022, 204.6mm of rain fell within a 5 day period. This led to wide ranging flooding throughout the region and site closures on 25th and 26th February. This rainfall was well in excess of the design capacity of the Lower Dam which can hold a 5 day 95th percentile of 90.7mm as referenced in Schedule 4 Condition 30. As a result, the Lower Dam overflowed at the constructed spillway at EPL7 as uncontrolled discharge.

To maintain operations in the pit, accumulated water from this storm event was pumped out from the Croome sumps into the Middle Dam via an open channel. The Middle Dam subsequently overflowed at EPL10 as uncontrolled discharge which was directed into Lower Dam.

Sampling was undertaken daily during discharge as per EPL77 from the 24th February through to the 1st March 2022. The site was inaccessible due to flooding and safety concerns on the 25th and 26th February when the site was closed. No monitoring occurred on these dates and the EPA was notified of the delay as per condition M2.4. A summary of monitoring results associated with this event is shown below in Table 18.

Table 18 Rainfall Event 1: 23rd February 2022 Wet Weather Discharge Monitoring

23 February Wet Weather Discharge Monitoring (204.6mm rainfall in 5 days)					
Sample	**Date**	**pH**	**Turbidity (NTU)**	**Conductivity (µS/cm)**	**TSS (mg/L)**
GS-1	24/02/2022	7.8	16	269	14
EPL#7	24/02/2022	6.9	16	218	32
EPL#10	24/02/2022	8.3	2.6	623	6
EPL#9	24/02/2022	6.7	15.1	294	26
GS-1	27/02/2022	7.1	12	197	7
EPL#7	27/02/2022	7.5	171	317	77
EPL#10	27/02/2022	8.2	39	593	11

23 February Wet Weather Discharge Monitoring (204.6mm rainfall in 5 days)					
Sample	**Date**	**pH**	**Turbidity (NTU)**	**Conductivity (µS/cm)**	**TSS (mg/L)**
EPL#9	27/02/2022	6.8	16	215	10
GS-1	28/02/2022	7.2	11	235	8
EPL#7	28/02/2022	7.9	252	438	195
EPL#10	28/02/2022	8.2	42	590	23
EPL#9	28/02/2022	6.9	10	222	15
GS-1	1/03/2022	7.9	16	300	19
EPL#7	1/03/2022	7.9	168	475	117
EPL#10	1/03/2022	8.1	41	587	19
EPL#9	1/03/2022	6.9	9.8	253	18

Results show that the water discharging from Lower Dam at EPL7 had elevated measured total suspended solids (TSS) on three days resulting from this rainfall event. On those days the downstream water quality monitoring results for EPL9 were very similar to upstream values at GS-1 indicating that any potential impact from the overflow was not significant and limited to the mixing zone. Water discharged via the Lower Dam spillway flows through a reedy riparian zone which aids in removing suspended solids from floodwaters. Additionally, during these events Rocklow Creek was in flood and the discharge from Lower Dam was quickly diluted in the mixing zone.

Turbidity, Conductivity and pH values of the downstream site were very similar to the upstream site throughout this discharge event.

These results confirm the observations that elevated TSS was isolated to the immediate vicinity Lower Dam and the immediate mixing zone of the floodwaters with Rocklow Creek. No breach of licence conditions occurred as the rainfall event was outside of the design capacity of the dam as denoted by S4.C30. No complaints were and overall water quality downstream was comparable with the ambient upstream site.

Rainfall Event 2: 2nd March 2022

Between 2nd March and 6th March 2022 inclusive, 255.6mm of rain fell within a 5 day period which led to wide ranging flooding throughout the region. This rainfall was well in excess of the design capacity of the Lower Dam which can hold a 5 day 95th percentile of 90.7mm as referenced in Schedule 4 Condition 30. As a result, the Lower Dam overflowed at the constructed spillway at EPL7 as uncontrolled discharge.

To maintain safe operations in the pit, accumulated water from this storm event was pumped out from the Croome sumps into the Middle Dam via an open channel. Middle Dam subsequently overflowed at EPL10 as uncontrolled discharge which was directed into Lower Dam.

The site was inaccessible due to flooding and safety concerns for the duration of this rainfall event and monitoring was delayed until safe access was confirmed on 10th March, the

results of which are presented in Table 10. The EPA was notified of the delay as required by condition M2.4.

Rainfall Event 3: 7th March 2022

From 7th March 2022, 196mm of rain fell within the 5 day period to12th March 2022. This rainfall led to continued wide spread flooding throughout the region and was well in excess of the design capacity of the Lower Dam, and as a result, the Lower Dam overflowed at the constructed spillway at EPL 7 as uncontrolled discharge.

To maintain safe operations in the pit, accumulated water from this storm event was pumped out from the Croome sumps into the Middle Dam via an open channel. Middle Dam subsequently overflowed at EPL10 as uncontrolled discharge which was directed into Lower Dam.

The site was inaccessible due to flooding and safety concerns from the commencement of this rainfall event until 9 March and monitoring was delayed until safe access was confirmed on 10 March, the results of which are presented in Table 10. The EPA was notified of the delay as required by condition M2.4.

Following this rainfall event, as a result of groundwater saturation, catchment runoff and an additional 18mm of rainfall on the 19th March, discharge at EPL7 and EPL10 continued until 24th March. Daily monitoring was undertaken and the results are summarised in the Table 10 below. EPL7 was inaccessible from the 12th March to the 20th March due to high water flow and safety concerns.

A comparison of the Rocklow Creek upstream (GS1) and downstream (EPL9) results show that any potential impacts to the creek from the quarry discharge did not extend past the mixing zone. Whilst the immediate vicinity of the spillway (EPL7) had elevated measured total suspended solids (TSS) above 50mg/L on the 10/03/2022 and 11/03/2022 the corresponding results for the downstream point and upstream point were similar and lower in TSS indicating that any potential impacts from the overflow was minimal. This is due to the relatively small discharge volume compared to the flooded receiving waters as well as the reeds in the riparian zone which rapidly remove any suspended solids from these waters. This is also reflected in the turbidity results which were very similar between the upstream and downstream values.

Both the upstream and downstream EC results remained similar throughout this discharge event with the one exception of 21/03/2022. This day also showed downstream TSS slightly above the goal of 50mg/L. Both upstream and downstream pH results were very similar.

These results confirm the observations that elevated TSS was isolated to the immediate vicinity Lower Dam and mixing zone in Rocklow Creek. No breach of licence conditions occurred as the rainfall event was outside of the design capacity of the dam as denoted by S4.C30. No complaints were received and overall water quality at the downstream monitoring point as comparable with the ambient water quality during this rainfall event.

Table 19:7th March 2022 Wet Weather Discharge Monitoring

7th March Wet Weather Discharge Monitoring (196mm rain in 5 days)					
Sample	**Date**	**pH**	**Turbidity (NTU)**	**Conductivity (µS/cm)**	**TSS (mg/L)**
GS-1	10/03/2022	7.1	12	205	8
EPL#7	10/03/2022	7.7	114	415	74
EPL#10	10/03/2022	8.2	66	429	51
EPL#9	10/03/2022	7.75	10.1	287	11
GS-1	11/03/2022	6.8	8.23	225	7
EPL#7	11/03/2022	7.2	80.8	395	64
EPL#10	11/03/2022	7.9	74.3	446	26
EPL#9	11/03/2022	6.9	5.32	220	7
GS-1	12/03/2022	7.34	19.1	295	7
EPL#7*	12/03/2022				
EPL#10	12/03/2022	8.23	67.0	578	24
EPL#9	12/03/2022	7.05	10.2	323	10
GS-1	13/03/2022	7.1	6.5	237	5
EPL#7*	13/03/2022				
EPL#10	13/03/2022	8.2	69	463	26
EPL#9	13/03/2022	7	8.4	268	13
GS-1	14/03/2022	8.0	9.6	335	5
EPL#7*	14/03/2022				
EPL#10	14/03/2022	7.69	60.4	611	28
EPL#9	14/03/2022	7.15	3.6	361	11
GS-1	15/03/2022	6.9	3.84	255	3
EPL#7*	15/03/2022				
EPL#10	15/03/2022	8	42.8	471	29
EPL#9	15/03/2022	6.8	4.95	295	5
GS-1	16/03/2022	6.9	3.98	267	4
EPL#7*	16/03/2022				
EPL#10	16/03/2022	7.9	43.2	473	17
EPL#9	16/03/2022	6.8	7.04	327	11

7th March Wet Weather Discharge Monitoring (196mm rain in 5 days)					
Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
GS-1	17/03/2022	7.2	4	288	3
EPL#7*	17/03/2022				
EPL#10	17/03/2022	8.3	46	481	16
EPL#9	17/03/2022	7	10	342	19
GS-1	18/03/2022	6.9	3.02	278	6
EPL#7*	18/03/2022				
EPL#10	18/03/2022	8.3	33.6	500	21
EPL#9	18/03/2022	7	22.3	391	47
GS-1	19/03/2022	6.8	3.67	257	13
EPL#7*	19/03/2022				
EPL#10	19/03/2022	8.1	29.6	515	11
EPL#9	19/03/2022	6.9	16.3	365	37
GS-1	20/03/2022	7	8.21	242	9
EPL#7*	20/03/2022				
EPL#10	20/03/2022	8.1	37.5	487	18
EPL#9	20/03/2022	6.8	3.67	257	13
GS-1	21/03/2022	7	4.22	260	9
EPL#7	21/03/2022	7.6	98.4	487	62
EPL#10	21/03/2022	8	36.2	493	17
EPL#9	21/03/2022	7.8	104	501	58
GS-1	22/03/2022	7.4	3.88	289	4
EPL#7*	22/03/2022				
EPL#10	22/03/2022	8.5	30.4	501	15
EPL#9	22/03/2022	6.9	5.82	302	12
GS-1	23/03/2022	7	2.98	268	6
EPL#7*	23/03/2022				
EPL#10	23/03/2022	8.5	19.8	512	11
EPL#9	23/03/2022	6.9	8.21	315	22
GS-1	24/03/2022	7.4	3.8	302	2
EPL#7*	24/03/2022				

7th March Wet Weather Discharge Monitoring (196mm rain in 5 days)					
Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
EPL#10	24/03/2022	8.4	20	511	4
EPL#9	24/03/2022	7	20	367	45

*Note: site was not accessible

Rainfall Event 4: 25th March 2022

From 25th March 2022, 128 mm of rain fell within a 5 day period period to 30th March 2022. This rainfall led to continued wide spread flooding throughout the region and was well in excess of the design capacity of the Lower Dam, and as a result, the Lower Dam overflowed at the constructed spillway at EPL 7 as uncontrolled discharge.
To maintain safe operations in the pit, accumulated water from this storm event was pumped out from the Croome sumps into the Middle Dam via an open channel. Middle Dam subsequently overflowed at EPL10 as uncontrolled discharge which was directed into Lower Dam.

The site was inaccessible due to flooding and safety concerns on the 30 March. No monitoring occurred on this date and the EPA was notified of the delay as per condition M2.4.

Following this rainfall event, as a result of groundwater saturation, catchment runoff and an additional 40mm, 12.6mm and 21mm of rain on the 30th March, 31st March and 1st April respectively, discharge at EPL7 and EPL10 continued until 6 April. Daily monitoring was undertaken and the results are summarised in the Table 20 below. EPL7 was inaccessible on the 27th March due to high water flow and safety concerns.

Table 20: 25th March 2022 Wet Weather Discharge Monitoring

25th March Wet Weather Discharge Monitoring (128mm in 5 days)					
Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
GS-1	25/03/2022	6.6	37	166	38
EPL#7	25/03/2022	7.6	345	353	164
EPL#10	25/03/2022	8	23	508	2
EPL#9	25/03/2022	7	24	299	47
GS-1	26/03/2022	7	21	174	11
EPL#7	26/03/2022	7.9	508	338	335
EPL#10	26/03/2022	8	27	520	2
EPL#9	26/03/2022	6.9	26	154	17
GS-1	27/03/2022	7	15	198	12
EPL#7*	27/03/2022				
EPL#10	27/03/2022	8	31	550	7

25th March Wet Weather Discharge Monitoring (128mm in 5 days)					
Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
EPL#9	27/03/2022	6.8	15	203	7
GS-1	28/03/2022	7.2	20	173	16
EPL#7	28/03/2022	7.3	45	191	28
EPL#10	28/03/2022	8.2	30	525	12
EPL#9	28/03/2022	7	16	192	14
GS-1	29/03/2022	7.1	105	129	154
EPL#7	29/03/2022	7.8	548	421	563
EPL#10	29/03/2022	8.1	22	501	11
EPL#9	29/03/2022	7.1	15	200	11
GS-1	31/03/2022	7.1	16	188	15
EPL#7	31/03/2022	7.3	106	260	64
EPL#10	31/03/2022	8.1	48	510	24
EPL#9	31/03/2022	7	20	206	13
GS-1	1/04/2022	7.0	26	203	14
EPL#7	1/04/2022	7.9	450	418	668
EPL#10	1/04/2022	8.1	55	515	25
EPL#9	1/04/2022	7.1	24	205	14
GS-1	2/04/2022	7.1	25	220	14
EPL#7	2/04/2022	7.5	260	370	246
EPL#10	2/04/2022	7.9	55	797	20
EPL#9	2/04/2022	7.1	22	218	14
GS-1	3/04/2022	7	19	226	5
EPL#7	3/04/2022	7.4	70	353	33
EPL#10	3/04/2022	7	45	489	11
EPL#9	3/04/2022	7.1	22	250	23
GS-1	4/04/2022	7.1	12	252	5
EPL#7	4/04/2022	6.9	30	284	24
EPL#10	4/04/2022	8.1	40	485	11
EPL#9	4/04/2022	7.0	10	280	10
GS-1	5/04/2022	8.3	38	262	15

25th March Wet Weather Discharge Monitoring (128mm in 5 days)					
Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
EPL#7	5/04/2022	7.6	65	480	51
EPL#10	5/04/2022	8.2	9.7	484	16
EPL#9	5/04/2022	7.0	65	303	21
GS-1	6/04/2022	7.0	9.7	263	14
EPL#7	6/04/2022	7.0	25	380	21
EPL#10	6/04/2022	8.3	32	464	17
EPL#9	6/04/2022	7.1	7.7	327	14

*Note: site was not accessible due to floodwater levels

A comparison of the Rocklow Creek upstream (GS1) and downstream (EPL9) results show that any potential impacts to the creek from the quarry discharge did not extend past the mixing zone. Whilst the immediate vicinity of the spillway (EPL7) had elevated measured total suspended solids (TSS) above 50mg/L on seven occasions, the corresponding results for the downstream point and upstream point were similar and lower in TSS indicating that any potential impacts from the overflow was minimal. This is due to the relatively small discharge volume compared to the flooded receiving waters as well as the reeds in the riparian zone which rapidly remove any suspended solids from these waters.

Turbidity, Conductivity and pH values of the downstream site were very similar to the upstream site throughout this discharge event.

These results confirm the observations that elevated TSS was isolated to the immediate vicinity Lower Dam and the immediate mixing zone of the floodwaters from Rocklow Creek. No breach of consent condition occurred as the rainfall event was outside of the design capacity of the dam as denoted by S4.C30. No complaints were received and overall water quality at the downstream monitoring point as comparable with the ambient water quality during this rainfall event.

Rainfall Event 5: 7th April 2022

From 7th April 2022, 152.6 mm of rain fell within a 5 day period to 12th April 2022. This rainfall led to continued wide spread flooding throughout the region and was well in excess of the design capacity of the Lower Dam, and as a result, the Lower Dam overflowed at the constructed spillway at EPL 7 as uncontrolled discharge.

To maintain safe operations in the pit, accumulated water from this storm event was pumped out from the Croome sumps into the Middle Dam via an open channel. Middle Dam subsequently overflowed at EPL10 as uncontrolled discharge which was directed into Lower Dam. Pumping from the Croome sumps ceased over the Easter break and no discharge occurred from 14th to 19th April.

Following this rainfall event, as a result of groundwater saturation, catchment runoff and an additional 13.2mm, 6.4mm and 7.4mm rain on 14th April, 20th April and 28th April respectively, discharge at EPL7 and EPL10 continued until 9th May. Daily monitoring was undertaken and the results are summarised in the **Table 21** below. EPL7 was inaccessible from the 20th to the 23rd April due to high water flow.

Table 21 Rainfall Event 5: 7th April 2022 Wet Weather Discharge Monitoring

7th April Wet Weather Discharge Monitoring (152.6mm rainfall in 5 days)					
Sample	**Date**	**pH**	**Turbidity (NTU)**	**Conductivity (µS/cm)**	**TSS (mg/L)**
GS-1	7/04/2022	7.1	20	211	4.0
EPL#7	7/04/2022	7.1	22	224	6.5
EPL#10	7/04/2022	7.0	22	190	7.0
EPL#9	7/04/2022	8.1	32	369	4.5
GS-1	8/04/2022	7.0	29	187	24
EPL#7	8/04/2022	7.0	37	235	25
EPL#10	8/04/2022	8.1	50	471	32
EPL#9	8/04/2022	6.9	26	179	22
GS-1	9/04/2022	7.0	29	211	13
EPL#7	9/04/2022	6.8	23	283	31
EPL#10	9/04/2022	8.0	45	495	30
EPL#9	9/04/2022	6.9	20	243	10
GS-1	10/04/2022	7.2	22	208	3
EPL#7	10/04/2022	8.0	170	425	87
EPL#10	10/04/2022	8.4	40	484	13
EPL#9	10/04/2022	8.4	26	285	14
GS-1	11/04/2022	7.1	16	234	16
EPL#7	11/04/2022	7.0	11	265	33
EPL#10	11/04/2022	8.7	33	505	16
EPL#9	11/04/2022	7.1	16	267	23
GS-1	12/04/2022	7.1	15	249	14
EPL#7	12/04/2022	7.1	95	454	68
EPL#10	12/04/2022	8.4	29	505	25
EPL#9	12/04/2022	7.0	11	275	14
GS-1	13/04/2022	6.9	13	256	5
EPL#7	13/04/2022	7.8	90	471	24
EPL#10	13/04/2022	8.2	32	496	11
EPL#9	13/04/2022	7.0	17	304	10
GS-1	20/04/2022	7.0	3.7	306	10

7th April Wet Weather Discharge Monitoring (152.6mm rainfall in 5 days)					
Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
EPL#7*	20/04/2022				
EPL#10	20/04/2022	8.8	21	489	15
EPL#9	20/04/2022	7.6	25	373	13
GS-1	21/04/2022	7.0	5.9	305	9
EPL#7*	21/04/2022				
EPL#10	21/04/2022	8.6	18	496	16
EPL#9	21/04/2022	7.2	12	385	14
GS-1	22/04/2022	7.1	12	282	3
EPL#7*	22/04/2022				
EPL#10	22/04/2022	8.4	26	464	5
EPL#9	22/04/2022	7.6	22	370	11
GS-1	23/04/2022	7.6	19	318	8
EPL#7*	23/04/2022				
EPL#10	23/04/2022	8.1	24	470	5
EPL#9	23/04/2022	7.2	21	358	6
GS-1	24/04/2022	7.0	15	288	7
EPL#7	24/04/2022	7.9	290	506	315
EPL#10	24/04/2022	7.8	27	462	16
EPL#9	24/04/2022	7.0	20	366	12
GS-1	25/04/2022	6.9	15	287	5
EPL#7	25/04/2022	6.9	23	347	10
EPL#10	25/04/2022	7.9	27	459	8
EPL#9	25/04/2022	6.9	13	358	14
GS-1	26/04/2022	7.1	11	303	5
EPL#7	26/04/2022	7.0	22	335	11
EPL#10	26/04/2022	8.2	24	454	11
EPL#9	26/04/2022	7.0	15	362	12
GS-1	27/04/2022	7.2	6.3	294	2
EPL#7	27/04/2022	7.1	30	368	12
EPL#10	27/04/2022	8.1	24	451	2

7th April Wet Weather Discharge Monitoring (152.6mm rainfall in 5 days)					
Sample	**Date**	**pH**	**Turbidity (NTU)**	**Conductivity (µS/cm)**	**TSS (mg/L)**
EPL#9	27/04/2022	7.3	20	392	10
GS-1	28/04/2022	7.3	22	309	8
EPL#7	28/04/2022	7.1	90	384	51
EPL#10	28/04/2022	8.2	32	444	9
EPL#9	28/04/2022	7.1	20	366	17
GS-1	29/04/2022	7.2	11	305	10
EPL#7	29/04/2022	7.9	36	492	110
EPL#10	29/04/2022	8.2	22	448	19
EPL#9	29/04/2022	7.1	13	366	16
GS-1	30/04/2022	7.1	9.7	291	2
EPL#7	30/04/2022	7.2	32	392	25
EPL#10	30/04/2022	7.7	26	427	15
EPL#9	30/04/2022	7.2	13	375	12
GS-1	1/05/2022	7.1	2	301	3
EPL#7	1/05/2022	7.6	100	504	46
EPL#10	1/05/2022	8.3	13	443	9
EPL#9	1/05/2022	7.4	2.9	402	1
GS-1	2/05/2022	7.1	1.8	297	4
EPL#7	2/05/2022	7.9	80	508	53
EPL#10	2/05/2022	8.3	13	454	15
EPL#9	2/05/2022	7.1	5.3	393	15
GS-1	3/05/2022	7	1.3	307	3
EPL#7	3/05/2022	7.9	85	507	60
EPL#10	3/05/2022	8	10	448	9
EPL#9	3/05/2022	7.1	7.9	410	27
GS-1	4/05/2022	7.1	1.2	307	7
EPL#7	4/05/2022	7.8	90	524	54
EPL#10	4/05/2022	8.2	11	448	11
EPL#9	4/05/2022	7.1	2.5	402	10
GS-1	5/05/2022	7.1	1.2	300	4

7th April Wet Weather Discharge Monitoring (152.6mm rainfall in 5 days)					
Sample	**Date**	**pH**	**Turbidity (NTU)**	**Conductivity (µS/cm)**	**TSS (mg/L)**
EPL#7	5/05/2022	7.2	13	391	15
EPL#10	5/05/2022	8.4	10	462	9
EPL#9	5/05/2022	7.1	3	417	9
GS-1	6/05/2022	7	0.8	300	15
EPL#7	6/05/2022	7.9	80	520	61
EPL#10	6/05/2022	8.2	9.3	454	21
EPL#9	6/05/2022	7.2	5.7	418	34
GS-1	7/05/2022	6.9	7.4	307	1
EPL#7	7/05/2022	7.7	85	422	70
EPL#10	7/05/2022	8	26	462	3.5
EPL#9	7/05/2022	7.8	22	432	18
GS-1	8/05/2022	7	6.9	302	1
EPL#7	8/05/2022	7.9	90	531	57
EPL#10	8/05/2022	8.2	29	459	8
EPL#9	8/05/2022	7.3	18	435	5
GS-1	9/05/2022	6.9	8.1	299	3
EPL#7	9/05/2022	7.4	38	457	25
EPL#10	9/05/2022	8.2	30	457	5
EPL#9	9/05/2022	7	18	438	13

*Note: Site not accessible

A comparison of the Rocklow Creek upstream (GS1) and downstream (EPL9) results show that any potential impacts to the creek from the quarry discharge did not extend past the mixing zone. Whilst the immediate vicinity of the spillway (EPL7) had elevated measured total suspended solids (TSS) above 50mg/L on 11 occasions, the corresponding results for the downstream point and upstream point were similar and lower in TSS indicating that any potential impacts from the overflow was minimal. This is due to the relatively small discharge volume compared to the flooded receiving waters as well as the reeds in the riparian zone which rapidly remove any suspended solids from these waters.

Turbidity, Conductivity and pH values of the downstream site were very similar to the upstream site throughout this discharge event.

These results confirm the observations that elevated TSS was isolated to the immediate vicinity Lower Dam and the immediate mixing zone of the floodwaters from Rocklow Creek. No breach of consent condition occurred as the rainfall event was outside of the design

capacity of the dam as denoted by S4.C30. No complaints were received and overall water quality at the downstream site was comparable with the upstream ambient site.

Rainfall Event 6: 10th May 2022

From 10th May 2022, 91.4 mm of rain fell within a 5 day period to 15th May 2022. This rainfall led to continued wide spread flooding throughout the region and was well in excess of the design capacity of the Lower Dam, and as a result, the Lower Dam overflowed at the constructed spillway at EPL 7 as uncontrolled discharge.

To maintain safe operations in the pit, accumulated water from this storm event was pumped out from the Croome sumps into the Middle Dam via an open channel. Middle Dam subsequently overflowed at EPL10 as uncontrolled discharge which was directed into Lower Dam.

Following this rainfall event, as a result of groundwater saturation and catchment runoff discharge at EPL7 and EPL10 continued until 20th May. Daily monitoring was undertaken and the results are summarised in the Table 22 below.

Table 22 Rainfall Event 6: 10th May 2022 Wet Weather Discharge Monitoring

10th May Wet Weather Discharge Monitoring (91.4mm rainfall in 5 days)					
Sample	**Date**	**pH**	**Turbidity (NTU)**	**Conductivity (µS/cm)**	**TSS (mg/L)**
GS-1	10/05/2022	7.1	6.2	303	2
EPL#7	10/05/2022	8.1	400	500	293
EPL#10	10/05/2022	8	14	460	3.5
EPL#9	10/05/2022	7.3	6.2	432	4.5
GS-1	11/05/2022	7.2	14	279	10
EPL#7	11/05/2022	8	600	453	293
EPL#10	11/05/2022	8.1	19	458	3
EPL#9	11/05/2022	7.2	16	321	7
GS-1	12/05/2022	7.1	30	194	16
EPL#7	12/05/2022	7	32	250	20
EPL#10	12/05/2022	8	21	442	5.5
EPL#9	12/05/2022	6.9	29	217	13
GS-1	13/05/2022	8.1	31	233	18
EPL #7	13/05/2022	7.1	35	231	15
EPL #10	13/05/2022	8.2	31	430	14
EPL#9	13/05/2022	6.9	32	192	14
GS-1	14/05/2022	7.1	18	221	7.5
EPL #7	14/05/2022	7.6	160	360	90

10th May Wet Weather Discharge Monitoring (91.4mm rainfall in 5 days)					
Sample	Date	pH	Turbidity (NTU)	Conductivity (µS/cm)	TSS (mg/L)
EPL #10	14/05/2022	8.2	32	421	12
EPL#9	14/05/2022	7.1	16	247	7.5
GS-1	15/05/2022	7.1	12	240	7
EPL #7	15/05/2022	6.8	29	315	21
EPL #10	15/05/2022	8.2	29	418	12
EPL#9	15/05/2022	6.8	9	277	7
GS-1	16/05/2022	7.2	11	255	7.5
EPL #7	16/05/2022	7	13	296	10
EPL #10	16/05/2022	8.2	27	424	12
EPL#9	16/05/2022	7	6.9	297	6.5
GS-1	17/05/2022	7.1	8.8	257	2
EPL#7	17/05/2022	7.8	140	449	100
EPL#10	17/05/2022	8.1	35	430	19
EPL#9	17/05/2022	7.2	7.3	303	4
GS-1	18/05/2022	7	6.8	262	6.5
EPL#7	18/05/2022	7.7	140	442	116
EPL#10	18/05/2022	8.1	35	430	28
EPL#9	18/05/2022	7.1	8.4	327	28
GS-1	19/05/2022	7.4	4.5	302	11
EPL#7	19/05/2022	7.9	140	454	116
EPL#10	19/05/2022	8.1	29	433	30
EPL#9	19/05/2022	7.1	4.7	332	11
GS-1	20/05/2022	7	4.6	270	1.5
EPL#7	20/05/2022	7.8	120	469	81
EPL#10	20/05/2022	8.1	39	420	15
EPL#9	20/05/2022	7	15	332	32

A comparison of the Rocklow Creek upstream (GS1) and downstream (EPL9) results show that any potential impacts to the creek from the quarry discharge did not extend past the mixing zone. Whilst the immediate vicinity of the spillway (EPL7) had elevated measured total suspended solids (TSS) above 50mg/L on seven occasions, the corresponding results for the downstream point and upstream point were similar and lower in TSS indicating that

any potential impacts from the overflow was minimal. This is due to the relatively small discharge volume compared to the flooded receiving waters as well as the reeds in the riparian zone which rapidly remove any suspended solids from these waters

Turbidity, Conductivity and pH values of the downstream site were very similar to the upstream site throughout this discharge event.

These results confirm the observations that elevated TSS was isolated to the immediate vicinity Lower Dam and the immediate mixing zone of the floodwaters from Rocklow Creek. No breach of consent condition occurred as the rainfall event was outside of the design capacity of the dam as denoted by S4.C30. No complaints were received and overall water quality at the downstream site was comparable with the upstream ambient site.

Rainfall Event 7 23rd May 2022

Starting on 23rd May 2022, 90.6mm of rain fell within a three day period up until 25th May 2022. This rainfall was in line with the design capacity of the Lower Dam which can hold a 5 day 95th percentile of 90.7mm as referenced in Schedule 4 Condition 30. However, due to high groundwater levels, and saturated catchment conditions, this rainfall caused the Lower Dam to overflow at the constructed spillway at EPL 7 as uncontrolled discharge.

To maintain safe operations in the pit, accumulated water from this storm event was pumped out from the Croome sumps into the Middle Dam via an open channel. Middle Dam subsequently overflowed at EPL10 as uncontrolled discharge which was directed into Lower Dam.

Overflow was monitored for three days at EPL7 and EPL10 and daily monitoring results are summarised in the Table 23 below.

Table 23 Rainfall Event 7: 23 May 2022 Wet Weather Discharge Monitoring

23 May Wet Weather Discharge Monitoring (90.6mm rainfall in 5 days)					
Sample	**Date**	**pH**	**Turbidity (NTU)**	**Conductivity (µS/cm)**	**TSS (mg/L)**
GS-1	23/05/2022	7.1	28	170	18
EPL#7	23/05/2022	7	40	184	35
EPL#10	23/05/2022	8.2	28	282	16
EPL#9	23/05/2022	8	230	232	252
GS-1	24/05/2022	7	18	220	10
EPL#7	24/05/2022	7	21	278	17
EPL#10	24/05/2022	8	40	434	25
EPL#9	24/05/2022	6.8	17	232	18
GS-1	25/05/2022	7	15	221	10
EPL#7	25/05/2022	7.1	22	289	13
EPL#10	25/05/2022	8	32	427	26
EPL#9	25/05/2022	6.9	12	268	14

On 23rd May the downstream site showed elevated TSS and Turbidity which did not correspond to elevated discharge solids. Variability in pH and Conductivity was similar to previous events. This is likely a result of general sediment movement within the catchment following the extended period of high flow.

Water discharged via EPL7 into Rocklow Creek during this rainfall event met the water quality objectives for all parameters. No breach of consent condition occurred as the rainfall event was outside of the design capacity of the dam as denoted by S4.C30. No complaints were received. With one exception, overall water quality downstream was comparable with the upstream ambient quality.

5.5.3. Surface Water Long Term Analysis and Trends

The Lower Dam (GS-4/EPL#8) ambient water quality for the 2022 reporting period was above average for Turbidity and TSS. The average for conductivity was lower than the long term overall average while pH was closer to neutral than in previous reporting periods. These trends are due to the above average rainfall and extreme flooding events experienced throughout the reporting period. The results are provided in Figures 21 to Figure 24 below.

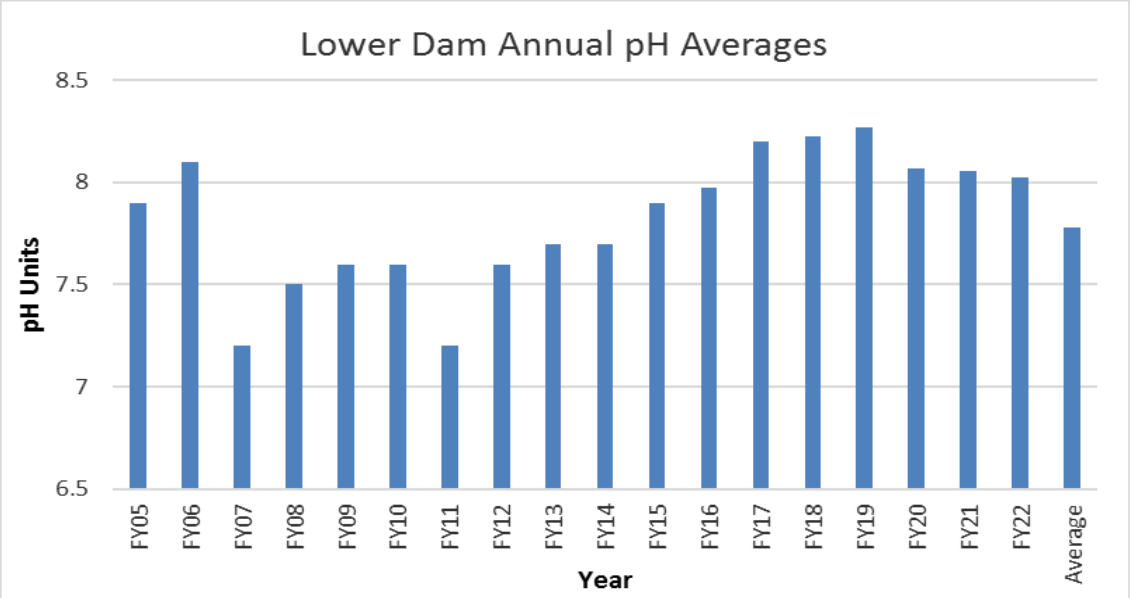

Figure 21 Lower Dam Annual pH Averages

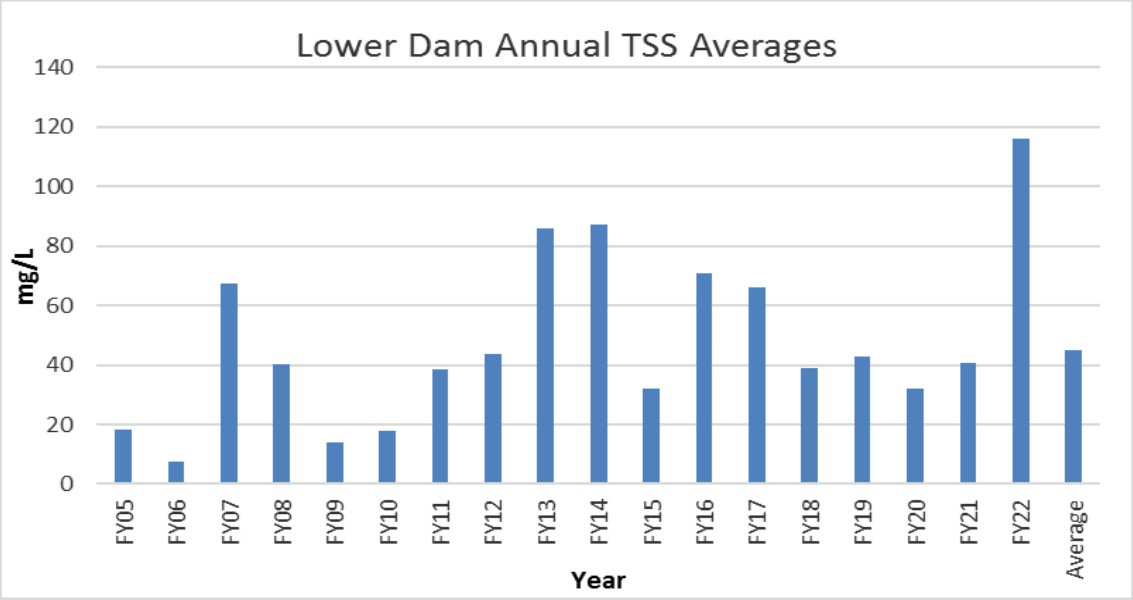

Figure 22 Lower Dam Annual TSS Averages

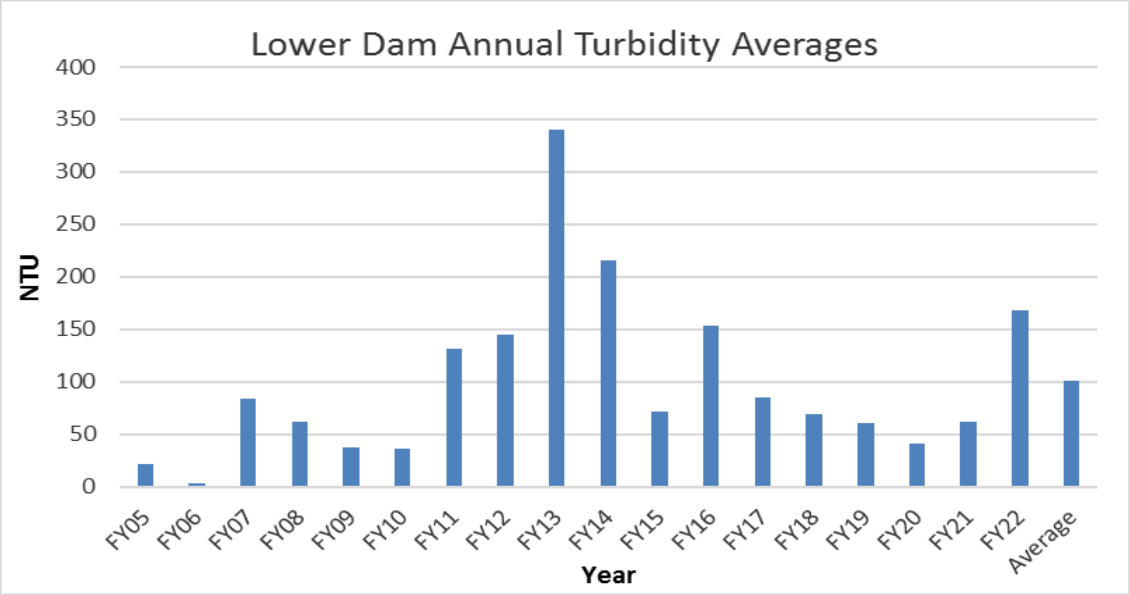

Figure 23 Lower Dam Annual Turbidity Averages

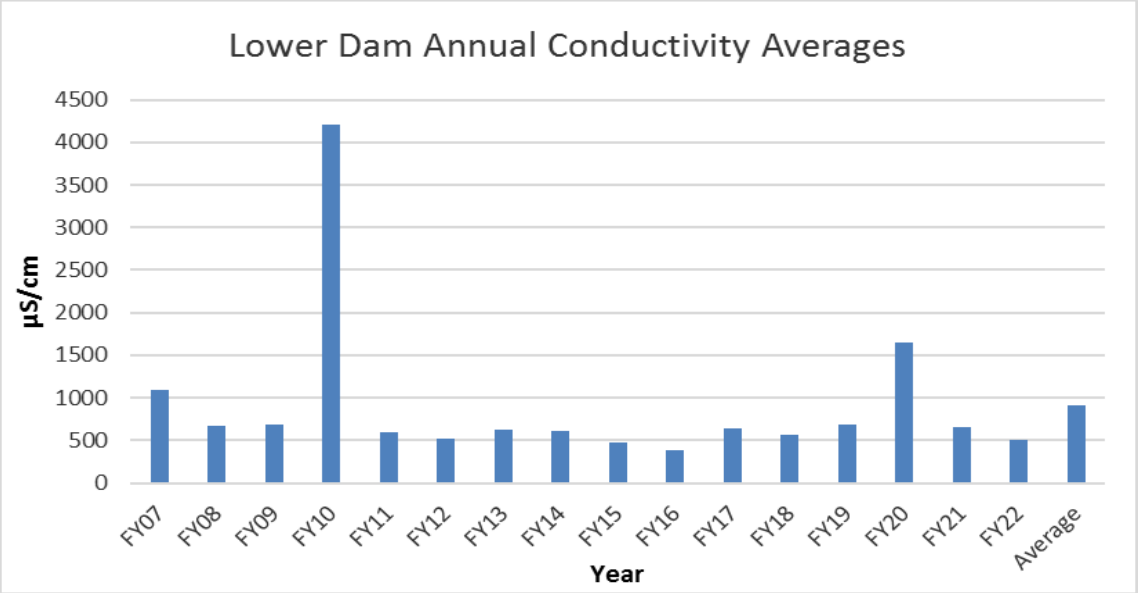

Figure 24 Lower Dam Annual Conductivity Averages

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 including dust suppression and process water, or lost to evaporation, 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. The NSW Natural Resources Access Regulator has delayed rollout of new metering framework for non-urban water take for coastal regions until 1 December 2023 for pumps below 500 mm.

The quarry recycles water collected in the three main pollution control storages. The Croome Sump is located within the extraction pit void and has a nominal volume of 40 ML, however being located within the extraction area it can be used to temporarily store significantly greater volumes during high rainfall periods.

Following periods of high rainfall, excess water is pumped to Middle Dam which overflows into the Lower Dam. Process water can be pumped from either the Middle Dam or the Lower Dam into storage tanks located adjacent to the processing plant area. This water is then used in the processing plant as well as filling the water cart for haul road dust suppression.

The location of water storage infrastructure is shown below in Figure 25 while a generalised schematic is provided in Figure 26.

Figure 25 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 FY22 period (annual rainfall was 1,978mm) as shown in Figure 26. 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.

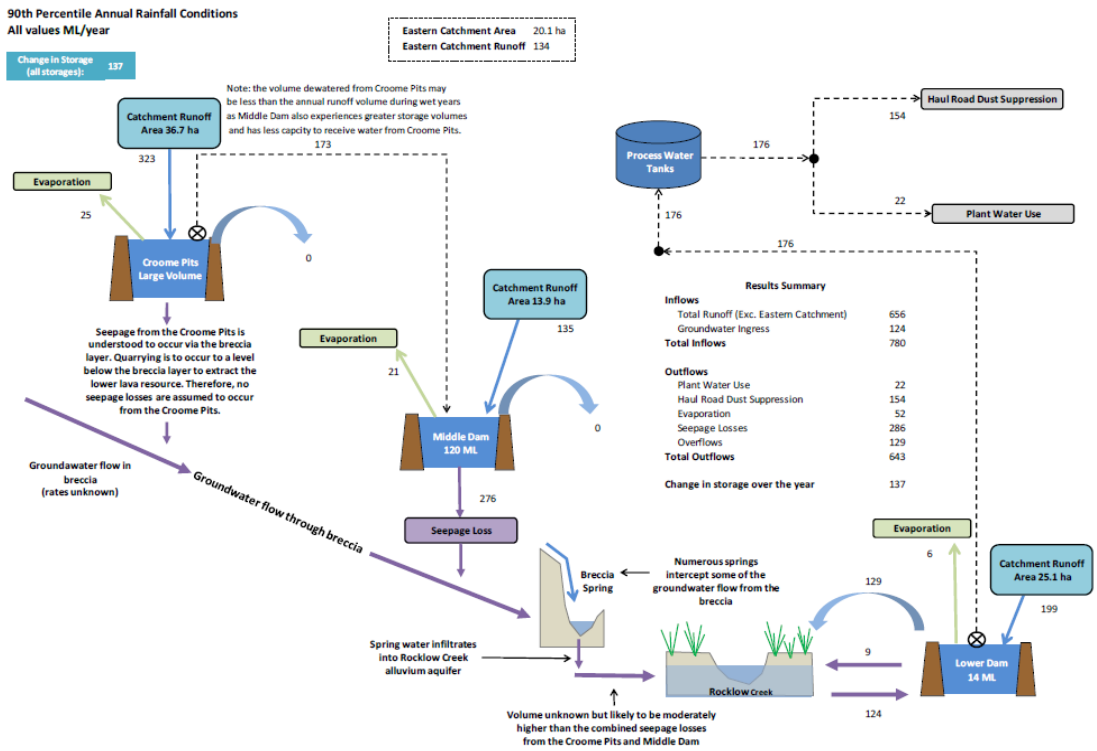

Figure 4.8 Existing water management system: typical wet year results

Figure 26 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 upgraded over the past few years. The main changes have included:

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

Boral is currently in the process of updating the water management plan which will seek approval for a number of additional improvements. These improvement are designed to reduce the instances where Rocklow Creek inundates the Lower Dam causing it to fill up. A summary of these improvements is provided in Table 19 below and will be addressed in the updated WMP.

Table 21 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. Relocate primary sedimentation chamber to western end of dam. Raise embankment at existing spillway location from 2.8 to 4.0 m AHD.	• 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. • 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 43, Schedule 4 of the consent. This report is included in full within Appendix E. The monitoring program uses the established down gradient bores at Dunmore Sand and Soil (DG-17, DG-21 and DG-31) and four established up gradient bores at Dunmore Quarry (GW-1, GW-2, GW-3 and GW-4). Location of Groundwater monitoring bores are shown below in Figure 27.

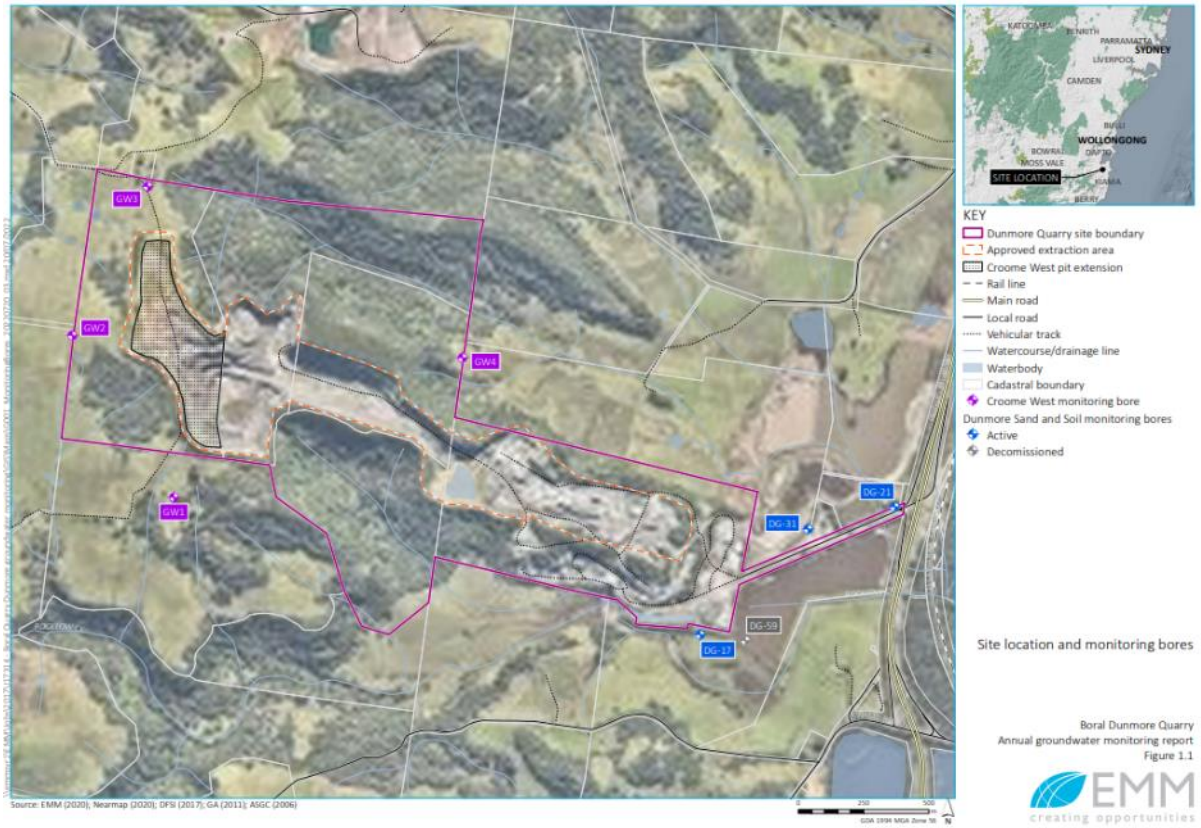

Figure 27 Groundwater Monitoring Bores

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 quarterly 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 FY22 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 FY22 monitoring year regarding water levels are:

- Groundwater level trends in the alluvium (DG-17, DG-31 and DG-21) are comparable to the previous monitoring period. The shallow alluvium shows a direct and immediate response to rainfall with DG-21 and DG-31 showing the most pronounced response.
- There is an increasing trend in groundwater levels across the alluvium from September 2021 onwards which reflects the observed above average rainfall conditions over this period.

- 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. Although GW1 is deeper, this bore is partially screened within the Kiama Sandstone, which responds to regional groundwater recharge.
- Groundwater quality data collected during the 2021/2022 monitoring year was generally consistent with previous years. The exceptions were in June 2022 for phosphorus at GW1, which had increased and was the highest result on record, and in August 2021 for a spike in nitrate at DG-17. Groundwater is marginal to brackish, with a neutral to slightly alkaline pH.
- The dissolved metal results were comparable to the previous sampling results, and iron was typically higher in the alluvial groundwater and manganese was typically higher at the Bumbo Latite monitoring sites (GW1, GW2 and GW4).
- Nitrate results at GW3 continue to be an order of magnitude higher than the other Bumbo Latite and alluvial monitoring bores. This could be related to the proximity to farmland. Total phosphorus results continue to be an order of magnitude higher at DG-17 compared to the other alluvial and Bumbo Latite bores.

The results for the FY22 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 to collect background information for any associated future modifications of consent.

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 28.

Figure 28 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 29 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 with a focus on continuing primary weed control top protect and enhance natural vegetation within the bushland remnants. This work is summarised in the Annual Monitoring report located in Appendix E.

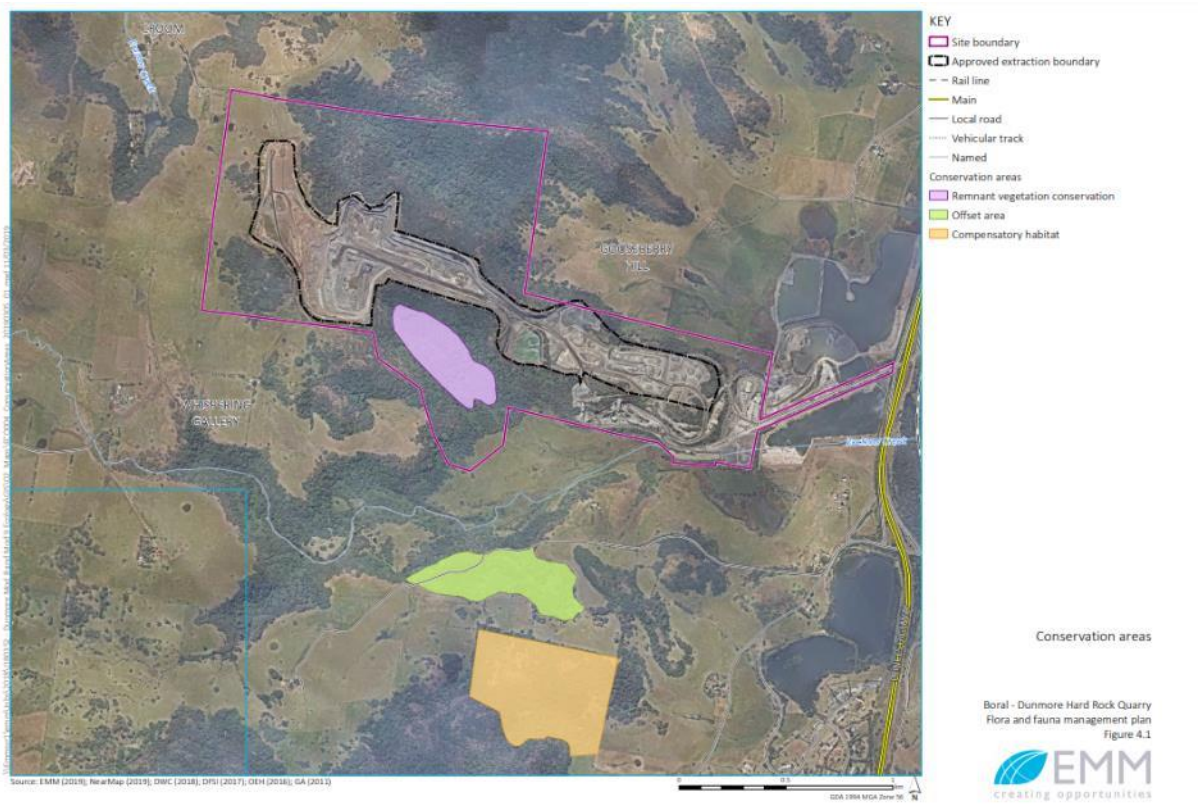

Figure 29 Conservation Areas

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. Independent Audit

The 3 yearly Independent Environmental Audit (IEA) was undertaken for Boral Resources NSW Pty Limited's Dunmore Hard Rock Quarry (DA 470-11-2003) by Environmental Property Services (EPS) in August 2020 as required by Condition 10 in Schedule 5 (COA 10). The IEA scope outlined in COA 10 required the assessment of Plans required by the Development Consent, including assessing the performance, reviewing the adequacy and recommending actions or measures to improve the performance of the Flora and Fauna Management Plan (See IEA page 89).

A similar audit of the Flora and Fauna Management Plan conducted every 5 years is required by Condition 51 in Schedule 4 (COA 51). COA 51 was one of the original requirements when the consent was approved in 2003. The requirement for the IEA was added when Modification 8 was approved in 2016.

Boral contends that the IEA required in COA 10 satisfies the audit requirement outlined by COA 51 and is superior as the IEA occurs every 3 years compared to the 5 yearly audit required in COA 51. It appears that the audit required by COA 51 may have been overlooked in the drafting of new conditions for Modification 8.

Condition 3 in Schedule 3 outlines that if there is any inconsistency between the consent conditions the most recent document prevails, further supporting that the IEA in COA 10 satisfies the audit requirement in COA 51.

Boral Resources NSW Pty Limited has sent a letter in September 2022 to confirmation from the Secretary that the IEA satisfies the audit requirement in COA 51.

5.7.3. Flora and Fauna and Rehabilitation FY22 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.

5.7.3.1. Zone 1 Remnant Vegetation Conservation Area

In the past, works within the RVCA zone have consisted of primary weed control activities targeting woody weeds throughout the established approximately 15 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 has previously been carried out within this zone.

No works were carried out within this Zone during the reporting period due to the lack of fencing surrounding the site. Work will recommence within this area once the fencing has been repaired to keep the cattle out. Fencing of this area was not possible during the reporting period due to extended rainfall restricting access to the site. Large amounts of Gorse (*Ulex europaeus*) is thriving in the paddocks surrounding this zone. Illawarra District Weeds Authority (IDWA) have been notified to treat the infestation as part of their Gorse control program.

Table 22 RVCA1 vegetation condition summary

Photo Point	RVCA1		
Commencement of works date	September 2021		
Completion of works date	August 2022		
Vegetation condition		Percentage cover prior to works	Percent cover post works
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of *Melaleuca armillaris* and *Acacia maidenii*	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by *Solanum mauritianum**	20% native cover 80% weed cover	0% native cover 0% weed cover
Shrub Layer	The shrub layer surrounding this photo point is dominated by *Lantana camara** and *Ulex europaeus**	0% native cover 100% 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 *Lantana camara, Bidens pilosa** and *Pellaea falcata*	60% native cover 30% weed cover	70% native cover 30% weed cover

*Indicates exotic plant species

a) Photopoint prior to primary weed control November 2019

b) Similar area after primary weed control, September 2020

Figure 30 Photomontage of vegetation condition at RVCA1

Table 23 RVCA2 vegetation condition summary

Photo Point	RVCA2		
Commencement of works date	September 2021		
Completion of works date	August 2022		
Vegetation condition		Percentage cover prior to works	Percent cover post works
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of *Melaleuca armillaris* and *Acacia maidenii*	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by *Solanum mauritianum**	20% native cover 80% weed cover	0% native cover 0% weed cover
Shrub Layer	The shrub layer surrounding this photo point is dominated by *Lantana camara** and *Ulex europaeus**	0% native cover 100% 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 *Lantana camara*, Bidens Pilosa** and *Pellaea falcata*	60% native cover 30% weed cover	70% native cover 30% weed cover

*Indicates exotic plant species

a) Photopoint prior to primary weed control November 2019

b) Similar area after primary weed control, September 2020

Figure 31 Photomontage of vegetation condition at RVCA2

5.7.3.2. Zone 2 Offset Area

This contract period bush regeneration works focused on secondary and primary weed control within the woodland remnants and the rainforest ecotone at the eastern extent of this zone. Rainfall has been adequate this year compared to prior years and regeneration of weeds and natives has become more widespread. Mass regeneration of rainforest pioneer species has been a positive sign and several additional local native plants have appeared within this area over the past 12 months.

Extensive 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 24 Zone 2a Melaleuca armillaris Tall Shrubland vegetation condition summary

Photo Point	**A1, A3**		
Commencement of works date	September 2021		
Completion of works date	August 2022		
Vegetation condition		Percentage cover prior to works	Percent cover post works
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of *Melaleuca armillaris* and *Eucalyptus tereticornis*	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by *Zieria granulate, Dodonea viscosa* and *Olea europaea* subsp. *Cuspidate**	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* and *Leucopogon juniperinus*	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** and *Tagetes minuta**	40% native cover 60% weed cover	95% native cover 5% weed cover

*Indicates exotic plant species

a) A1 Photo point prior to commencement of works in 2017

b) A1 Photo point after primary weed control and maintenance, August 2022

c) A3 Photo point prior to commencement of works in 2017

d) A3 Photo point: regeneration of woodland species and *Zieria granualata*, August 2022

Figure 32 Photomontage of vegetation condition at Zone 2a

Table 25 Zone 2c vegetation condition summary

Photo Point	A2		
Commencement of works date	September 2021		
Completion of works date	August 2022		
Vegetation condition		Percentage cover prior to works	Percent cover post works
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of *Melaleuca armillaris* and *Eucalyptus tereticornis*	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by *Notolea venosa, Acacia maidenii, Dodonea viscose* and *Olea europaea* subsp. *Cuspidate**	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**, and *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**, and *Bidens pilosa**	40% native cover 60% weed cover	80% native cover 20% weed cover

*Indicates exotic plant species

a) A2 photopoint prior to works in 2017

b) A2 photopoint after primary weed control and maintenance, September 2021

Figure 33 Photomontage of vegetation condition at Zone 2c

5.7.3.3. 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 26 Zone 3a vegetation condition summary

Photo Point	3A		
Commencement of works date	September 2021		
Completion of works date	August 2022		
Vegetation condition		**Percentage cover prior to works**	**Percent cover post works**
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of *Melaleuca armillaris* and *Eucalyptus tereticornis* and *Acacia maidenii,*	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by *Hakea salicifolia, Dodonea viscosa* and *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*,* and *Solanum mauritianum*.*	100% native cover 0% 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 *Sida rhombifolia*, Sigesbeckia orientalis* and *Bidens pilosa**	40% native cover 60% weed cover	80% native cover 20% weed cover

*indicates exotic plant species

a) 3A Photo point prior to commencement of works

b) Same view following primary and secondary weed control, August 2022

Figure 34 Photomontage of vegetation condition at Zone 3a

Table 27 Zone 3b vegetation condition summary

Photo Point	3B		
Commencement of works date	September 2021		
Completion of works date	August 2022		
Vegetation condition		**Percentage cover prior to works**	**Percent cover post works**
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of *Melaleuca armillaris* and *Eucalyptus tereticornis* and *Acacia maidenii,*	100% native cover	100% native cover
Mid Stratum (sub canopy)	The mid stratum surrounding this photo point is dominated by *Hakea salicifolia, Dodonea viscosa* and *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*,* and *Solanum mauritianum*.*	100% native cover 0% 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 *Sida rhombifolia*, Sigesbeckia orientalis* and *Bidens pilosa**	40% native cover 60% weed cover	80% native cover 20% weed cover

*indicates exotic plant species

a) 3B Photo point prior to commencement of works

b) Same view following primary and secondary weed control, August 2022

Figure 35 Photomontage of vegetation condition at Zone 3b

Table 28 Zone 3c vegetation condition summary

Photo Point	3C		
Commencement of works date	September 2021		
Completion of works date	August 2022		
Vegetation condition		**Percentage cover prior to works**	**Percent cover post works**
Upper Stratum (emergent canopy)	The upper stratum surrounding this photo point is dominated by a tall canopy of *Melaleuca armillaris* and *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* and *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* and *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**, *Pellaea falcata* and *Bidens pilosa**	60% native cover 30% weed cover	80% native cover 20% weed cover

*indicates exotic plant species

a) 3C Photo point prior to commencement of works

b) Same view following primary and secondary weed control, August 2022

Figure 36 Photomontage of vegetation condition at Zone 3c

Table 29 Zone 3d vegetation condition summary

Photo Point	3D		
Commencement of works date	September 2021		
Completion of works date	August 2022		
Vegetation condition		**Percentage cover prior to works**	**Percent 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 *Clerodendrum tomentosum, Maclura cochinensis,* and *Elaeodendron australe*	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*, Cestrum nocturnum* and *Pittosporum multiflorum*	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 *Oplismenus imbecillis, Solanum pseudocapsicuum** and *Bidens pilosa**	40% native cover 60% weed cover	70% native cover 30% weed cover

*indicates exotic plant species

a) 3D Photo point prior to commencement of works

b) Same view following primary weed control, August 2022

Figure 37 Photomontage of vegetation condition at Zone 3d

5.7.4. 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. Repairs to the fence line of the RCVA is also scheduled for the next reporting period to reduce instances of cattle intrusion.

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 30 Waste Tracking Data

Month	General Waste (t)	Cardboard (t)	Commingle (t)	Timber (t)	Scrap Metal (t)	Oil & Oily Water (m^3)	Effluent (L)	Filter (t)*	Rags (t)**	Rubber (t)
Jul-2021	1.242	0.24	0.047	0	0	0	18.6	0	0	0
Aug-2021	0.964	0.215	0.039	0	0	12.84	0	0	0	0
Sep-2021	8.642	0.17	0.022	0	0	0	12.5	0	0	15.36
Oct-2021	1.469	0.13	0.0198	0	0	0	0	1.64	0.41	104.42
Nov-2021	4.494	0.1	0.014	0.4	0	4.44	21	1.64	0.41	23
Dec-2021	1.257	0.12	0.015	0	0	0	0	0		0
Jan-2022	3.364	0.128	0.02	0.76	0	0	24	0	0	0
Feb-2022	1.31	0.06	0.023	0	0	0	0	0	0	0
Mar-2022	1.511	0.1	0.016	0	0	0	14.5	0	0	0
Apr-2022	7.761	0.06	0.02	0	0	0	0	1.64	0.41	0
May-2022	4.11	0.22	0.017	0	0	0	20.5	0		0
Jun-2022	0.827	0.08	0.013	0	0	0	0	1.64	0.41	0
Total	**36.951**	**1.623**	**0.2658**	**1.16**	**0**	**17.28**	**111.1**	**6.56**	**1.64**	**142.78**

* Based on an average weight of 0.004 tonne per filter bin

** Based on an average weight of 0.04 tonne per rag bin

Table 31 Historical Waste Data

Waste Classification		FY17	FY18	FY19	FY20	FY21	FY22
Solid Waste	General Waste (t)	45.123	38.032	41.814	34.398	37.237	36.951
	Cardboard Tonnes (t)	2.152	1.531	0.93	3.355	2.32	1.623
	Timber Tonnes (t)	8.14	13	13.24	10.24	10.24	1.16
	Comingle Recycling (t)	ND	ND	0.63	3.825	0.255	0.266
	Used Oil Filters/ Rags (t)	ND	2.4	0.936	1.072	2.46	8.2
	Scrap Metal (t)	ND	ND	110	79.64	557.46	0
	Rubber (t)	0	0	0	0	0	142.78
Liquid Waste	Oil/Oily Water Litres (L)	25,400	43,250	46,900	68,883	41,900	17,280
	Effluent Litres (L)	60,000	61,000	140,000	190,000	170,208	11,111
	Other Litres (L)	400	0	0	0	0	0

It can be seen that a significant increase in the percentage of waste recycled via cardboard or comingle recycling has occurred since 2020. This is mostly due to the improvements in visibility and access to recycling bins, as well as part of the improvements to the waste minimisation strategies made during the reporting period.

An audit of stored tyres was completed as part of the independent audit actions as shown below in Table 30. Excess tyres were recycled in late 2021 to remove excess tyres. The tyre register will be updated to reflect the removed tyres. 142.78t of rubber was recycled and diverted from landfill.

Table 32 Stored tyres audit outcome

Storage Locations	*2016*	*2019*	*2021*	*Purpose*	*Colour code*
Old Workshop Southern End	50	77		990H and Haul Truck Tyres	Red- Waste Storage
Old Workshop Northern end	55	14	121	Bitz tyre storage	Red- Waste Storage
Graveyard	6	89		Mixed Waste Storage	Red- Waste Storage
New Workshop		16	50	Bund Retaining Wall	Blue- Retaining Wall
Go Line	26	21	21	Parking Bay Dividers	Orange - Road Dividers/Stockpile markers
Rail Loading Area	10	8	9	Area Markers, Road Dividers	Orange - Road Dividers/Stockpile markers
Pipe Rd Blues Blvd	2	2	2	Road Divider	Orange - Road Dividers/Stockpile markers
Croome Intersection		1	1	Road Divider	Orange - Road Dividers/Stockpile markers
Level 3 Sales	16	17	13	Stockpile Markers	Orange - Road Dividers/Stockpile markers
Bottom of Pipe Rd	2	16	0	Marker	
Dust Extractors		1	0	Utility to pick up bins	
CR01 and CR02 Access	Not Specified	Not Specified	Not Specified	Mixed Tyres - Retaining Wall	Blue Retaining Wall
CR01 Retaining Wall		15	15	Mixed Tyres - Retaining Wall	Blue Retaining Wall

CR02 Retaining Wall		185	185	Mixed Tyres - Retaining Wall	Blue Retaining Wall
Transport Area		2	2	Road Divider	Orange – Road Dividers/Stockpile markers
Level 2 Sales			3	Mixed Tyres	

A contractor has been engaged to collect and recycle excess stored tyres which are not being utilised for retaining walls. This work was completed in late 2021 and will maintain the level of stored tyres to only what is needed for construction activities.

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 FY22. 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 November 2021. The current version is available online at https://www.boral.com.au/what-we-do/environmental-reporting

5.11. Dangerous and Hazardous Goods Storage

Storage of dangerous goods and hazardous material have continued as part of normal 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. The resource regulator undertook a further audit in April. The audit was in April and hazardous material storage was observed to be as per AS1940. MSDS sheets and Chem Alert databases were updated in May as part of recommendations in the audit.

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

Due to COVID-19 restrictions, the CCC only met once during the FY22 reporting period (September 2021). This meeting provided initial consultation in relation to the proposed 8 ha quarry expansion into the adjacent land previously owned by the former Rail Infrastructure Corporation. The representatives were informed that the environmental studies were underway and that community consultation would follow similar procedures to the Croome West Expansion.

6.1. Environmental Complaints Management

There was one environmental complaints received during the reporting period. On the 16th August 2021 the EPA received a complaint that dust was blowing from the quarry towards Dunmore and Minnamurra. The Quarry confirmed dust suppression sprays at the transfer points in the plant were operational and the water cart was in use during the day.

A graph showing the community complaints over time can be seen in Figure 38.

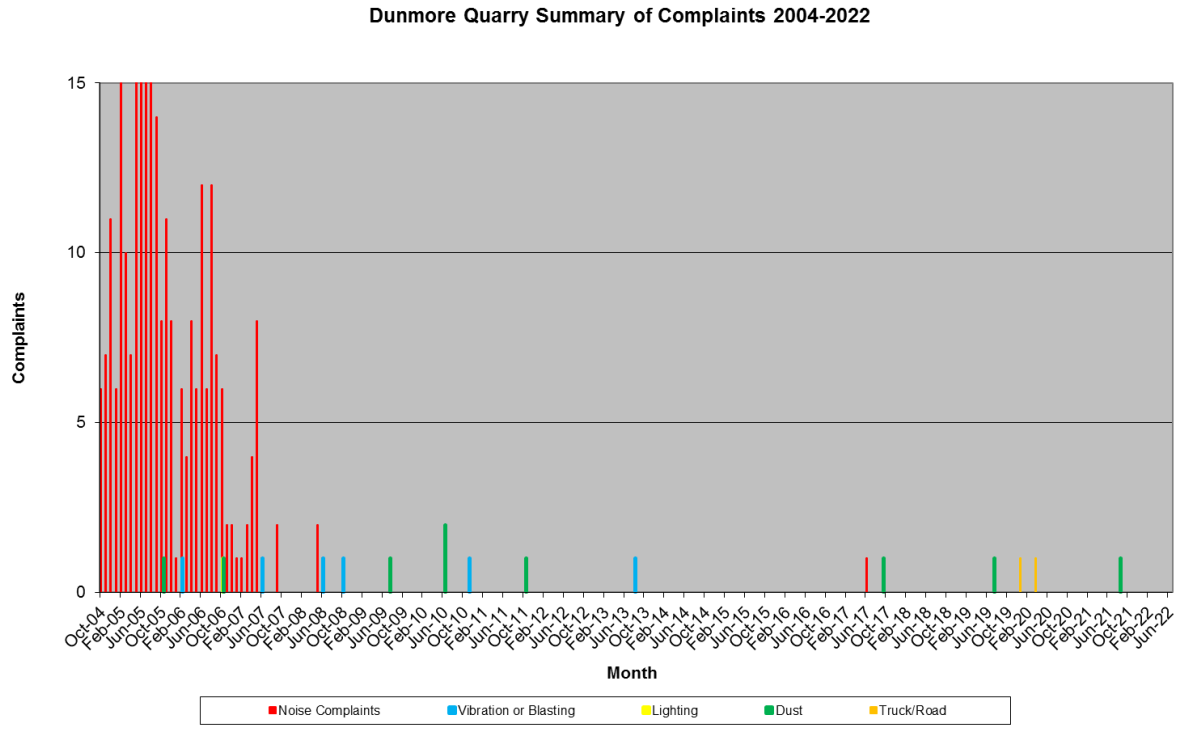

Figure 38 Historical Community Complaints

6.2. Summary of Regulatory Notifications

There were no regulatory authority notifications during the reporting period. Boral liaised with NSW DPIE in relation to MOD12 which was an administrative modification to remove the multiple hourly dispatch volumes across any given day and replaced these with a single hourly limit. This modification did not change the overall daily limit of 400 heavy vehicles.

The EPA was also regularly advised as per M2.3 EPL requirements that the site was discharging and that due to widespread flooding, some monitoring sites could not be accessed.

7. Activities to be completed by the Next Reporting Period

The next reporting period (FY23) will focus on the approval of the updated Water Management Plan and implementing the plan's recommended upgrades as well as maintaining regulatory compliance and optimising management actions established in the FY22 reporting period.

Table 33 Activities to be Completed by the Next Reporting Period (FY23)

Reference	Description of Action
AR 1	Update Water Management Plan as part of MOD 12 post approval documentation
AR 2	Update Air Quality Management Plan as part of MOD 12 post approval documentation to denote that DSS is included in the monitoring program
AR 3	Update Rehabilitation Management Plan post calculation of the Rehabilitation Conservations Bond
AR 4	Recalculate and lodge the rehabilitation bond
AR 5	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
AR 6	Complete Transport options review
AR 7	Update Transport Management Plan as part of MOD 12 post approval documentation to reflect the transport dispatch monitoring undertaken onsite
AR 8	Update Tyre Register after recycling of excess tyres by licenced contractor
AR 9	Complete re-fencing of rehabilitation areas to limit intrusion of cattle when the RVCA area is accessible.

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 FY22 period had a strong focus on maintaining regulatory compliance and optimising management actions established in the FY21 reporting period. The reporting period was characterised by a significant rainfall event which caused wide spreading flooding and impacted local and regional construction markets.

The next reporting period will continue to focus on implementation of management processes and plans post approval of modification 12 of the consent and the commencement of environmental studies associated with the quarry extension into the 8 ha RIC slot.

9. Appendix A Meteorological Monitoring Locations Data and Graphs

The location of the onsite weather station is shown Figure 39 below.

Figure 39 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 34 Rainfall Data Summary

Rainfall (mm)			
Month	**FY22**	**Site Average**	**Regional Average**
July	14.8	63.3	49
August	73.4	71	53.5
September	46.37	47.7	42.7
October	61.85	72.5	64.5
November	164.1	89.9	83.1
December	78.36	84.3	67
January	151	85.4	72.9
February	295.8	144.7	140.5
March	670.6	140.9	122.3

Rainfall (mm)			
Month	FY22	Site Average	Regional Average
April	216.8	84.3	73.8
May	202.8	72.2	55.8
June	1.8	114.7	93.7
Total	1978	1070.4	925.6

Table 35 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	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	60.9	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	71.1	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	47.6	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	72.0	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	93.2	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	84.0	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	88.7	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	152.3	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	167.4	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	91.0	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	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	109.1	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	1115.8	925.6

Monthly wind roses and seasonal wind roses are shown in Figure 40 to Figure 51. Please note calm is defined as winds averaging less than 0.3m/s over the averaging period.

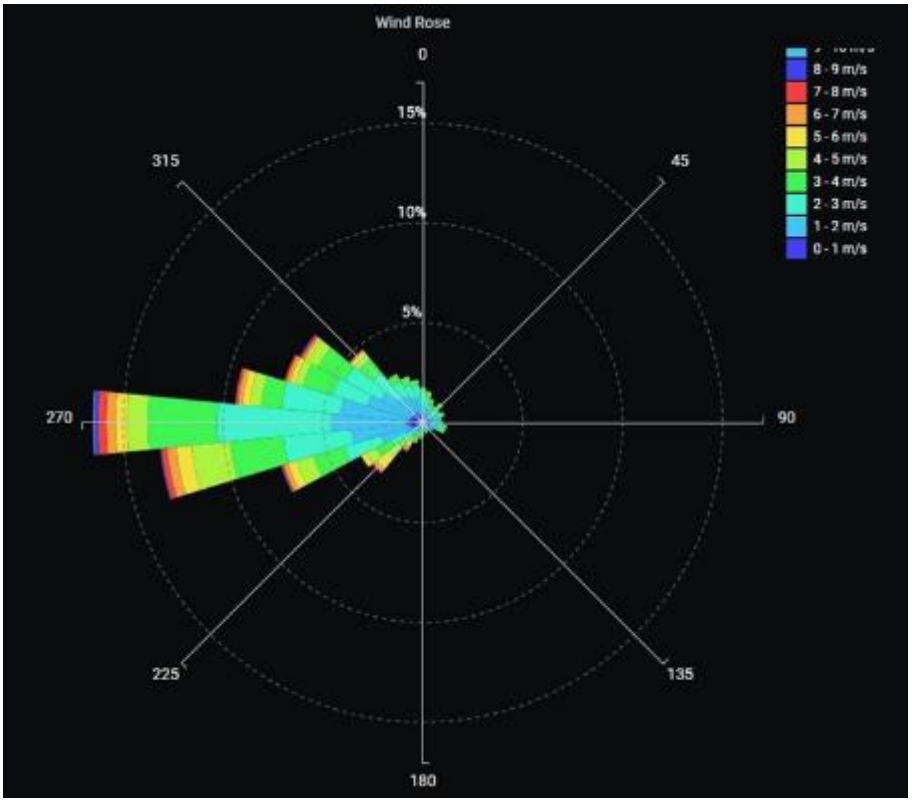

Figure 40 July 2021 Wind Rose

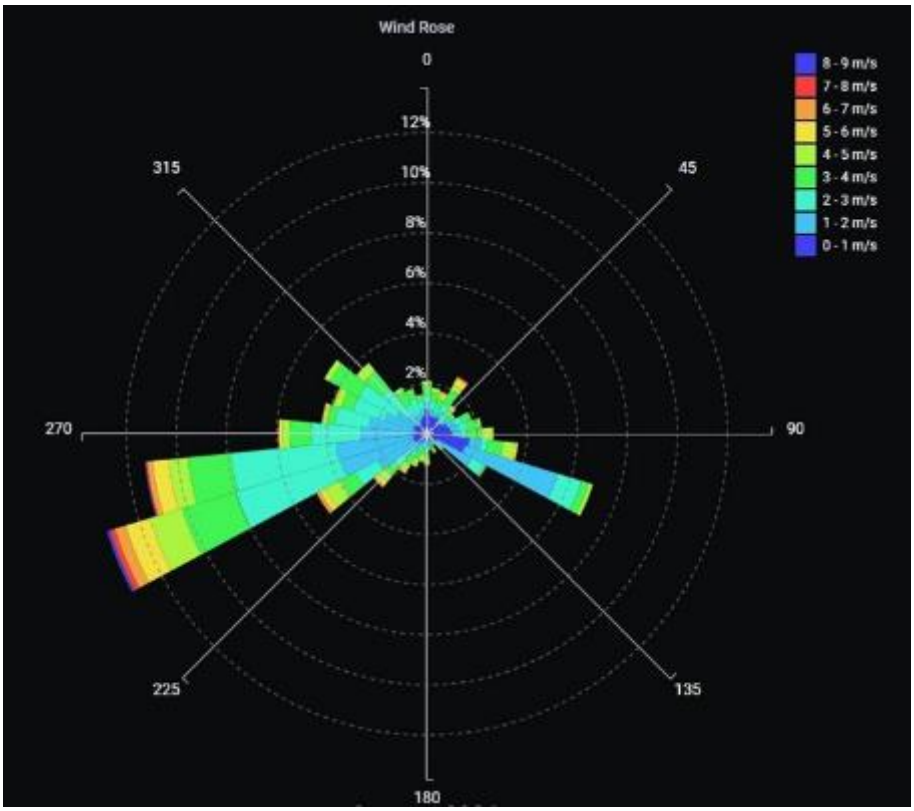

Figure 41 August 2021 Wind Rose

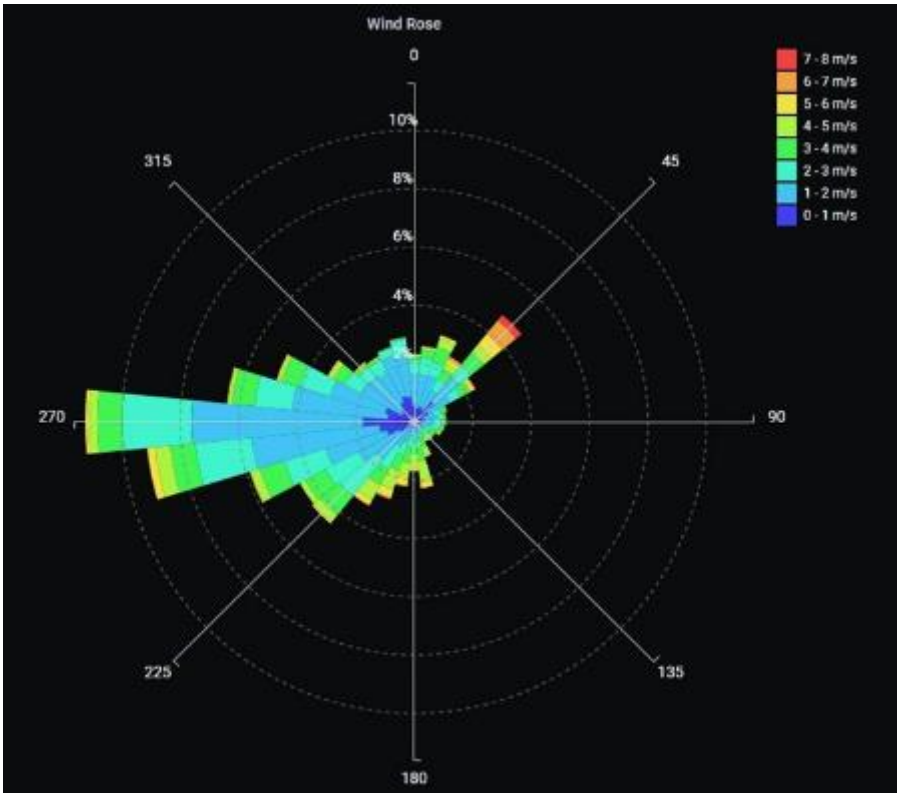

Figure 42 September 2021 Wind Rose

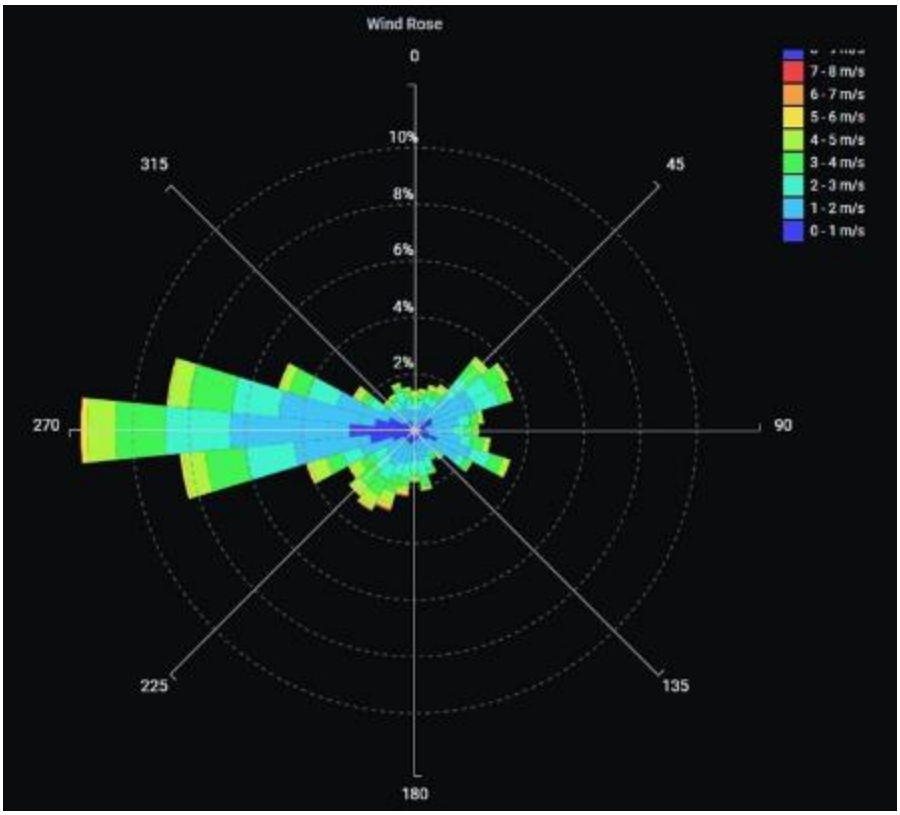

Figure 43 October 2021 Wind Rose

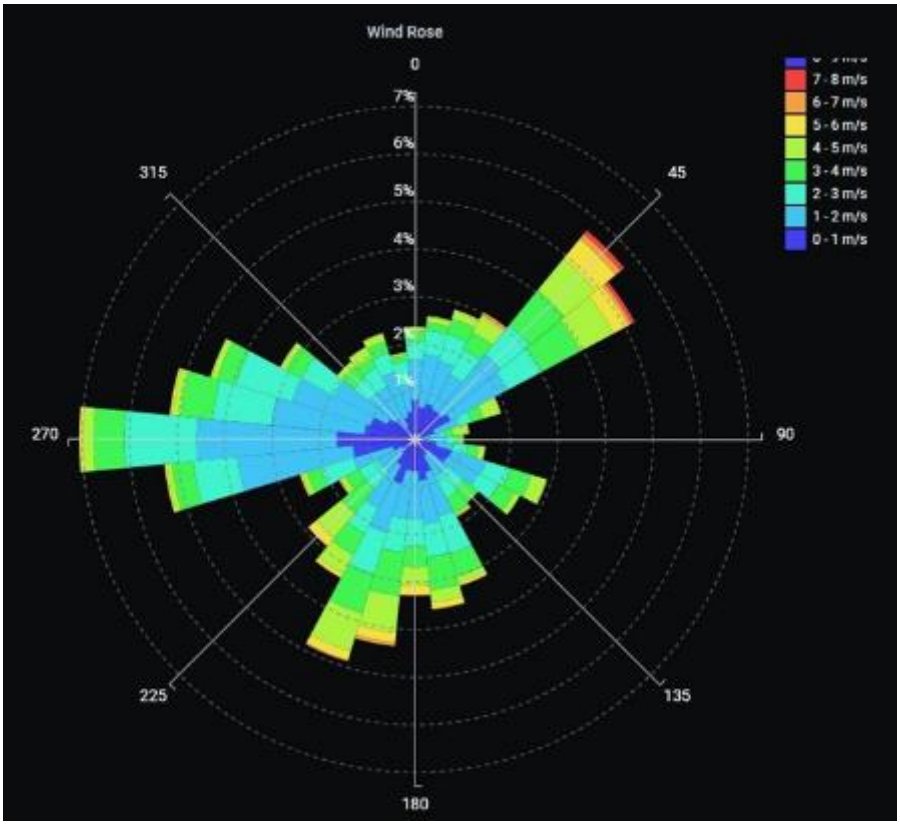

Figure 44 November 2021 Wind Rose

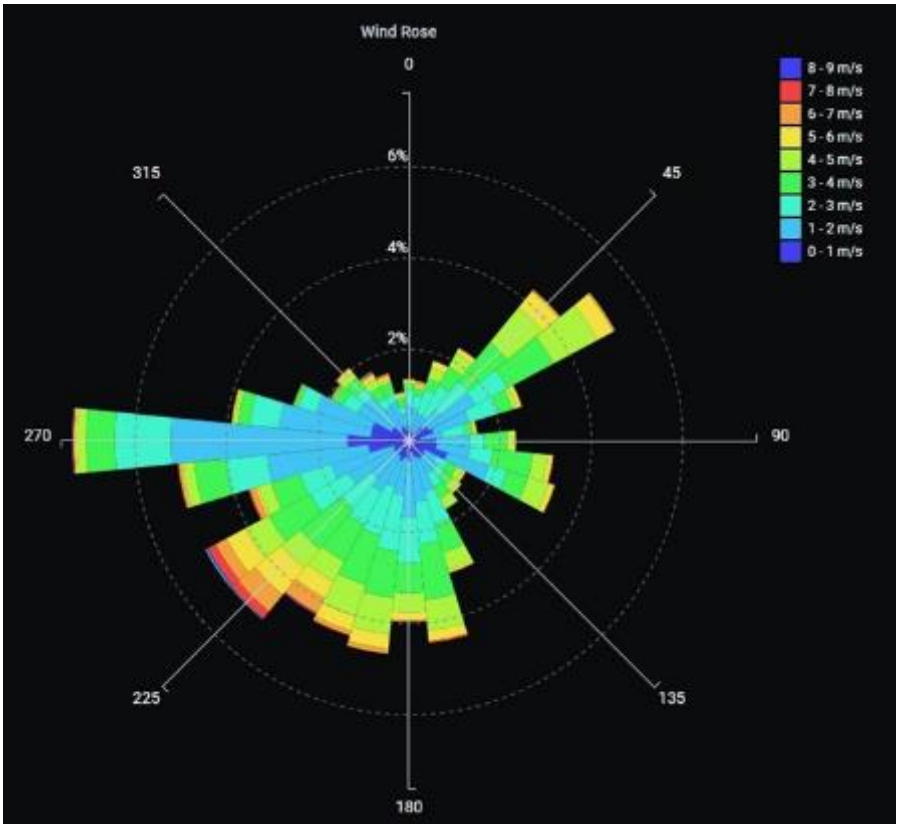

Figure 45 December 2021 Wind Rose

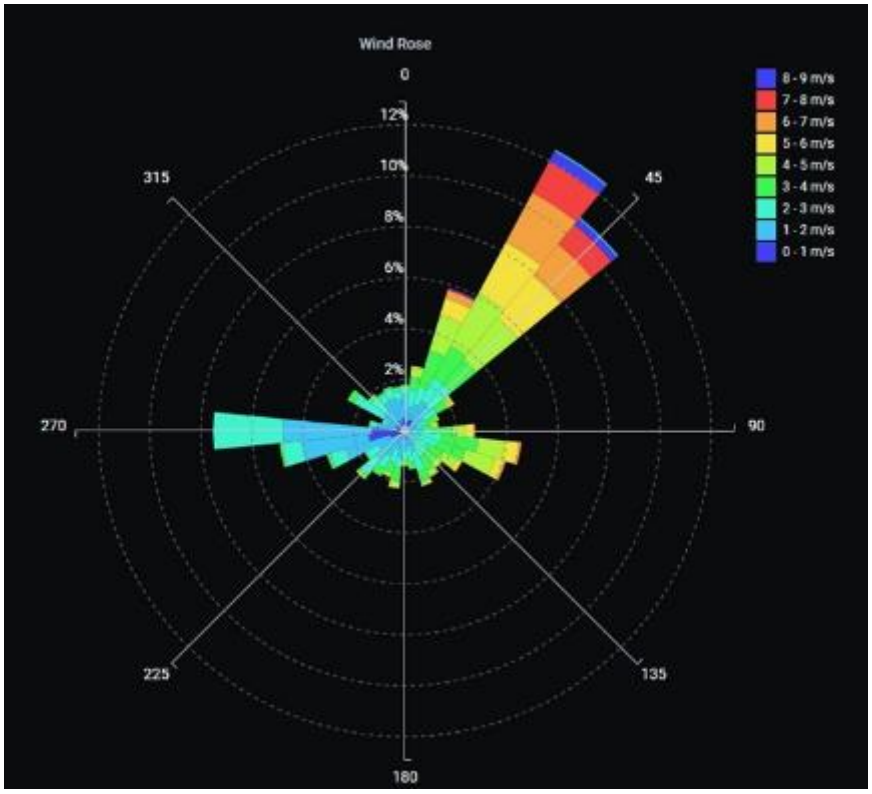

Figure 46 January 2022 Wind Rose

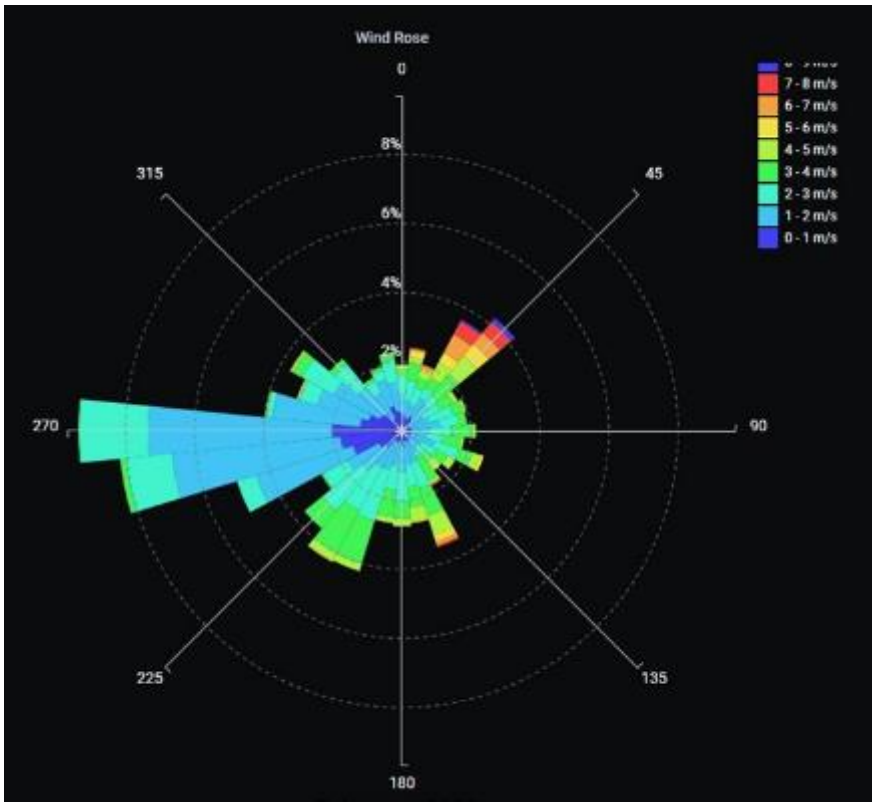

Figure 47 February 2022 Wind Rose

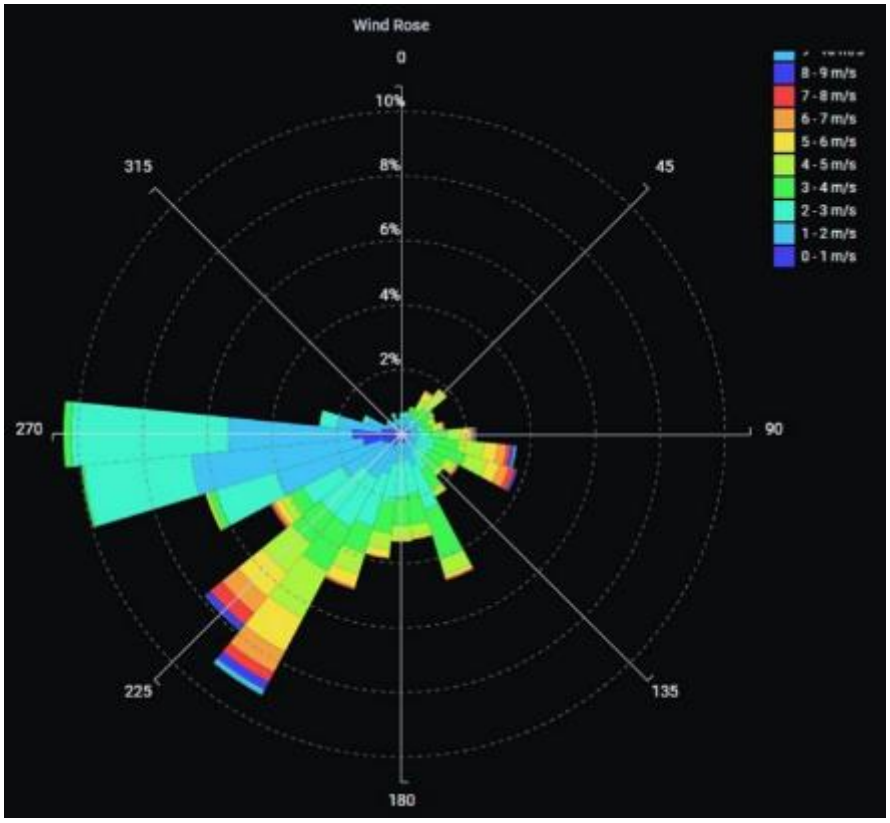

Figure 48 March 2022 Wind Rose

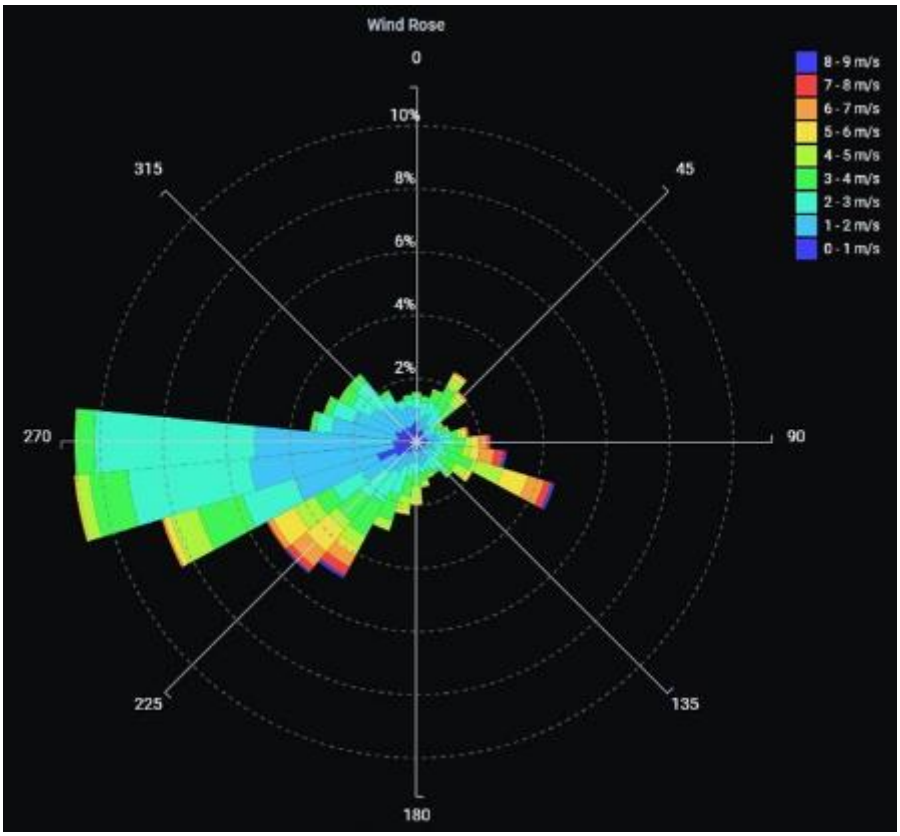

Figure 49 April 2022 Wind Rose

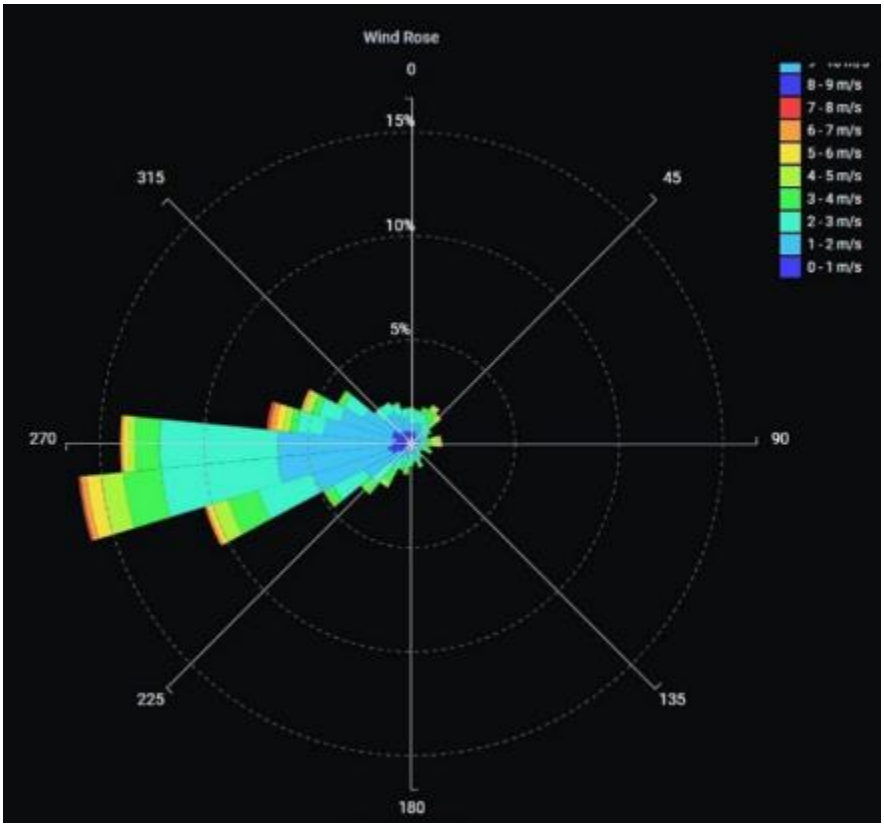

Figure 50 May 2022 Wind Rose

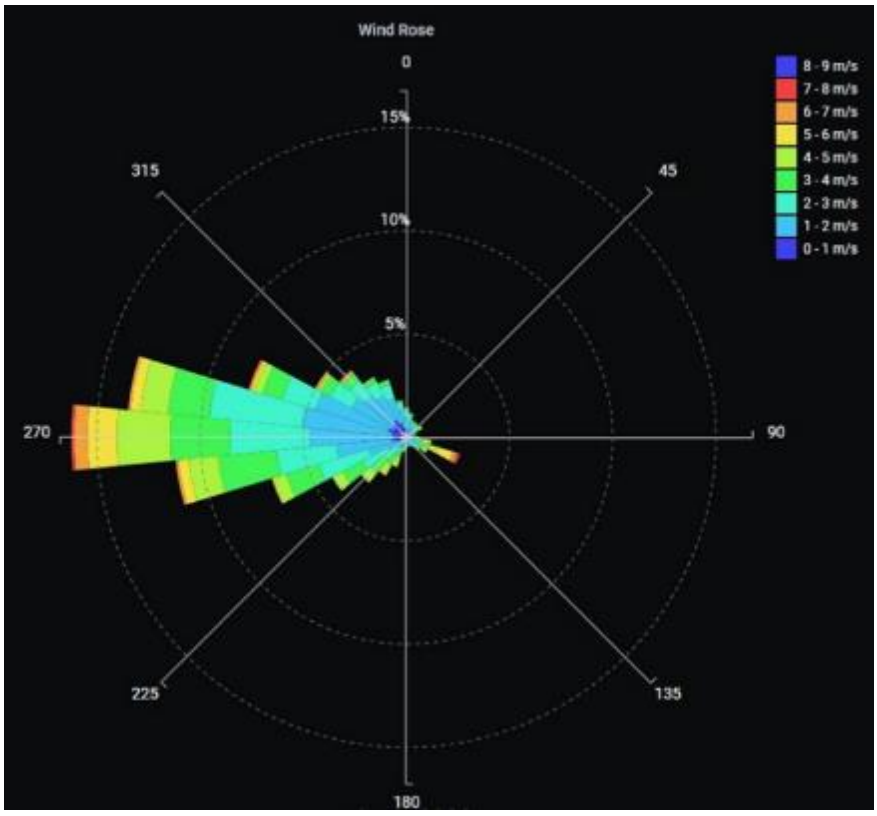

Figure 51 June 2022 Wind Rose

Figure 52 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 36 Historical Deposited Dust Results

Month	DD2 grams/m²/month		DD5 grams/m²/month		DD6 grams/m²/month		DD7b/10 grams/m²/month		Deposited Dust Goal	Dominant Wind Direction	Direction of Strongest Winds	Production Tonnes
	Insoluble Solids	Ash	Insoluble Solids	Ash	Insoluble Solids	Ash	Insoluble Solids	Ash				
FY07 Average	3.68	1.9	3.3	2.1	5.75	3.36	3.9	1.92	4			
FY08 Average	2.97	1.84	2.88	1.66	4.23	2.43	4.31	2.44	4			
FY09 Average	3.07	1.98	3.79	1.94	3.83	2.87	5.55	3.17	4			
FY10 Average	5.29	3.3	3.42	2.5	4.88	2.96	2.71	1.66	4			
FY11 Average	6.16	3.68	3.42	1.99	3.92	2.47	3.15	2.33	4			
FY12 Average	5.51	2.82	3.09	1.82	3.17	2.32	2.53	1.6	4			
FY13 Average	4.19	2.19	3.26	1.84	3.7	2.48	2.75	1.81	4			
FY14 Average	2.21	1.42	3.63	1.76	2.67	1.58	3.36	2.36	4			
FY15 Average	3.57	1.77	2.55	1.46	3.94	2	3.2	2	4			
FY16 Average	1.85	1.19	2.59	1.44	2.55	1.55	2.66	1.66	4			
FY17 Average	2.28	1.56	2.67	1.77	3.31	1.68	2.01	1.3	4			
FY18 Average	2.36	1.65	2.32	1.78	2.71	1.88	2.84	1.79	4			
FY19 Average	3.66	1.87	3.1	1.9	3.03	1.94	2.81	1.59	4			
FY20 Average	3.59	2.11	3.06	1.82	3.49	2.18	3.16	1.98	4			
FY21 Average	1.94	1.12	2.44	1.34	2	1.08	1.85	1.11	4			
FY22 Average	2.07	0.88	1.54	0.92	1.79	1.05	1.21	1.64	4			
Jul-21	1.6	0.41	1.77	0.65	2.47	0.89	1.02	2.33	4	W (19%)	W	33457
Aug-21	0.88	0.58	1.91	1.09	3.35	2.15	1.13	1.16	4	WSW (14%)	WSW	12899
Sep-21	1.13	0.45	0.99	0.88	2.07	1.04	1.16	1.71	4	W (12%)	W	6303
Oct-21	1.93	1.14	1.98	1.32	3.99	3.38	1.34	3.87	4	W (12%)	W	7361
Nov-21	0.68	0.4	1.29	0.82	1.71	1.2	1.36	1.36	4	W (7%)	NE	5926
Dec-21	1.32	0.57	1.62	0.82	2.6	0.99	1.34	2.47	4	N (12%)	S	3780
Jan-22	10.31	4.93	3.08	2.56	1.42	1.33	1.36	0.42	4	NE (13%)	NE	4251
Feb-22	1.35	0.44	0.94	0.25	0.97	0.51	1.33	1.42	4	W (10%)	NE	4841
Mar-22	ND	ND	0.32	0.03	0.13	0.05	1.23	0.5	4	W (12%)	SW	0
Apr-22	1.34	0.16	2.33	1.61	1.13	0.54	1.15	1.31	4	W (11%)	SW	971
May-22	1.67	0.22	1.62	0.57	1.08	0.25	1.11	2.44	4	W (20%)	WSW	1200
Jun-22	0.58	0.35	0.6	0.49	0.6	0.26	1.04	0.67	4	W (18%)	W	10136
FY22 Average	2.07	0.88	1.54	0.92	1.79	1.05	1.21	1.64	4			91125

A graph of the historical deposited dust values compared to production is shown in green for each deposited dust site in Figures 53 to 56.

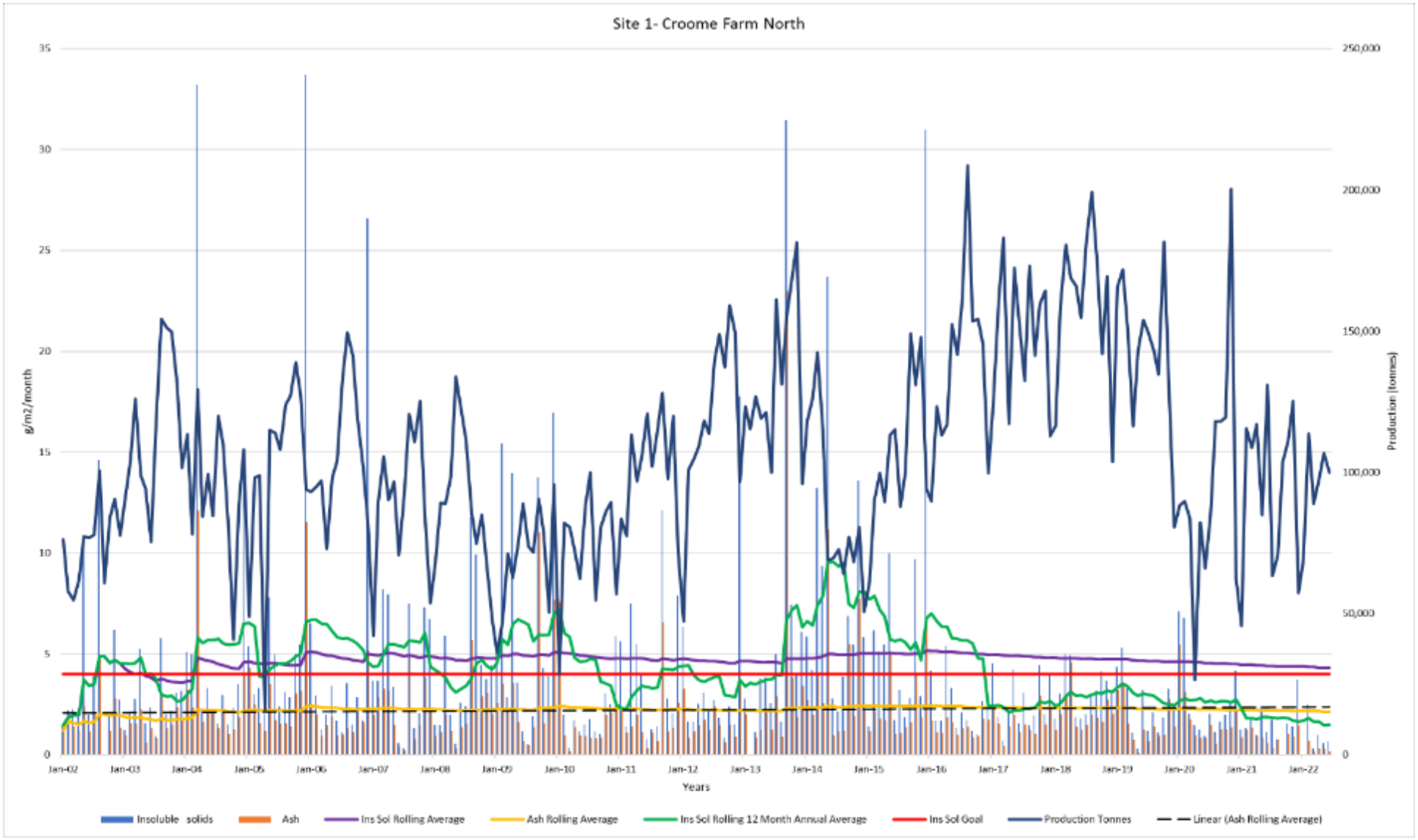

Figure 53 Historical Deposited Dust Values – DQ1

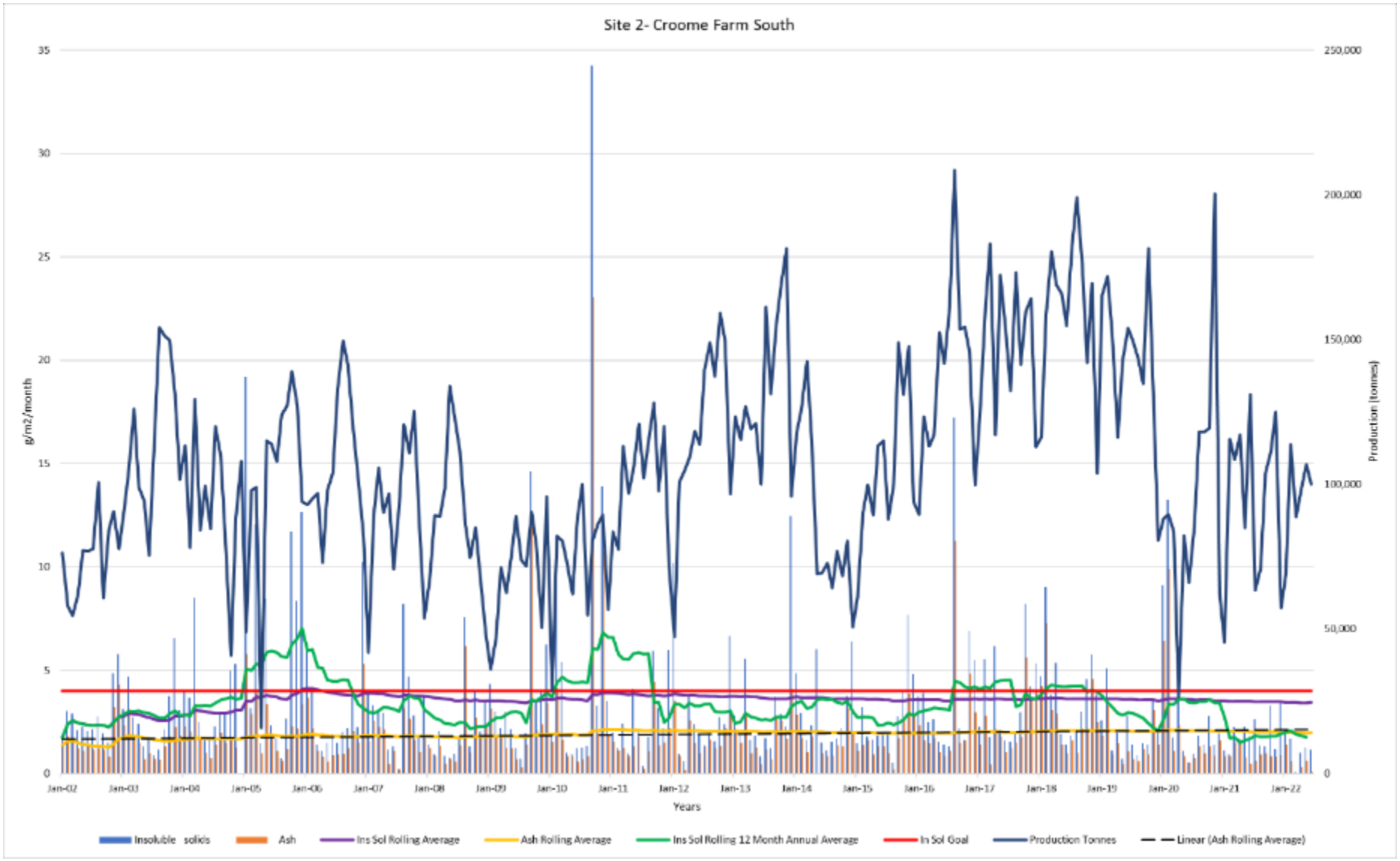

Figure 54 Historical Deposited Dust Values – DQ2

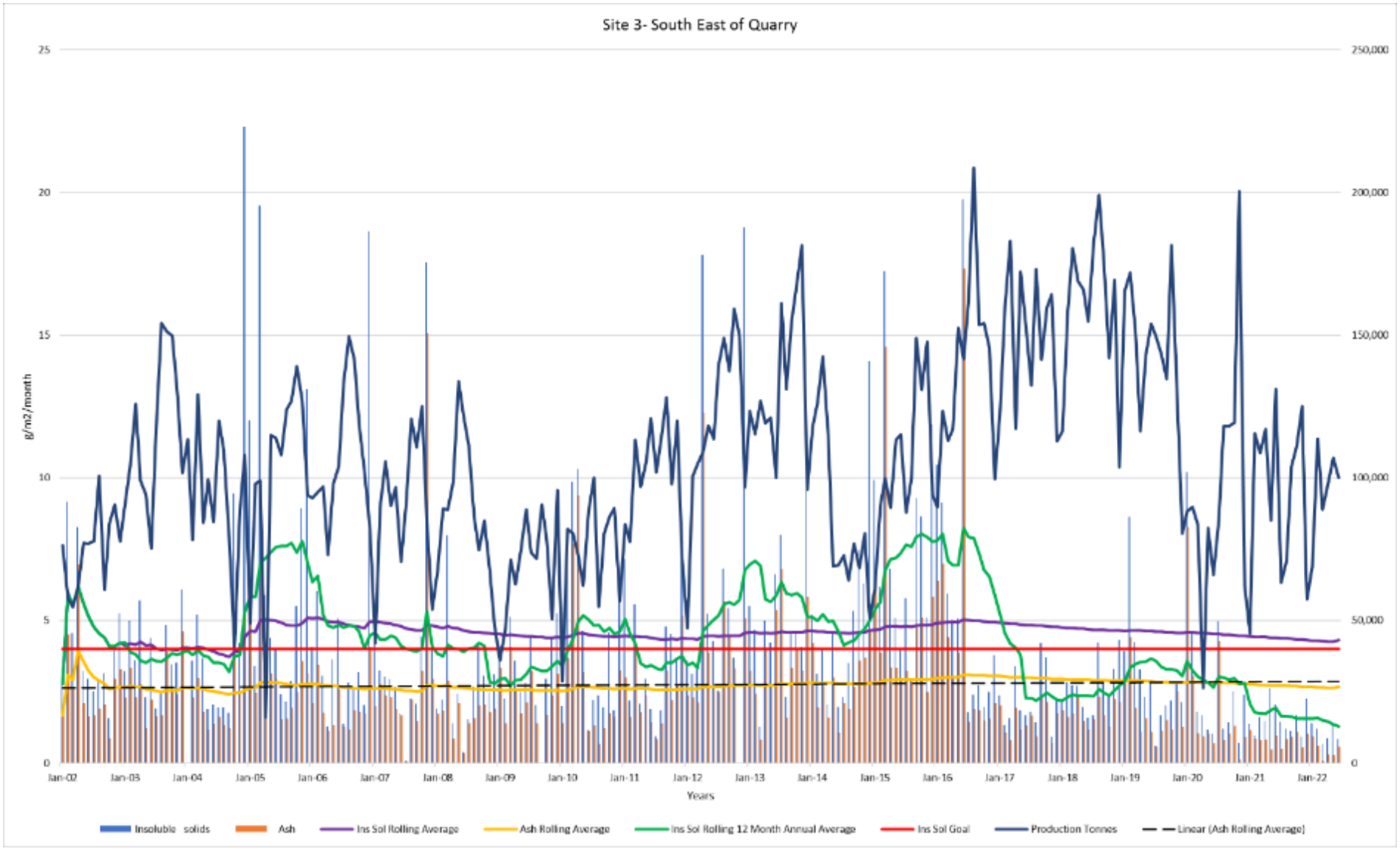

Figure 55 Historical Deposited Dust Values – DQ3

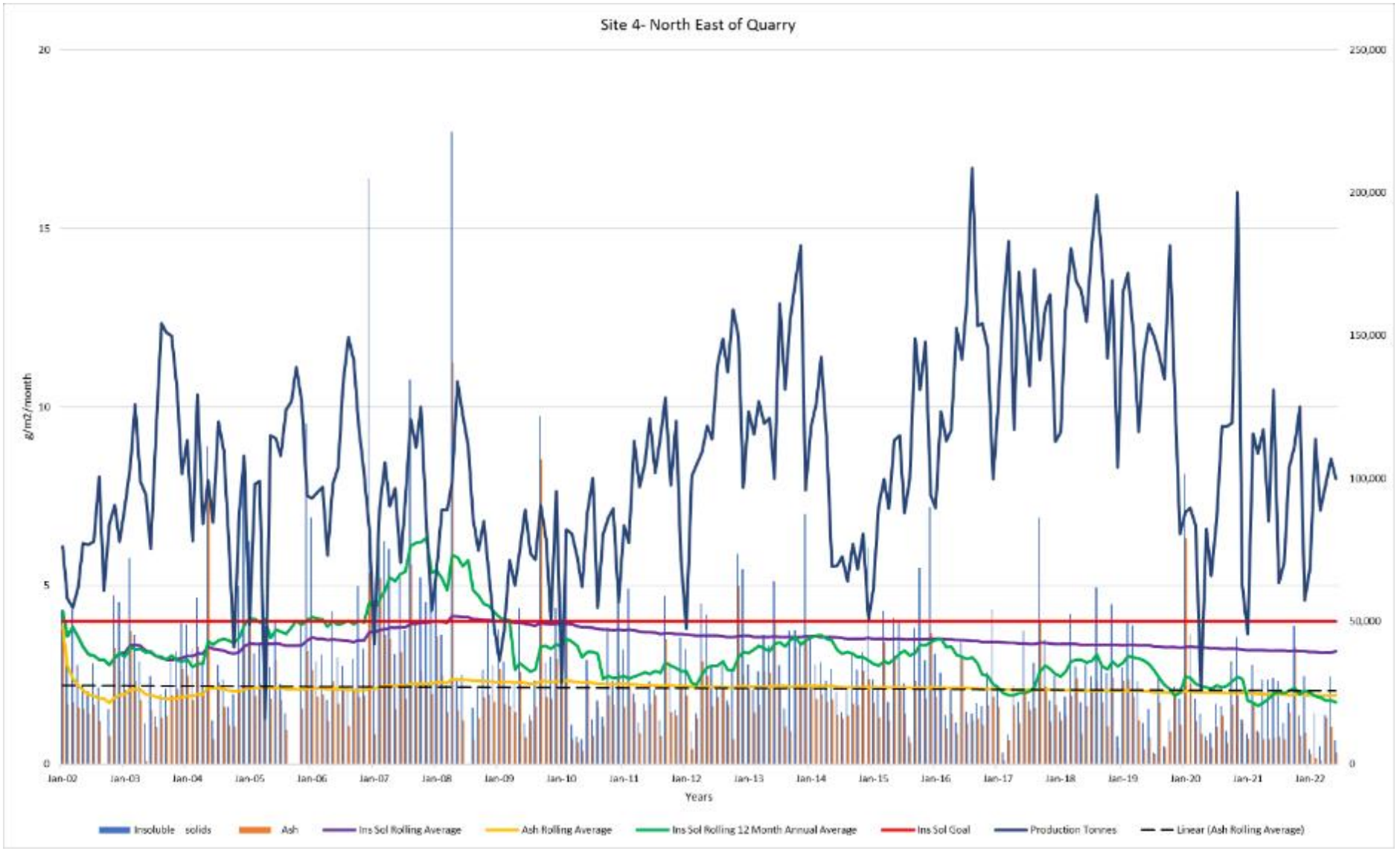

Figure 56 Historical Deposited Dust Values – DQ4

Table 37 Detailed Summary of PM_{10} Monitoring Data

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)	Comments
7/3/2021	0.71	50	30	9.06	
7/9/2021	3.57	50	30	8.96	
7/15/2021	0.95	50	30	8.84	
7/21/2021	1.6	50	30	8.7	
7/27/2021	0.65	50	30	8.15	
8/2/2021	1.01	50	30	8.06	
8/8/2021	1.84	50	30	7.93	
8/14/2021	2.2	50	30	7.76	
8/20/2021	5.35	50	30	7.73	
8/26/2021	0.24	50	30	7.65	
9/1/2021	15.92	50	30	7.71	
9/7/2021	5.53	50	30	7.67	
9/13/2021	2.26	50	30	7.64	
9/19/2021	8.73	50	30	7.73	
9/25/2021	5.64	50	30	7.37	
10/1/2021	7.01	50	30	7.41	
10/7/2021	18.54	50	30	7.54	
10/13/2021	6.36	50	30	7.53	
10/19/2021	5.23	50	30	7.44	
10/25/2021	18.6	50	30	7.67	
10/31/2021	5.53	50	30	7.7	
11/6/2021	18.6	50	30	7.86	
11/12/2021	2.61	50	30	7.57	
11/18/2021	17.53	50	30	7.68	
11/24/2021	22.28	50	30	7.84	
11/30/2021	9.51	50	30	7.94	
12/6/2021	16.76	50	30	8.04	

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)	Comments
12/12/2021	25.55	50	30	8.02	
12/18/2021	26.32	50	30	8.28	
12/24/2021	7.49	50	30	8.35	
12/30/2021	10.46	50	30	8.24	
1/5/2022	4.52	50	30	8.25	
1/11/2022	12.42	50	30	8.33	
1/17/2022	11.56	50	30	7.76	
1/23/2022	2.67	50	30	7.52	
1/29/2022	7.49	50	30	7.53	
2/4/2022	6.48	50	30	7.48	
2/10/2022	18.54	50	30	7.63	
2/16/2022	13.31	50	30	7.7	
2/22/2022	4.31	50	30	7.54	
2/28/2022	1.8	50	30	7.5	
3/6/2022	2	50	30	7.46	
3/12/2022	1.6	50	30	7.44	
3/18/2022	11.94	50	30	7.59	
3/24/2022	7.49	50	30	7.65	
3/30/2022	5.29	50	30	7.62	
4/5/2022	7.72	50	30	7.61	
4/11/2022	1.07	50	30	7.45	
4/17/2022	6.95	50	30	7.45	
4/23/2022	4.13	50	30	7.38	
4/29/2022	1	50	30	7.46	
5/5/2022	0.6	50	30	7.47	
5/11/2022	0.65	50	30	7.46	
5/17/2022	0.76	50	30	7.46	
5/23/2022	0.7	50	30	7.58	

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)	Comments
5/29/2022	0.42	50	30	7.51	
6/4/2022	0.1	50	30	7.6	
6/10/2022	0.11	50	30	7.69	
6/16/2022	1.13	50	30	7.76	
6/22/2022	0.24	50	30	7.88	
6/28/2022	0.18	50	30	8.03	

11. Appendix C MAC Noise Monitoring Annual Compliance Report

Annual Noise Monitoring Assessment 2021

Dunmore Quarry
Dunmore, NSW
September 2021.

Prepared for: Boral Resources (NSW) Pty Ltd
September 2021
MAC180747-01RP3

Muller Acoustic Consulting

Document Information

Annual Noise Monitoring Assessment 2021

Dunmore Quarry, Dunmore, NSW

September 2021

Prepared for: Boral Resources (NSW) Pty Ltd

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Document ID	Status	Date	Prepared By	Signed	Reviewed By	Signed
MAC180747-01RP3	Final	14 September 2021	Nicholas Shipman		Rod Linnett	

CONTENTS

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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, December 2017) during September 2021 and forms the annual noise monitoring program to address conditions outlined in the Development Consent (Ref: 470-11-2003). Typically, the NMA is completed during the winter months where temperature inversion conditions are more likely, however, due to COVID-19 restrictions, the NMA was delayed to September 2021.

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**.

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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

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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 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.

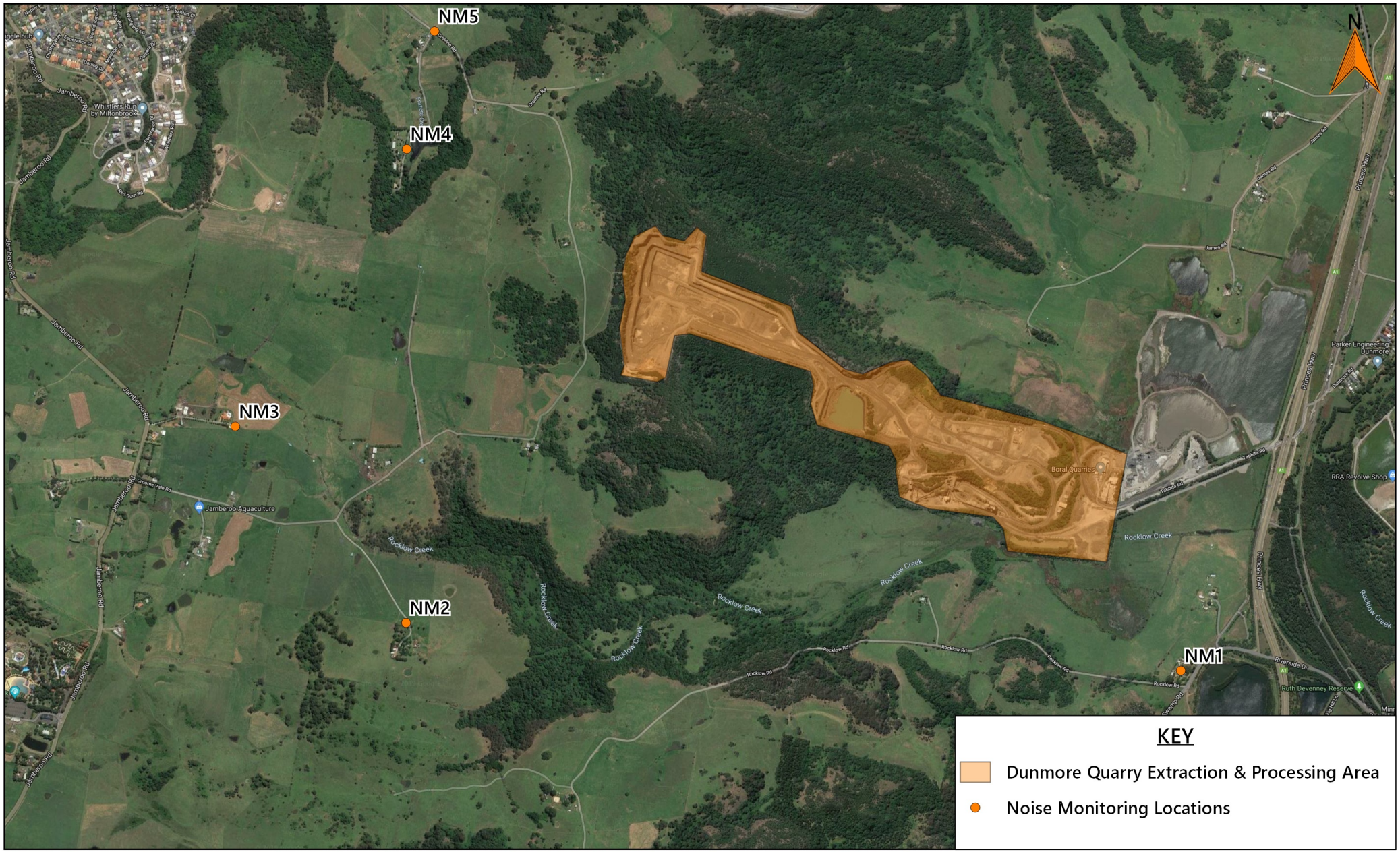
3.2 Assessment Methodology

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 Thursday 2 September 2021 and Friday 3 September 2021 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 morning shoulder periods on Thursday 2 September 2021 and Friday 3 September 2021, direct measurement of temperature profile was undertaken at NM1 Location K (Stocker) at 2m above ground level and at 50m above ground level using a weather balloon on Thursday 2 September 2021 during the morning shoulder period. Similarly, temperature measurements were taken at NM5 Location F (Croom) during the morning shoulder period of Friday 3 September 2021. 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. It is noted that temperate profile data was unavailable during the evening period due to increased wind speeds and unstable conditions.

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

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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 2.0m and 50.0m 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 $LA_{eq(15min)}$ and $LA_{90(15min)}$ in dB re 20µPa.
- Quarry $LA_{eq(15min)}$ and $LA_{1(1min)}$ noise level contribution.
- Noise Limit $LA_{eq(15min)}$ and $LA_{1(1min)}$.

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 morning shoulder periods of Thursday 2 September 2021 and Friday 3 September 2021 were outside the development consent conditions (ie greater than 3°C/100m), although quarry noise contribution was compliant with the noise limits.

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]	
02/09/2021 Morning Shoulder	06:25	0.2m/s WNW 15˚C	61	57	47/55	0.2	N	10.5	15.6	5.1	10.13	G	Traffic 53-66 Birds 56-71 Quarry not audible
Quarry Contribution													<40dB $L_{Aeq(15min)}$ <45dB $L_{A1(1min)}$
02/09/2021 Day	07:00	0.2m/s WNW 15˚C	59	55	49	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Traffic 51-64 Birds 51-67 Quarry not audible
Quarry Contribution													<45dB $L_{Aeq(15min)}$
02/09/2021 Evening	21:16	0.3m/s NE 17˚C	53	41	44	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Traffic 48-50 Train 40-59 Insects 40-46 Quarry not audible
Quarry Contribution													<40dB $L_{Aeq(15min)}$

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]	
03/09/2021 Morning Shoulder	06:30	0.2m/s N 12˚C	46	38	37/45	0.2	N	11.6	12.9	1.3	2.62	F	Local residential noise 37-40 Birds 40-47 Traffic 35-70 Quarry not audible
Quarry Contribution													<35dB $L_{Aeq(15min)}$ <40dB $L_{A1(1min)}$
03/09/2021 Day	08:19	0.5m/s N 16˚C	44	39	37	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Traffic 40-48 Insects 40-44 Birds 45-64 Quarry Truck 34-36
Quarry Contribution													35dB $L_{Aeq(15min)}$
02/09/2021 Evening	20:48	2.4m/s N 16˚C	36	33	37	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Insects 24-30 Livestock 30-44 Traffic 30-50 Quarry not audible
Quarry Contribution													<30dB $L_{Aeq(15min)}$

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]	
03/09/2021 Morning Shoulder	06:00	0.1m/s N 13˚C	54	39	36/45	0.1	N	11.9	12.7	0.8	1.53	E	Birds 35-75 Livestock 32-38 Traffic 44-52 Quarry not audible
Quarry Contribution													<30dB $L_{Aeq(15min)}$ <35dB $L_{A1(1min)}$
03/09/2021 Day	07:56	0.3m/s N 14˚C	51	40	36	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Traffic 40-46 Birds 60-74 Quarry Mobile Plant <35
Quarry Contribution													<35dB $L_{Aeq(15min)}$
02/09/2021 Evening	20:29	2.2m/s N 16˚C	37	29	36	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Wind in trees 27-46 Local residential noise 64-67 Aircraft 27-48 Traffic 27-56 Livestock 37-38 Quarry not audible
Quarry Contribution													<30dB $L_{Aeq(15min)}$

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]	
03/09/2021 Morning Shoulder	06:06	0.2m/s N 14˚C	49	39	40/45	0.2	N	11.9	12.7	0.8	1.53	E	Birds 37-60 Traffic 37-42 Insects 37-42 Quarry Inaudible
Quarry Contribution													<30dB $L_{Aeq(15min)}$ <35dB $L_{A1(1min)}$
03/09/2021 Day	07:24	0.1m/s N 12˚C	54	40	40	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Traffic 40-42 Birds 38-62 Local residential noise 35-75 Quarry Inaudible
Quarry Contribution													<35dB $L_{Aeq(15min)}$
02/09/2021 Evening	20:16	1.2m/s N 15˚C	52	36	40	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Insects 30-32 Local residential noise 32-71 Dog 32-62 Quarry Inaudible
Quarry Contribution													<30dB $L_{Aeq(15min)}$

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		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]	
03/09/2021 Morning Shoulder	06:25	0.2m/s N 15˚C	52	39	40/45	0.2	N	11.6	12.9	1.3	2.62	F	Birds 37-47 Traffic 37-77 Livestock 37-42 Quarry Inaudible
Quarry Contribution													<30dB $L_{Aeq(15min)}$ <35dB $L_{A1(1min)}$
03/09/2021 Day	07:04	m/s ˚C	45	41	40	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Traffic 38-45 Dogs 35-41 Birds 38-60 Livestock 38-40 Quarry Inaudible
Quarry Contribution													<30dB $L_{Aeq(15min)}$
02/09/2021 Evening	21:36	1m/s N 14˚C	37	33	40	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Insects 30-32 Traffic 30-36 Livestock 30-62 Quarry Inaudible
Quarry Contribution													<30dB $L_{Aeq(15min)}$

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 are 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 inaudible. Quarry 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 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 emissions were audible during the day period. All 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 and bird noise and agricultural noise such as livestock. Occasional local traffic on Jamberoo Road, approximately 1km to the west was audible for short periods. During the survey, quarry noise emissions were audible only during the day period. Quarry contributions were calculated to be below the relevant noise criteria for all periods.

5.4 Discussion of Results - Location NM4 and 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 emissions were inaudible. The 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	<45	<40	<40	<45	49	44	47	55	Yes	Yes	Yes	Yes
NM2	35	<30	<35	<40	37	37	37	45	Yes	Yes	Yes	Yes
NM3	<35	<30	<30	<35	36	36	36	45	Yes	Yes	Yes	Yes
NM4	<35	<30	<30	<35	40	40	40	45	Yes	Yes	Yes	Yes
NM5	<30	<30	<30	<35	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 Thursday 2 September 2021 and Friday 3 September 2021 at five representative monitoring locations. The assessment has identified that noise emissions generated by Dunmore Quarry were generally audible during the day period on two occasions. The quarry remained inaudible during the evening, and morning shoulder periods. Quarry contributed noise emissions were below the relevant noise criteria at all locations during all measurement periods, thus satisfying the relevant noise limits.

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Appendix A - Glossary of Terms

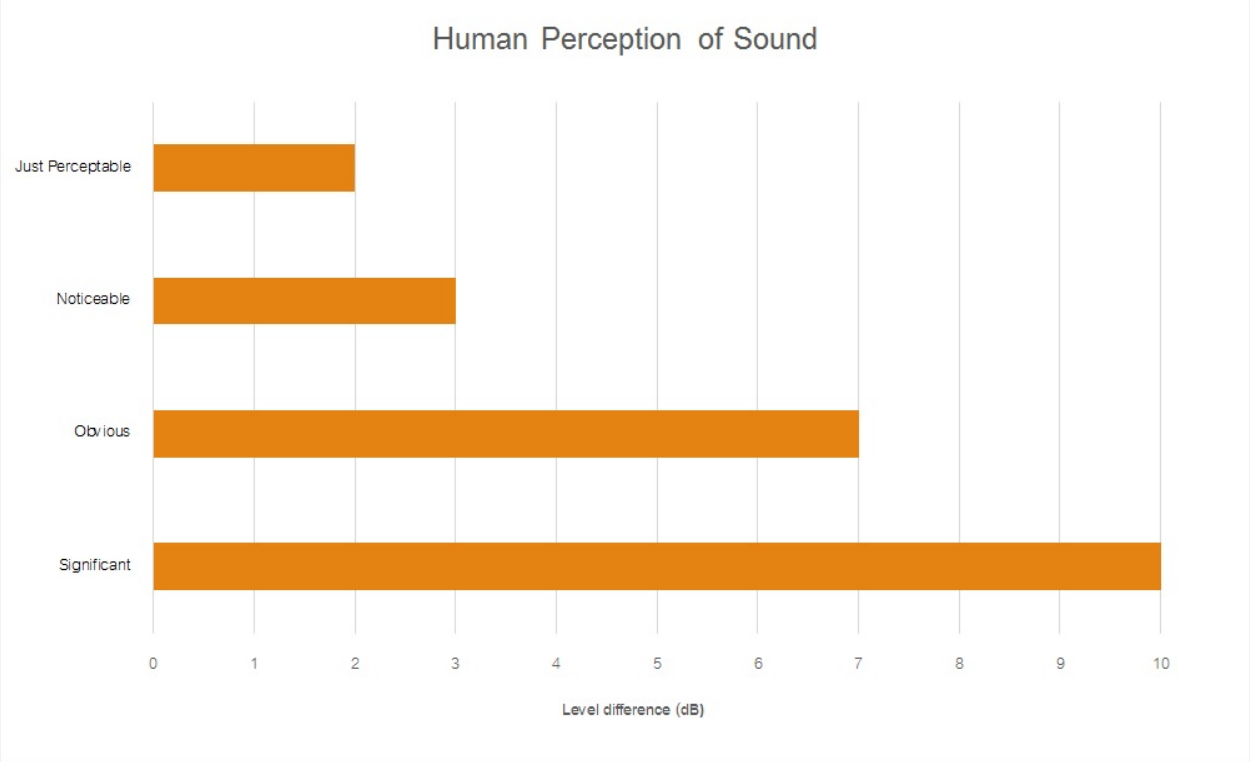
Table A1 provides a number of technical terms have been used in this report.

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



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MAC
Muller Acoustic Consulting

12. Appendix D Blast Monitoring Tables

Table 38 *Benny Residence FY22 Compliance Blast Monitoring Results*

Date	Time	Airblast Overpressure (dB(Lin Peak))	Ground Vibration (mm/s)	EIS Predicted Ground Vibration (100 MIC) (mm/s)	EIS Predicted Ground Vibration (30 MIC) (mm/s)
09-Aug-21	13:04	No Trigger	No Trigger	4.2	3.5
01-Sep-21	13:29	No Trigger	No Trigger	4.2	3.5
20-Sep-21	12:03	No Trigger	No Trigger	4.2	3.5
22-Oct-21	12:11	No Trigger	No Trigger	4.2	3.5
08-Nov-21	14:11	No Trigger	No Trigger	4.2	3.5
17-Nov-21	14:09	No Trigger	No Trigger	4.2	3.5
01-Dec-21	14:41	No Trigger	No Trigger	4.2	3.5
22-Dec-21	13:16	No Trigger	No Trigger	4.2	3.5
21-Feb-22	11:06	No Trigger	No Trigger	4.2	3.5
31-Mar-22	13:05	No Trigger	No Trigger	4.2	3.5
04-May-22	14:37	No Trigger	No Trigger	4.2	3.5
16-May-22	15:20	No Trigger	No Trigger	4.2	3.5
20-May-22	12:17	No Trigger	No Trigger	4.2	3.5
22-Jun-22	12:52	No Trigger	No Trigger	4.2	3.5
29-Jun-22	12:55	No Trigger	No Trigger	4.2	3.5

13. Appendix E EMM Ground Water Monitoring Annual Report

2021-2022 Annual Groundwater Monitoring Report

Dunmore Quarry

Prepared for Boral Resources (NSW) Pty Ltd

August 2022

2021-2022 Annual Groundwater Monitoring Report

Dunmore Quarry

Boral Resources (NSW) Pty Ltd

J17314 RP#5

August 2022

Version	Date	Prepared by	Approved by	Comments
1	9 August 2022	Quan Bui	Sean Cassidy	Draft
2	22 August 2022	Quan Bui	Sean Cassidy	Final

Approved by

Sean Cassidy
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22 August 2022

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Figures

1 Introduction

Dunmore Hard Rock Quarry (the quarry) is located at the end of Tabbita Road, in the Shellharbour local government area (LGA). The quarry is owned and operated by Boral Resources (NSW) Pty Ltd (Boral). The quarry supplies construction materials to markets in the Illawarra, Southern Highlands and Sydney regions.

Hard rock extraction from the Bumbo Latite of the Shoalhaven Group commenced at the quarry in the early 20th century. The quarry comprises one elongated open cut pit with an approved disturbance area of approximately 100 hectares (ha) (Figure 1.1). Site infrastructure includes a crushing and screening plant, product stockpiles, workshop and site offices located to the east of the pit.

Boral received approval for a pit modification to extend the quarry to the west (refer consent DA 470-11-2003) to enable the continued delivery of aggregate until approximately 2034, with the modified expansion area referred to as the Croome West pit (Figure 1.1). Staged extraction began in the 2017-2018 monitoring year with the construction of acoustic and visual bunding. During the 2018-2019 and 2019-2020 monitoring years, extraction continued in the Croome West pit moving slowly north, with overburden placement in the northern section of the formerly mined Croome pit. Throughout the 2020-2021 extraction has continued in the Croome West pit towards the west. The final pit will be extended both laterally and vertically with a maximum proposed pit depth of 60 metres Australian Height Datum (mAHD) in the Croome West pit. The recent Modification 13 proposes to extend the quarry north into the (formerly) Sydney Trains land with a pit depth of 43 mAHD.

Water management at the quarry comprises routine surface water and groundwater monitoring and the capture of intercepted surface water runoff. Captured runoff is directed into dedicated water management dams for storage and subsequent treatment. Stored water is utilised for site operations (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).

EMM Consulting Pty Limited (EMM) was engaged by Boral to characterise the hydrogeological environment and conduct groundwater monitoring and interpretation in relation to Dunmore Quarry.

1.1 Scope of works

This annual groundwater monitoring report has been prepared as a requirement of the groundwater monitoring program (GMP) (EMM 2016) in compliance with condition 44 (c) of the quarry's current approval (DA 470-11-2003). The monitoring program includes analysis and interpretation of groundwater quality and groundwater level data collected from the groundwater monitoring network. The monitoring network consists of four groundwater monitoring bores which are screened up hydraulic gradient within the Bumbo Latite and three down hydraulic gradient within the alluvium.

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

- conduct groundwater monitoring which includes a six-monthly groundwater sampling event at the Bumbo Latite monitoring bores located up hydraulic gradient from the quarry (Figure 1.1);
- analyse and interpret water level and water quality data obtained from the Bumbo Latite monitoring bores with reference to the conceptual model where relevant; and
- analyse and interpret water level and water quality data obtained from the Dunmore Sand & Soil (DSS) quarry monitoring bores located in the alluvium down hydraulic gradient from the quarry (Figure 1.1), relying on data collected and processed by International Environmental Consultants (IEC).

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

KEY

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

Dunmore Sand and Soil monitoring bores

- Active
- Decomissioned

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

0 250 500 m

GDA 1994 MGA Zone 56

N

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Site location and monitoring bores

Boral Dunmore Quarry
Annual groundwater monitoring report
Figure 1.1

EMM
creating opportunities

2 Environmental setting

2.1 Site setting and topography

The regional topography rises from coastal flats in the east to a ridge which then descends to a shallow and broad valley at the foot of a larger rise to the Southern Highlands region of the Great Dividing Range in the west.

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 mAHD. The elevation of the south-east processing area is 10 mAHD.

The project area 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 DSS quarry and the Dunmore Concrete Batching Plant (CBP) are generally east of the quarry. Quaternary alluvial sediments associated with the Minnamurra River system are extracted and processed at the DSS quarry.

Approximately 1.5 kilometres (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 (tpa) 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.

The average annual rainfall is 922.5 mm (BoM 068241) with the most significant rainfall events generally experienced in autumn (February and March) and the lowest rainfall in winter and spring (July to September).

The average annual evaporation (BoM 068241) is 1,479.5 mm 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	80.9	178.4	199.0
February	9.8	149.4	356	151.4
March	4.2	152.3	670.6	132.0
April	2.2	74.8	261.2	93.9
May	4.8	64.9	398.6	70.4
June	0	85.1	340.4	52.5

Table 2.1 Average monthly rainfall and evaporation statistics

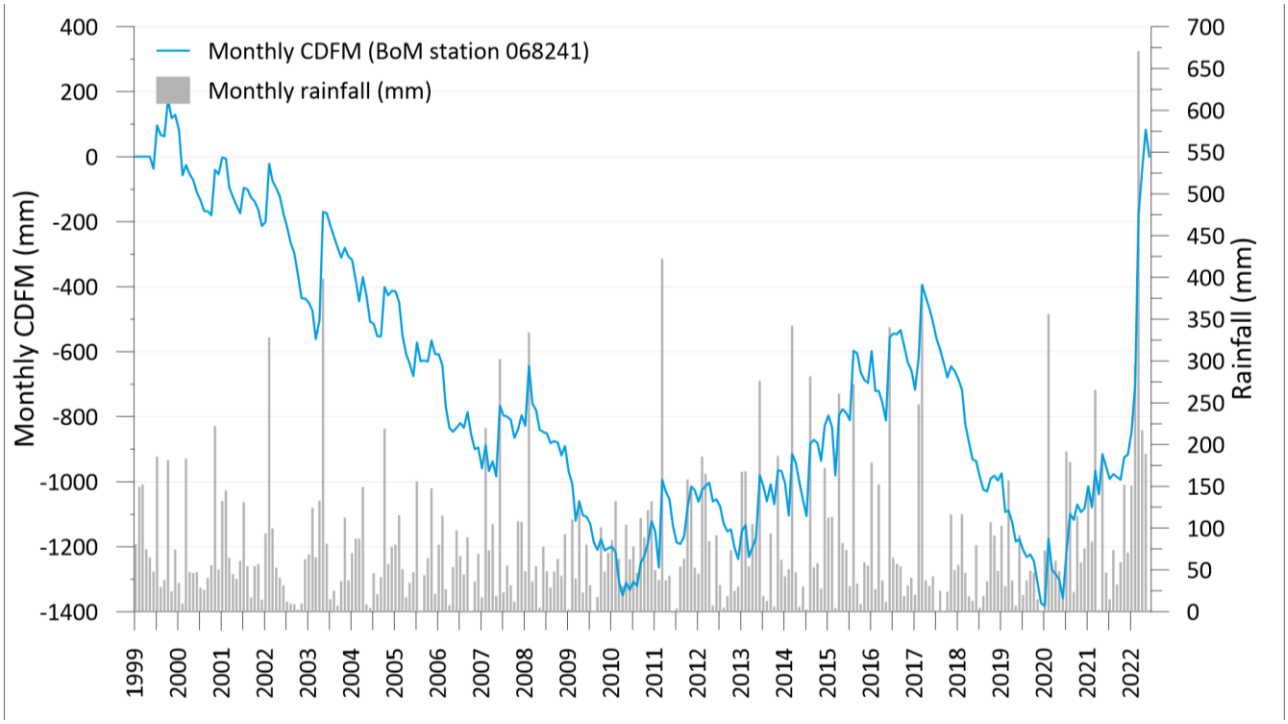
Time period (month)	Rainfall (mm)			Evaporation (mm)
	Min	Mean	Max	Mean
July	1.4	52.5	191.8	61.5
August	1.2	59.1	281.8	86.7
September	0	41.4	112.0	120.1
October	0.2	67.6	218.8	150.8
November	9.6	82.4	222.0	166.3
December	1.6	63.9	171.8	194.7

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-2022 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, consistent with widespread drought across NSW. From July 2020 to the current reporting period (June 2022) rainfall has been above the long-term average.

The monthly rainfall over the 2021-2022 monitoring period is presented in Figure 2.2. Monthly rainfall was around average from June 2021 to December 2021. Significantly higher rainfalls were recorded from January 2022 to May 2022. During the reporting period 1,941.6 mm of rain was recorded compared to the annual average of 922.5 mm, with 296.7 mm and 670.6 mm recorded in February and March 2022, respectively.



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

Figure 2.1 Cumulative deviation from long-term monthly mean rainfall

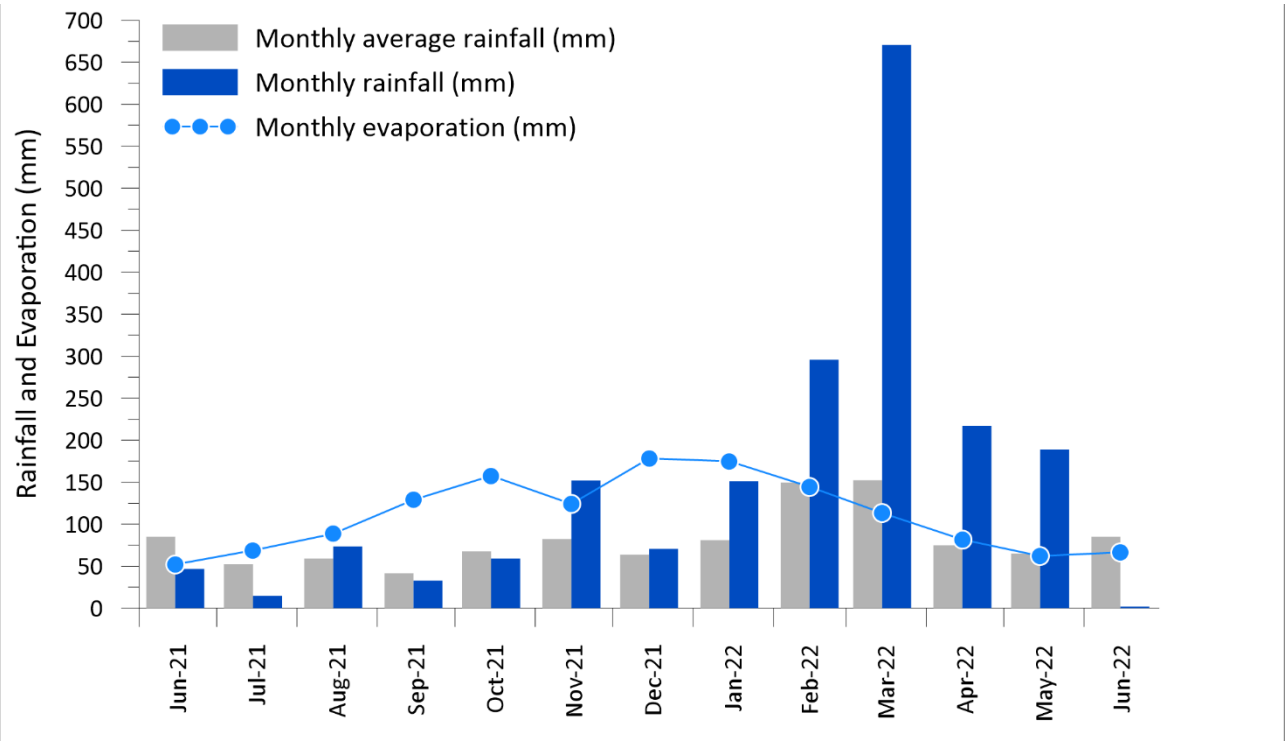


Figure 2.2 Monthly rainfall for June 2021 to June 2022 compared to average

2.3 Surface water

The quarry is in the Rocklow Creek catchment area, which forms part of the Minnamurra River Catchment. The Minnamurra River discharges into the Pacific Ocean approximately eight km south-east of the project area.

Rocklow Creek is located to the south of the quarry, flowing to the east and draining to the Minnamurra River. The Rocklow Creek catchment (21 km^2) 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 extraction licence (WAL 25152 under Section 12 of the Water Act) to extract up to 227 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. In the vicinity of the quarry, the Triassic and Late Permian sedimentary rocks have been eroded exposing the older early Permian aged Gerringong Volcanics of the Shoalhaven Group dominate (Geology of the Wollongong, Kiama and Robertson 1:50,000 Sheet, Department of Mines 1974).

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 surface geology across the project area is shown on Figure 2.3.

The Bumbo Latite is the areas greatest and most persistent lava flow and is the predominant geological unit at the quarry. The latite 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).

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).

The Bumbo Latite Member overlies the Kiama Sandstone Member at the quarry, although the Kiama Sandstone outcrops to the west of the quarry. This sandstone is easily weathered and therefore not extracted for quarrying activities.

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, governed by the dip of the strata and topography (Cohen 2006). Recharge to the Kiama Sandstone is via infiltration at outcrop and from overlying sedimentary units to the west of the project area. Regional groundwater in the Kiama Sandstone discharges to the Pacific Ocean (Cohen 2006).

Local groundwater flow 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 (although moderately higher) secondary porosity (Cohen 2006) restricting groundwater flow. Groundwater flow is minimal and predominantly occurs along fractures and at contacts between volcanic rock and the underlying sandstone (MMJ 2013).

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 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 (ie 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. Water use at these quarries constitutes only collected rainwater runoff.

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 $5.5x10^{-7}$ m/day (EMM 2014) which is comparable to the reported hydraulic conductivity in fractured igneous rocks: $8x10^{-9}$ –$3x10^{-4}$ 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 sub-horizontally along the bedding plane 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 (ie 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.

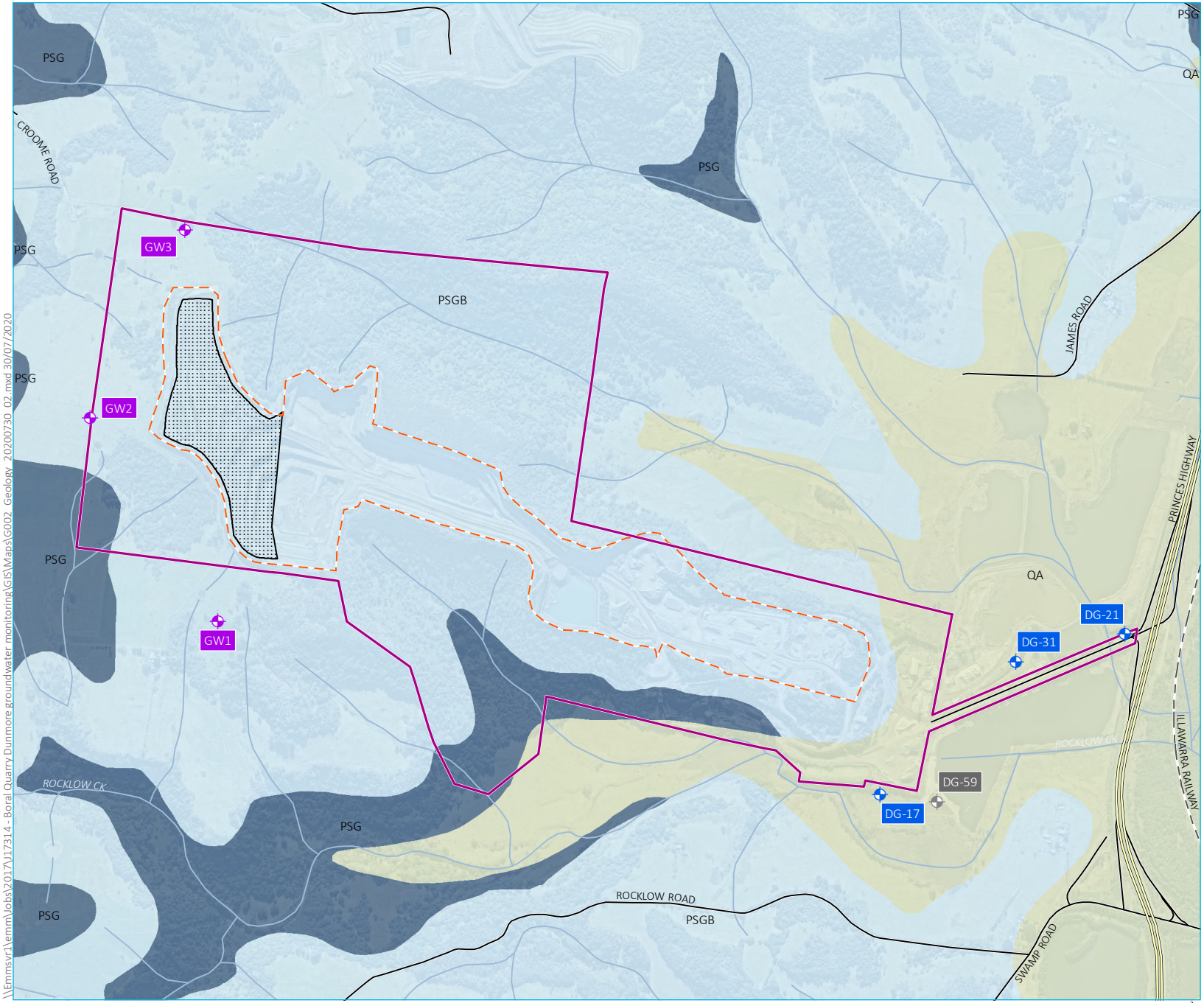
Groundwater from the shallow latite is largely thought to discharge to the Minnamurra River and Rocklow Creek, which form the main drainage systems in the vicinity of the quarry.

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)

\\Emmsvr1\emm\Jobs\2017\17314 - Boral Quarry Dunmore groundwater monitoring\GIS\Maps\G002_Geology_20200730_02.mxd 30/07/2020

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

0 250 500 m

GDA 1994 MGA Zone 56

N

Surface geology

Boral Dunmore Quarry
Annual groundwater monitoring report
Figure 2.3

EMM creating opportunities

3 Groundwater monitoring program

3.1 Monitoring network design

The monitoring network, designed in accordance with the GMP, consists of seven groundwater monitoring bores (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 (formerly) Sydney Trains land. GW4 is screened across the base of the latite and up hydraulic gradient of current quarrying activities.
- Three deep monitoring bores (GW1–3) targeting the Bumbo Latite (refer EMM 2014), installed in July 2014. GW1 is screened across the latite and the top of the underlying sandstone, GW2 is screened across the latite, and GW3 is screened across the latite and the breccia. These bores are located up hydraulic gradient from current quarrying activities.
- DSS installed and monitored several bores as part of their operations. Three shallow monitoring bores (DG-17, DG-31 and DG-21) are screened in the alluvium and located down hydraulic gradient from current quarrying activities.
- 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.

An overview of the groundwater monitoring network is presented in Table 3.1.

Table 3.1 Groundwater monitoring bore construction details

Monitoring bore	Total depth (mbgl)[1]	Ground level (mAHD)[2]	Total depth (mAHD)[2]	Screened interval (mbgl)[1]	Screened interval (mAHD)[2]	Screened formation	Duration of monitoring
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
DG-59 (decommissioned)	8.69	1.763	-6.927	tbc[3]	tbc[3]	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; tbc = to be confirmed by Boral.

3.2 Groundwater quality

In accordance with the GMP, groundwater quality sampling was undertaken as detailed in Table 3.2 over the monitoring period June 2021 – June 2022.

Table 3.2 Groundwater quality monitoring program

Monitoring bores	Monitoring events (during the 2021/2022 monitoring year)	Monitored by
GW1, GW2, GW3, GW4	December 2021 and June 2022	EMM
DG-17, DG-31, DG-21	August 2021, November 2021, February 2022	International Environmental Consultants (IEC)

3.2.1 Sampling techniques

Due to the low permeability of the Bumbo Latite, a grab sampling technique (decontaminated stainless steel double-check bailer) was used to obtain groundwater quality samples from the Croome West monitoring bores. A submersible pump or a bailer was used to obtain groundwater quality samples from the higher permeability shallow alluvial monitoring bores.

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

3.3 Chemical analysis

Water quality samples collected from the monitoring network and were analysed for a broad chemical suite designed specifically to assess the chemical characteristics of the different water bearing zones at the monitoring sites. The analytical suite is provided in Table 3.3.

Table 3.3 Water quality suite of analysis

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

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

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

Water samples for laboratory analysis were collected in sample bottles provided by the laboratory, with appropriate preservation where required. Samples undergoing dissolved metal analysis were filtered through 0.45 micron (µm) filters in the field prior to collection.

3.3.1 Quality assurance and quality control (QA/QC)

Field sampling procedures at the monitoring locations 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; and
- unstable parameters were analysed in the field (physiochemical parameters).

3.3.2 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. No duplicate samples were recovered during the 2021-22 monitoring year.

3.4 Groundwater levels

Following completion of GW1, GW2, GW3 and GW4, SolinstTM pressure transducers (dataloggers) were installed in the water column and programmed to record a groundwater level every six hours. To verify the level recorded by the dataloggers, manual measurements were recorded during each six-monthly monitoring event (December 2021 and June 2022) using an electronic dip meter.

Dataloggers were installed by Environmental Earth Sciences (EES) in monitoring bore DG-31 in May 2016, in DG-21 in December 2018 and in DG-17 in May 2019. These dataloggers were programmed to record a groundwater level every hour. Manual measurements have been recorded periodically since installation. Groundwater level data for the alluvial bores was supplied to EMM by Boral.

4 Groundwater levels and spatial trends

Hydrographs showing groundwater levels and rainfall from the start of monitoring until June 2022 are presented in Figure 4.1 and Figure 4.2. Individual hydrographs for each monitoring bore are included in Appendix A.

During the previous monitoring period in June 2021, the dataloggers at bores GW1 and GW2 were both found to have malfunctioned. The manual water level measurements confirmed no significant changes to long-term groundwater levels at either GW1 or GW2.

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). The shallow alluvium shows a direct and immediate response to rainfall with DG-21 and DG-31 showing the most pronounced response.

It is noted that the groundwater level trend at DG-21 preceding June 2020 is not considered representative as the logger was not submerged and did not record an accurate water level.

There is an increasing trend in groundwater levels across the alluvium from September 2021 onwards which reflects the observed above average rainfall conditions over this period.

4.2 Bumbo Latite

Groundwater elevations in the Latite monitoring bores at GW1–3 are between 105 and 128 mAHD (Figure 4.2). The groundwater elevation is highest at monitoring bore GW2 (~128 mAHD) which is screened in the Latite, and lower at monitoring bores GW1 (~110 mAHD) which is screened across the Latite and Kiama Sandstone

The groundwater level at GW1 has historically shown a direct response to rainfall recharge during periods of above average rainfall and has shown a close relationship to the CDFM. Comparatively, GW2 and GW3 show little to no response to rainfall. Although GW1 is deeper, this bore is partially screened within the Kiama Sandstone, which responds to regional groundwater recharge.

There is limited monitoring data at GW4, but the groundwater level is generally trending upwards, likely recovering post drilling and airlift development. The periodic drawdown shown on Figure 4.2 are in response to bore development during sampling campaigns.

Logger data was unavailable between June/December 2020 to June 2021 at GW1 and GW2 due to logger malfunctions. These loggers were replaced in June 2021. It is noted that prior to the malfunction, both loggers exhibited substantial drift in their pressure readings. Manual water level dip measurements were used instead to assess groundwater level trends over this period.

4.3 Summary

During the reporting period there was no observable groundwater impacts from quarrying activities 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.

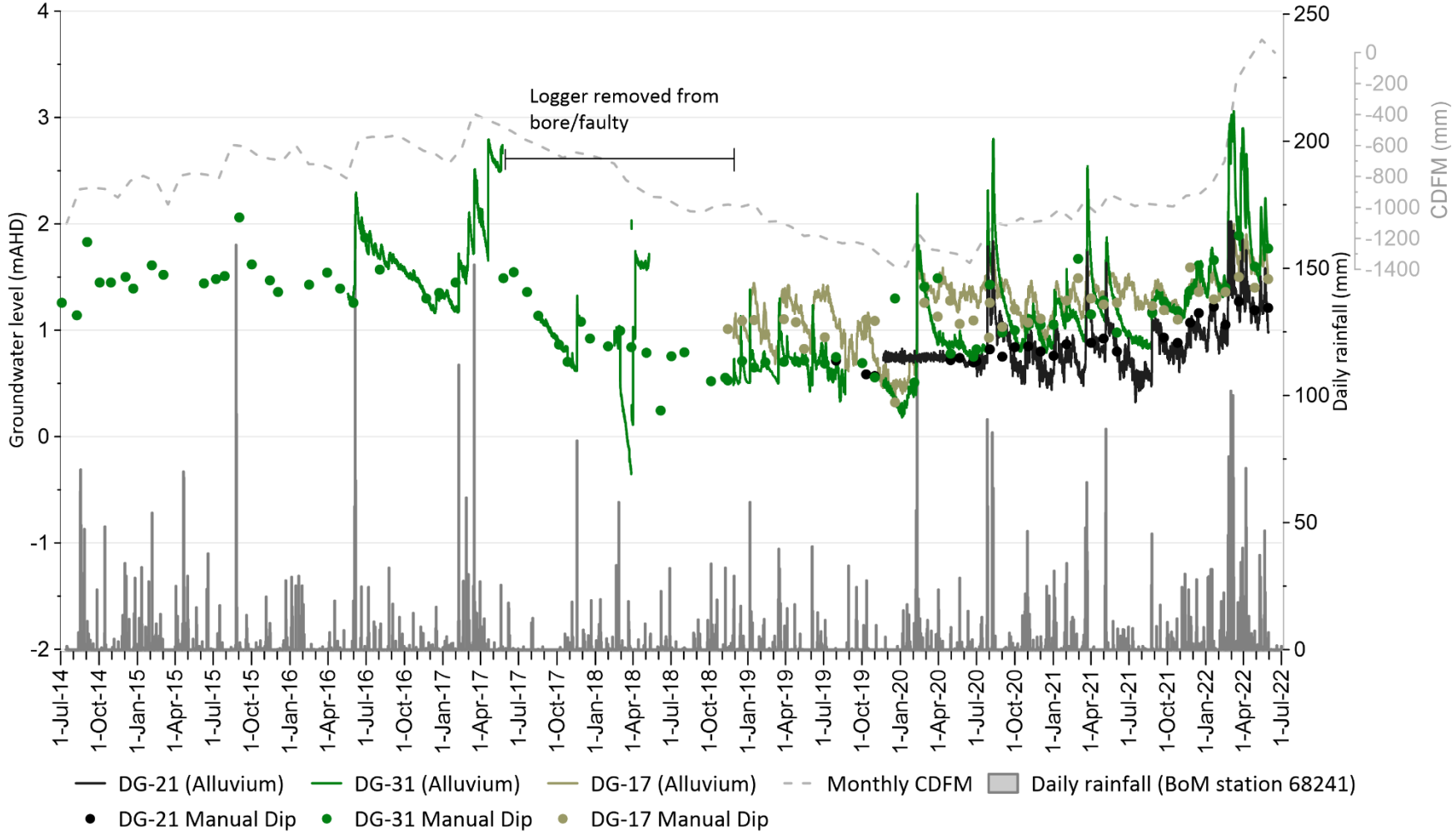


Figure 4.1 **Groundwater levels in the alluvium**

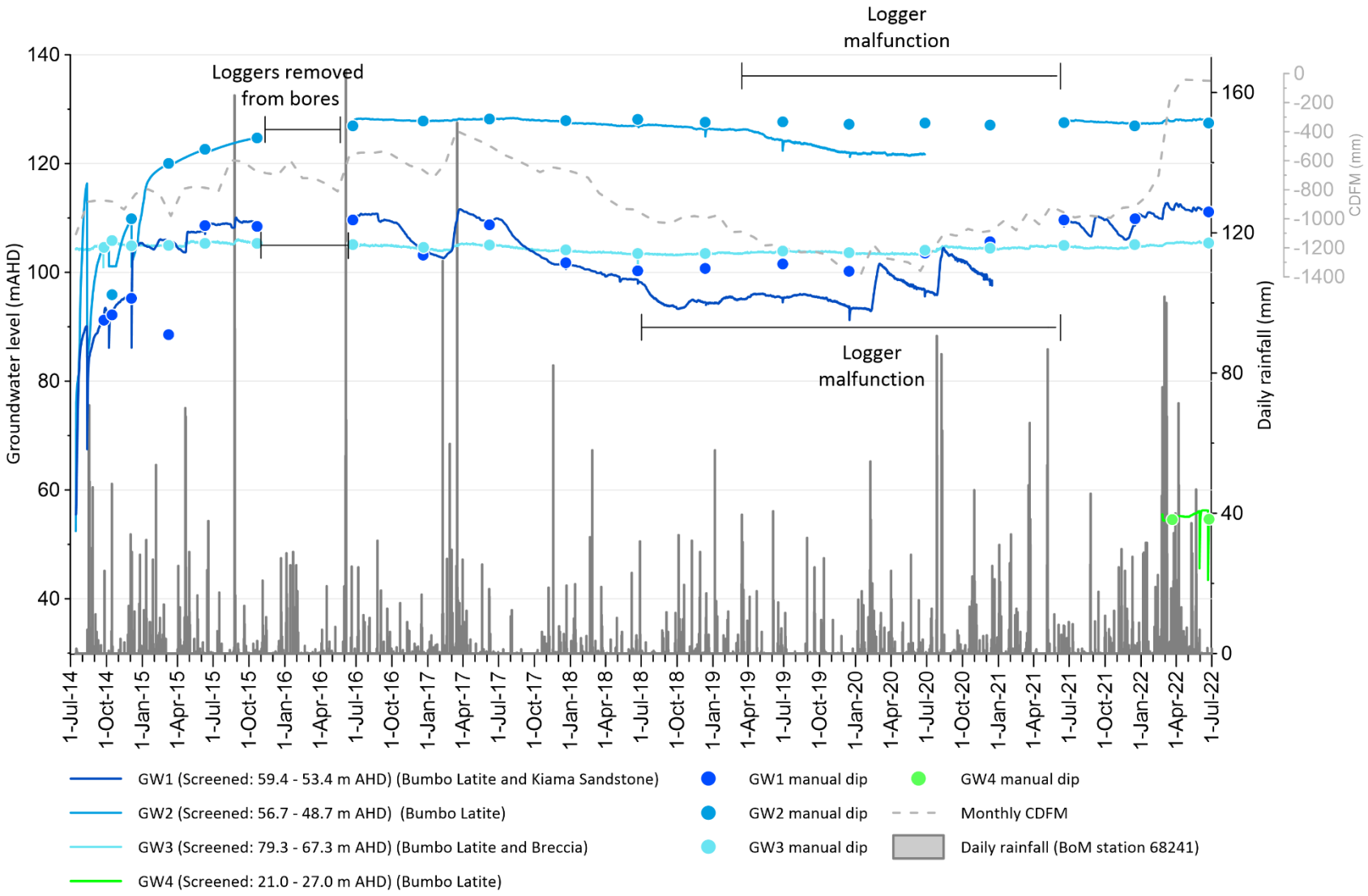


Figure 4.2 **Groundwater levels in the Bumbo Latite**

5 Groundwater quality

Water quality results for the 2021/2022 monitoring year are summarised in this chapter and are compared to previous monitoring years. 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 at GW1-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 except for DG-31 which measured a decline in EC.

EC in the Bumbo Latite was varied, averaging approximately 1,000 microseimens per centimetre (µS/cm) at GW3 and 1,600 µS/cm at GW2, and 2,600 µS/cm at GW1. A single measurement at GW4 was taken in June 2022 and measured to be 1,127 µS/cm. EC at GW1 displayed large fluctuation ranging from 834 to 4,187 µS/cm. The measured pH at GW1-GW4 are neutral to slightly alkaline, with an average of approximately 7.5 pH.

Alluvial groundwater is brackish, with an average concentration of approximately 1,800 µS/cm, and has a neutral to slightly acidic pH. The EC at DG-31 appears to be variable and potentially influenced by rainfall, displaying increased salinity loads between 2018 to 2021 during a period of low rainfall, and a general reduction in salinity from late-2020 which is indicative of dilution following sustained rainfall. In addition, 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 with higher flows.

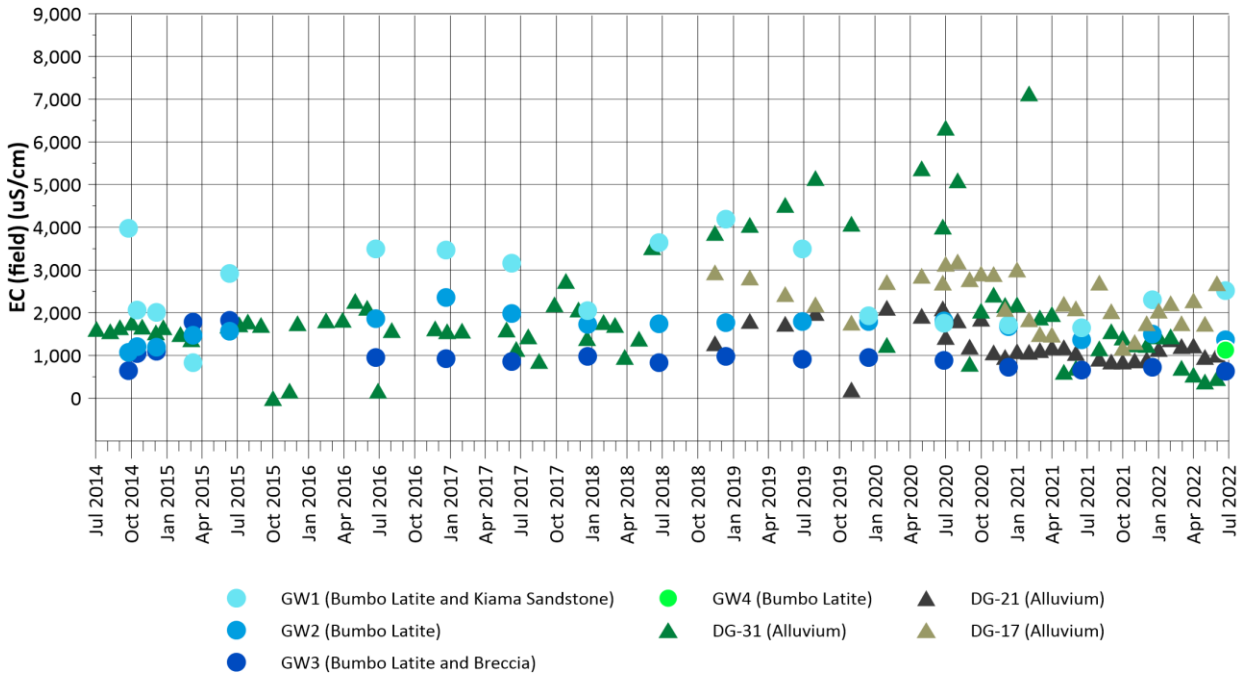


Figure 5.1 EC timeseries for all monitoring bores

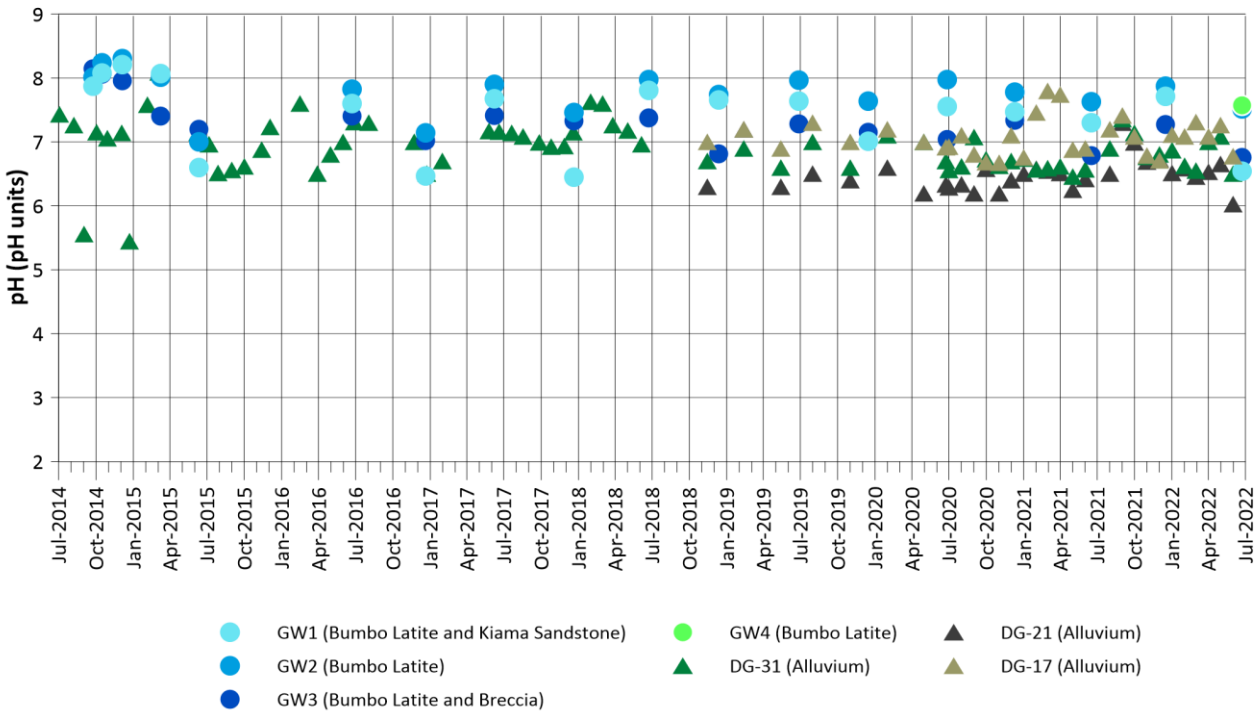


Figure 5.2 pH timeseries for all monitoring bores

5.2 Major ions

The major ion characteristics of groundwater samples for the GMP monitoring sites for the 2021/22 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-GW4 shows some variation in water type. Groundwater quality at GW1, GW2 and GW4 are interpreted as marginally bicarbonate dominant mixed type. Groundwater quality at GW3 has a magnesium-bicarbonate water type. Major ion concentrations measured at GW1-GW3 are comparable to previous monitoring years.

Groundwater chemistry from DG-17, DG-21 and DG-31 (alluvial monitroing sites) are sodium dominant. Alluvial bore DG-17 has a bicarbonate dominant mixed water type similar to GW1 and GW2, which is consistent with the conceptual model suggesting groundwater flow from the latite discharges to the alluvial river systems to the east. DG-21 is sodium chloride dominated indicating a surface water or tidal influence. DG-31 is mixed with no dominant type. Trends at the DSS sites are regularly monitored by IEC and will be further assessed in the DSS annual report.

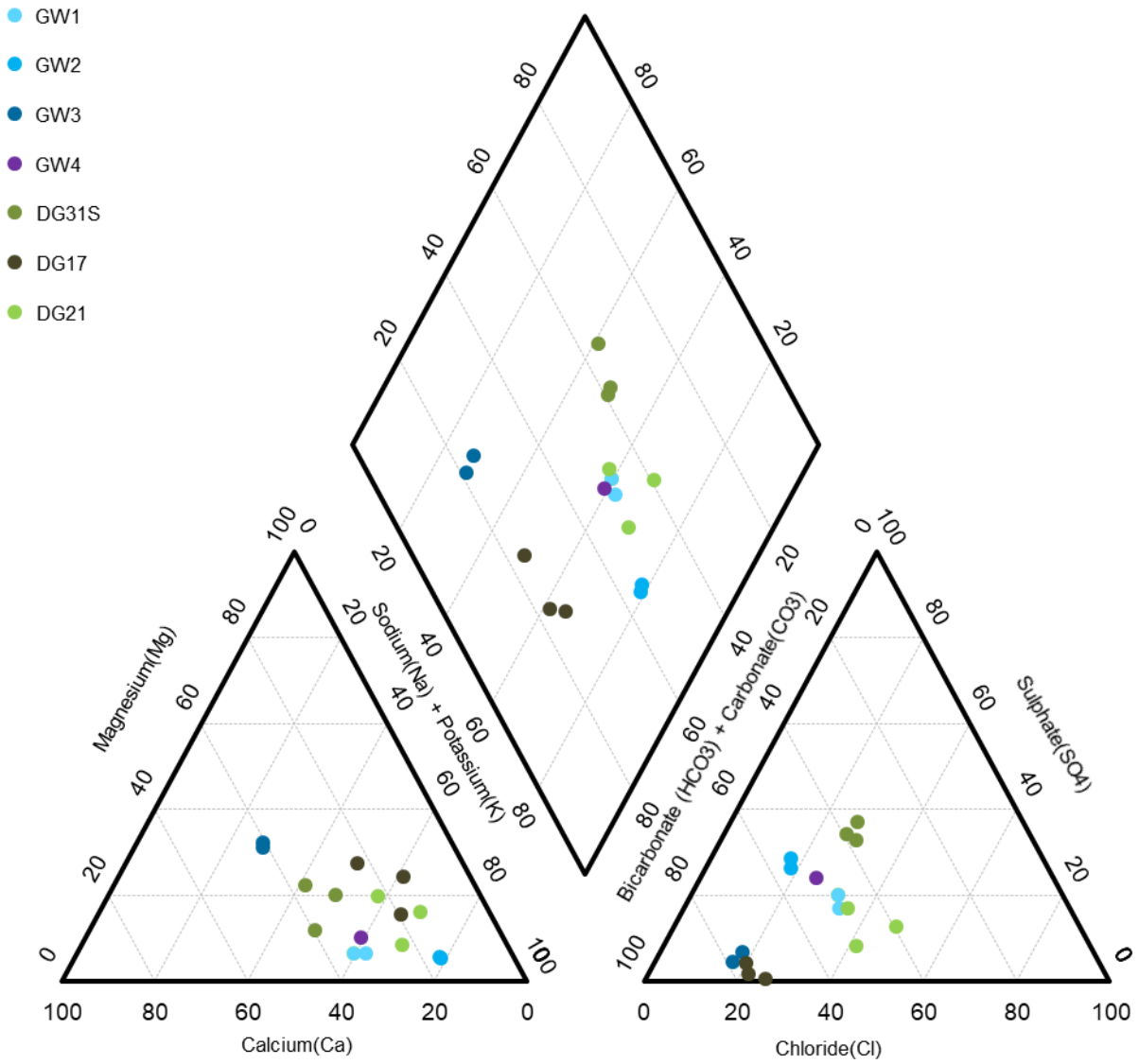


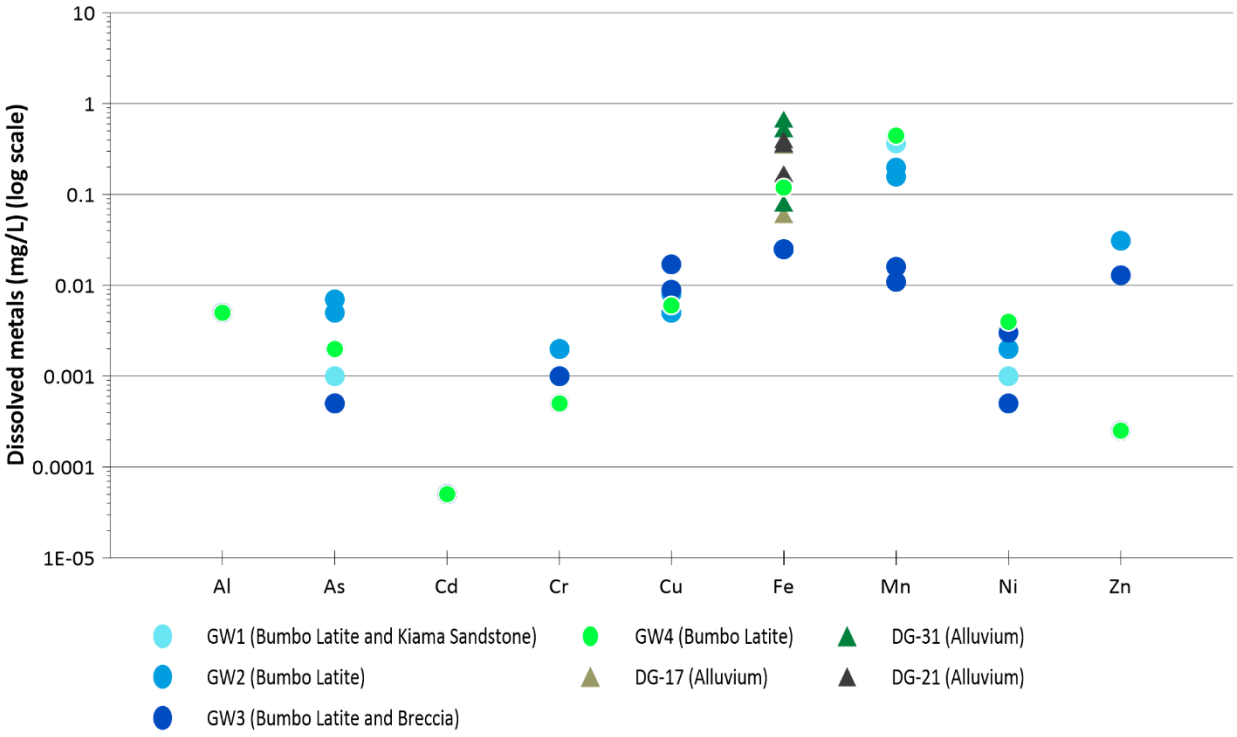
Figure 5.3 Piper plot for all monitoring bores (2021/2022 monitoring year)

5.3 Dissolved metals

Concentrations of all dissolved metals from all groundwater samples in the 2021/22 monitoring year are presented in Figure 5.4. A full suite of metals was analysed for the GW1-GW4 monitoring sites, with a timeseries of results shown in Appendix D. Only dissolved iron was analysed for the alluvial monitoring sites (DG-17, DG-21 and DG-31) during the monitoring year.

The dissolved metal measurements from GW1-GW4 were consistent, ie within the same order of magnitude, compared to the previous sampling events.

Iron concentrations were typically an order of magnitude higher across the alluvial monitoring sites (DG-17, DG-21 and DG-31) compared to GW1-GW4. Manganese was an order of magnitude lower at GW3 compared with the other latite groundwater monitoring sites (ie GW1, GW2 and GW4). Zinc was an order of magnitude lower at GW4.



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

Figure 5.4 Dissolved metal concentrations for the 2021/2022 sampling events

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.

The major findings for nutrients are as follows:

- Nitrate concentrations at most monitoring sites were comparable to previous monitoring years except for DG-17 which measured a temporary spike in August 2021 of 1.11 mg/L. Nitrate measurements from GW3 were typically an order of magnitude higher than all the other bores (both the Latite and Alluvial bores).
- Total phosphorus concentrations were comparable to previous monitoring years at GW2, GW3 and GW4. GW1 displayed an increasing trend in phosphorous concentrations, peaking at 6.7 mg/L in June 2022. The total phosphorous results at DG-17 continues to be an order of magnitude higher when compared with DG-21 and DG-31. The elevated concentration at DG-17 may be attributed to its location adjacent to the stormwater dam where all runoff from site flows towards.
- Ammonia concentrations at GW1-GW4 and the alluvial monitoring bores (DG-17, DG-21 and DG-31) were comparable to previous monitoring years and are comparable between the Bumbo Latite and alluvial monitoring sites, with the exception of GW2, which continues to be an order magnitude higher than the other monitoring sites.

The elevated nutrient concentration at the Latite bores is 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.

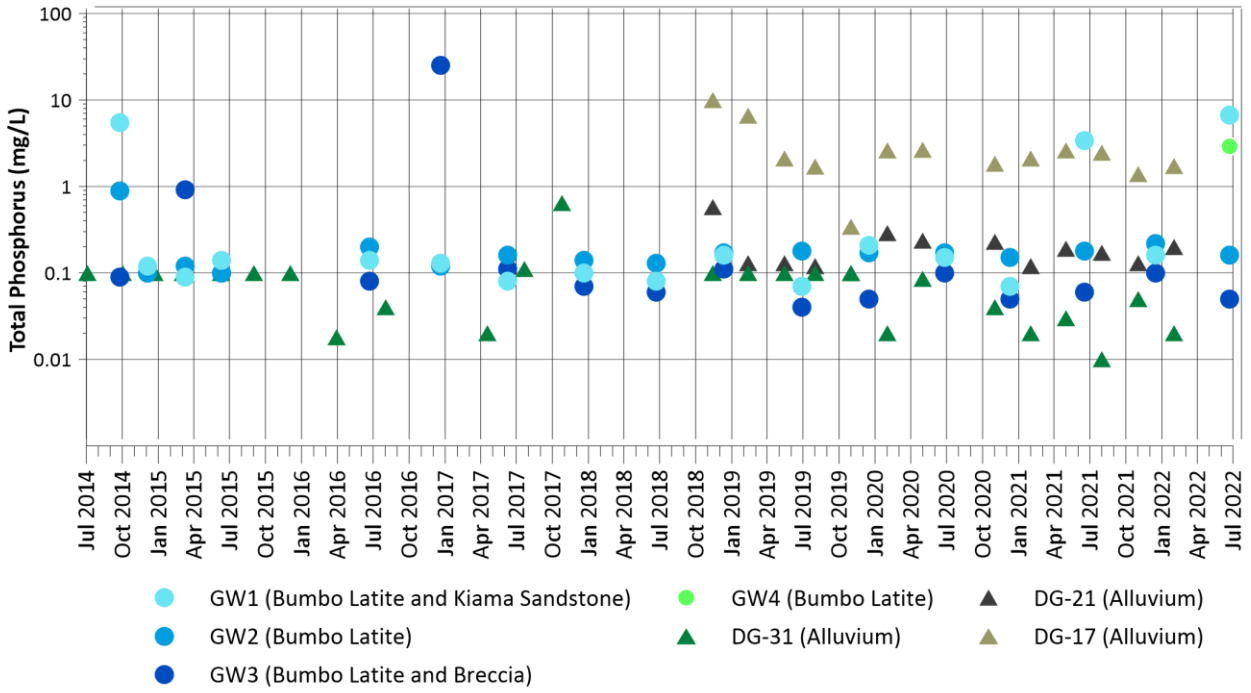


Figure 5.5 **Nitrate concentrations**

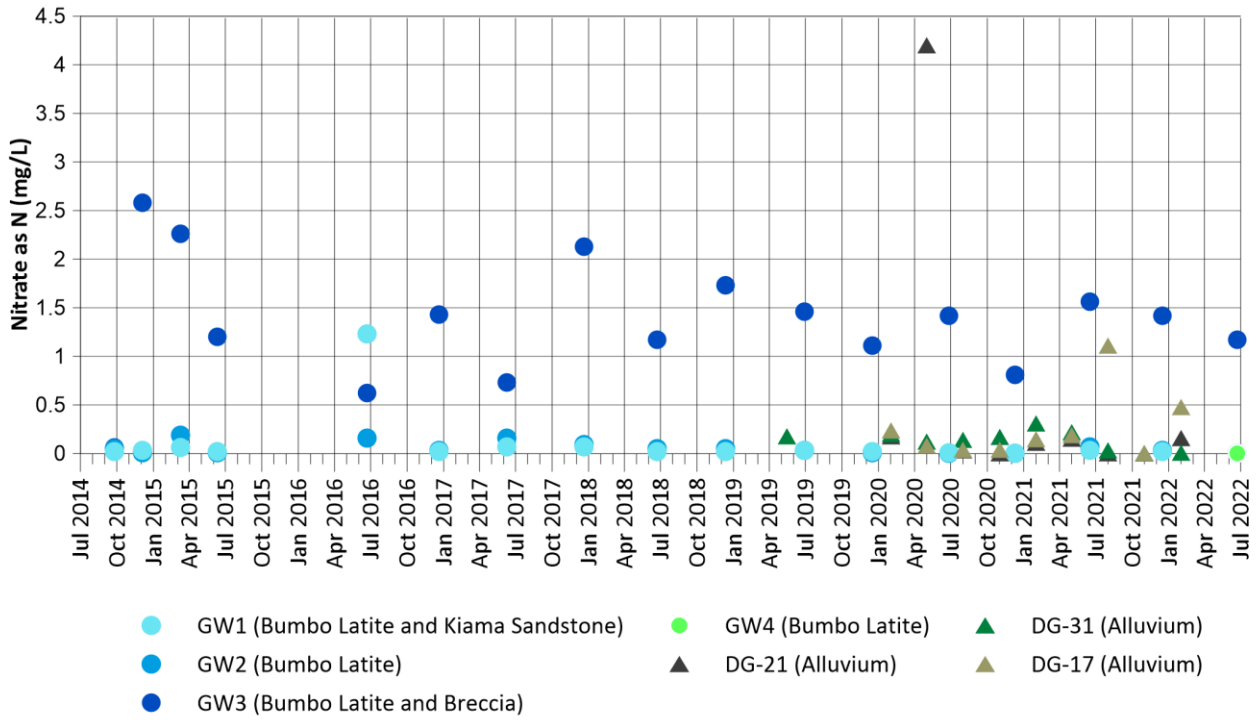


Figure 5.6 **Total phosphorus concentrations**

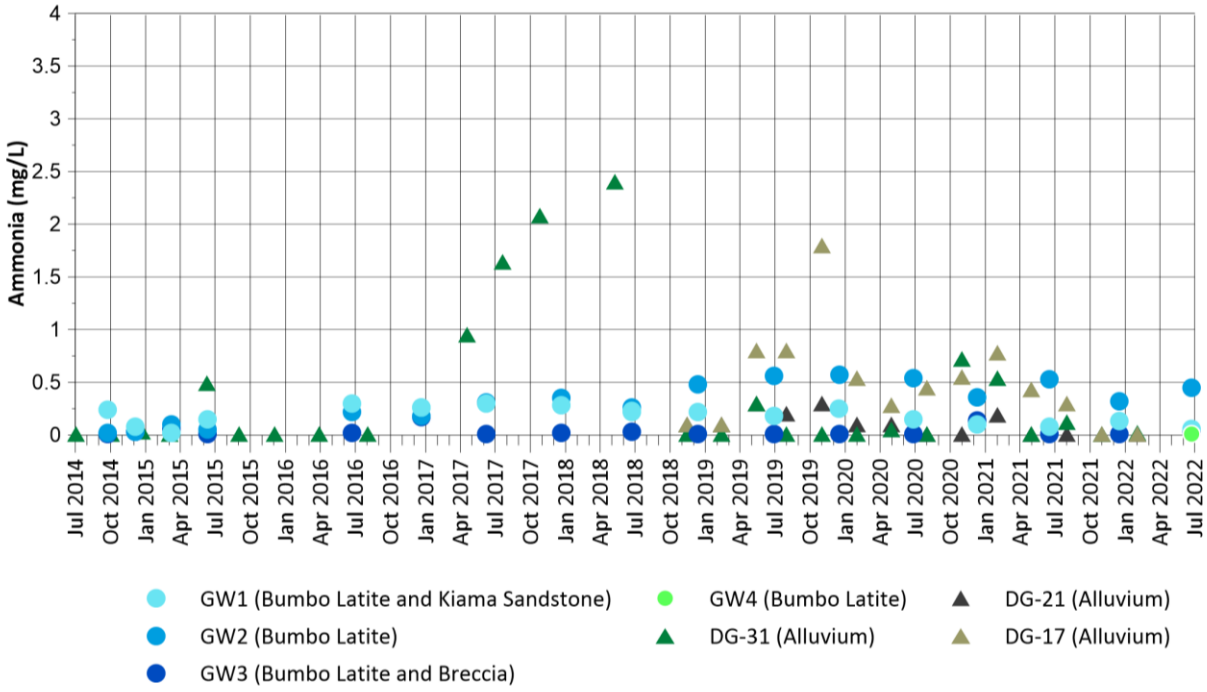


Figure 5.7 Ammonia concentrations

5.5 Summary

Groundwater quality data collected during the 2021/2022 monitoring year was generally consistent with previous years. The exceptions were in June 2022 for phosphorus at GW1, which had increased and was the highest result on record, and in August 2021 for a spike in nitrate at DG-17. Groundwater is marginal to brackish, with a neutral to slightly alkaline pH.

The dissolved metal results were comparable to the previous sampling results, and iron was typically higher in the alluvial groundwater and manganese was typically higher at the Bumbo Latite monitoring sites (GW1, GW2 and GW4).

Nitrate results at GW3 continue to be an order of magnitude higher than the other Bumbo Latite and alluvial monitoring bores. This could be related to the proximity to farmland. Total phosphorus results continue to be an order of magnitude higher at DG-17 compared to the other alluvial and Bumbo Latite bores.

6 Conclusions and recommendations

Groundwater levels measured in monitoring bores, which are screened in both the alluvium and Bumbo latite units, have been recorded on a six-hourly interval by dedicated dataloggers. Groundwater quality monitoring is conducted six-monthly at GW1, GW2, GW3 and GW4 and quarterly at DG-17, DG-21 and DG-31.

The main findings for the 2021/22 monitoring year regarding water levels are:

- groundwater levels at alluvial monitoring sites (DG-17, DG-21 and DG-31) continue to show a direct response to rainfall. These bores also show an increasing trend in response to sustained above average rainfall; and
- groundwater levels in GW1, GW2, GW3 and GW4 did not show any quarry-related impacts associated with groundwater depressurisation. Groundwater levels generally show a muted response to rainfall compared to the alluvial monitoring sites, except for GW1 which is partially screened across the underlying Kiama Sandstone and is more influenced by regional recharge.

The main findings for the 2021/22 monitoring year regarding groundwater quality are:

- groundwater quality at the alluvial monitoring sites was generally consistent with historical data, except for DG-17 which measured a temporary spike in nitrate; and
- groundwater quality measured at GW1-GW4 is consistent with previous monitoring years, with the exception of Total phosphorous at GW1.

The results for the 2021/22 monitoring year are consistent with the conceptual model for the project. There were no changes to groundwater levels or water quality observed in the groundwater monitoring bores during the monitoring 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 two 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.

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MMJ Wollongong (MMJ) 2013*, Environmental Assessment, Modification of Development Consent 10639 of 2005 Albion Park Quarry.*

Walker G., Gilfedder M., Evans R., Dyson P., Stauffacher M. 2003*, Groundwater Flow Systems Framework – Essential Tools for Planning Salinity Management*, Murray Darling Basin Commission and CSIRO Land and Water.

Appendix A
Groundwater hydrographs

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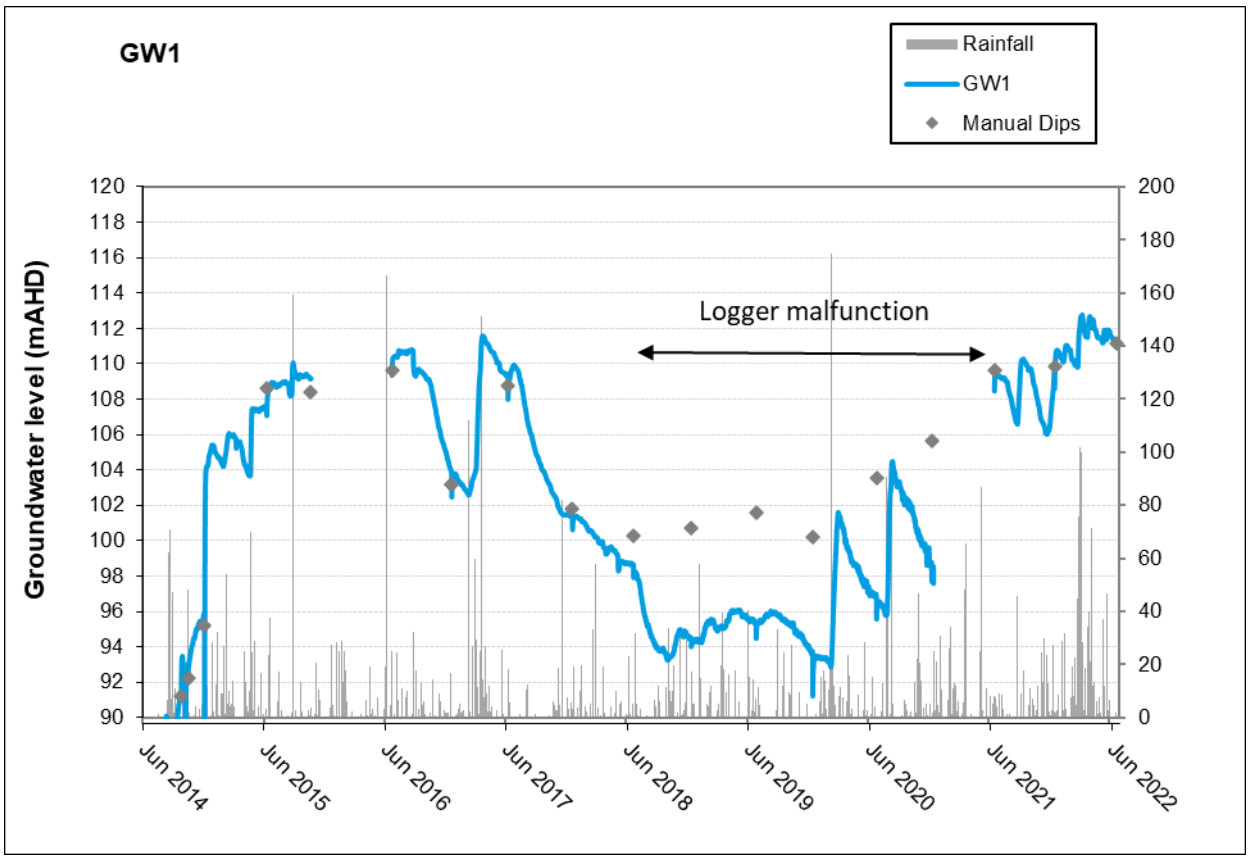
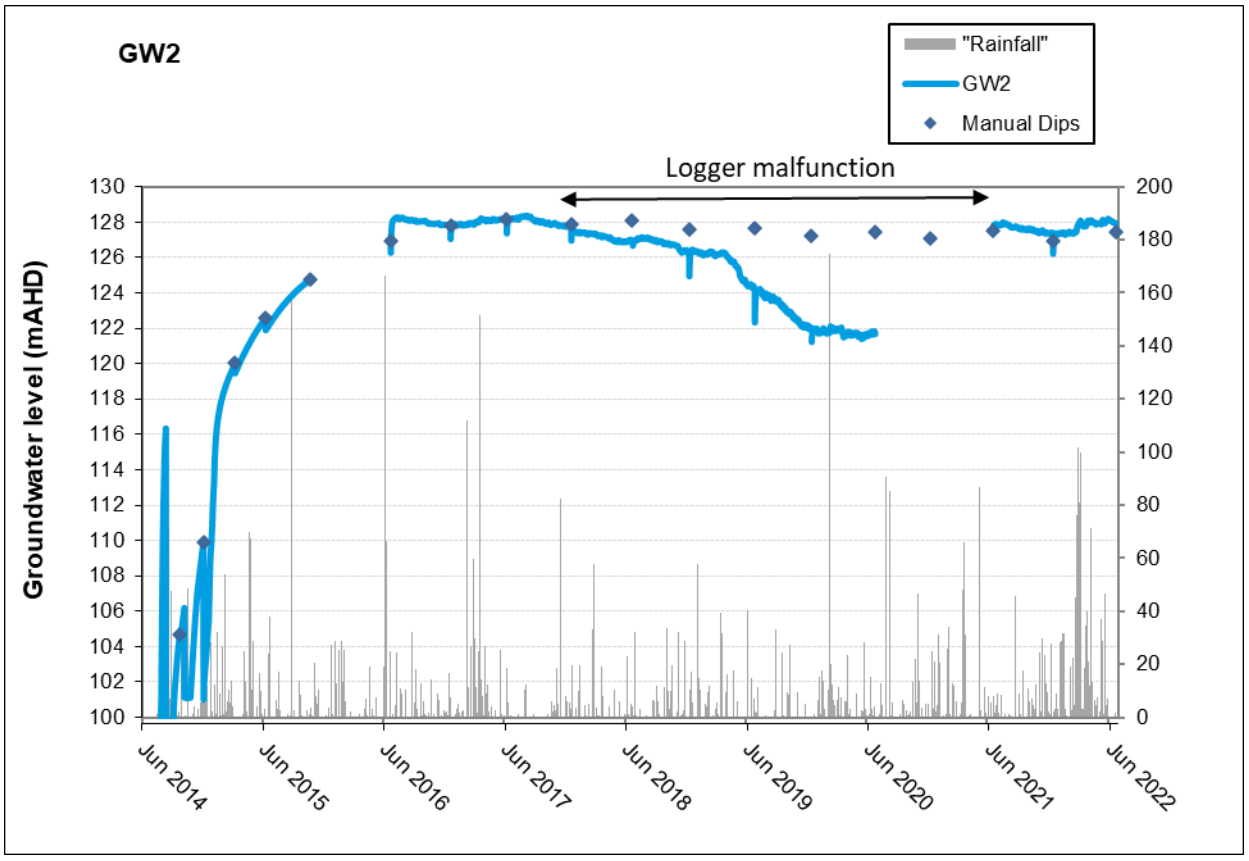
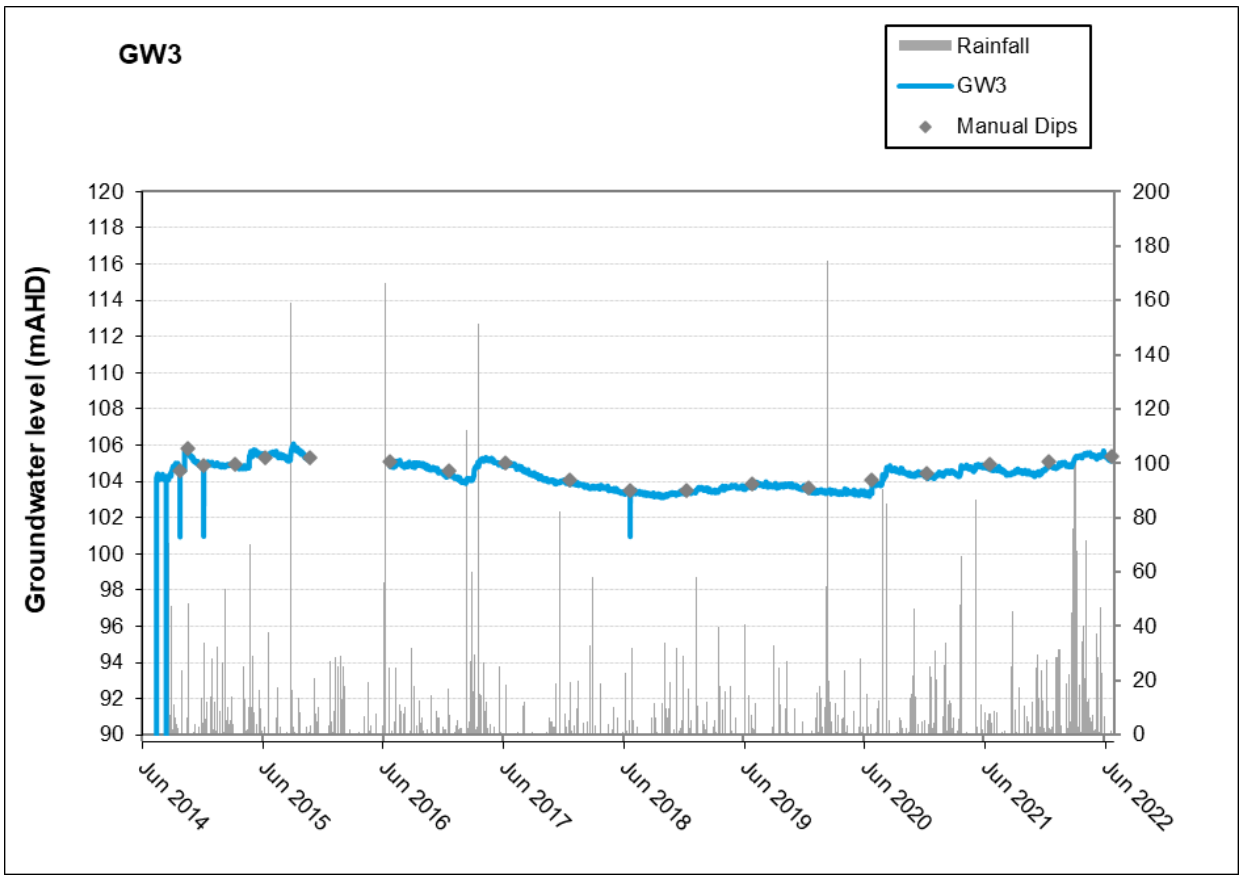
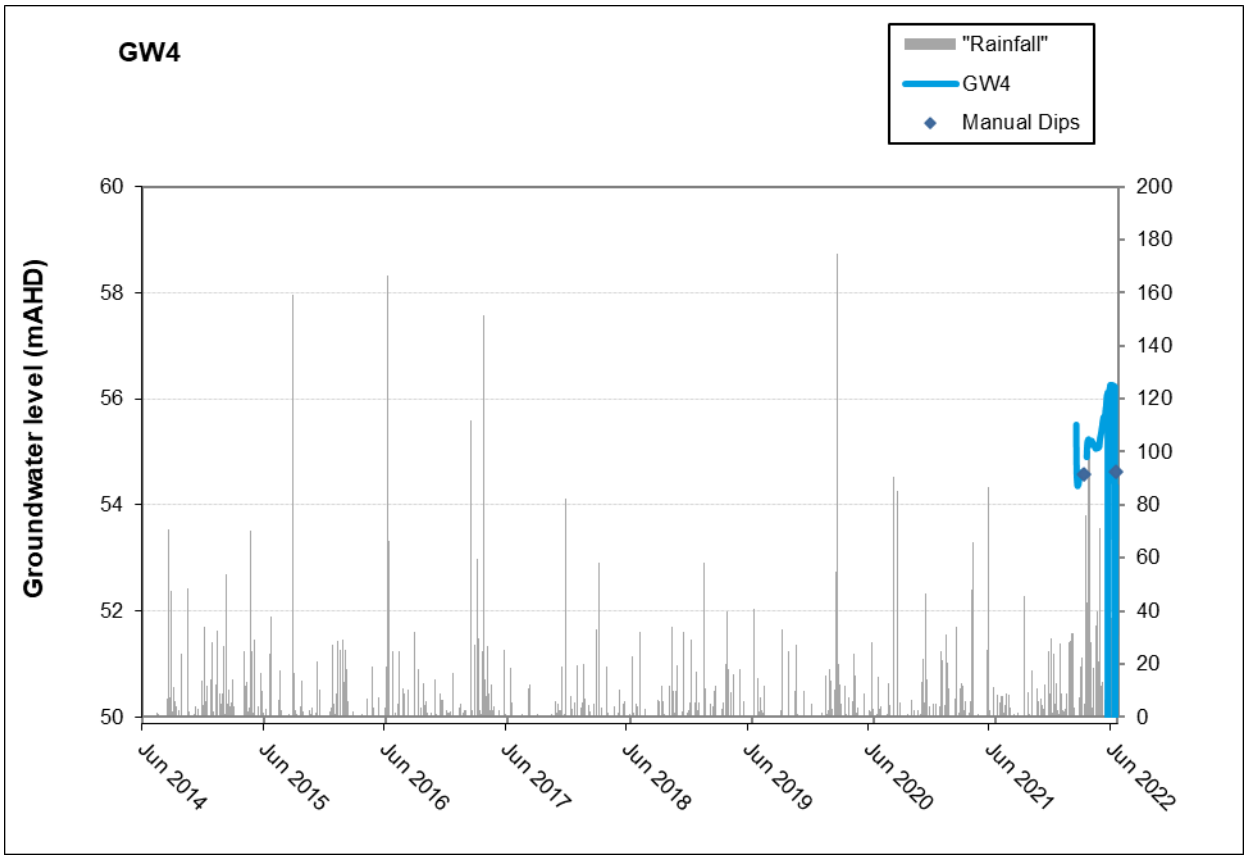
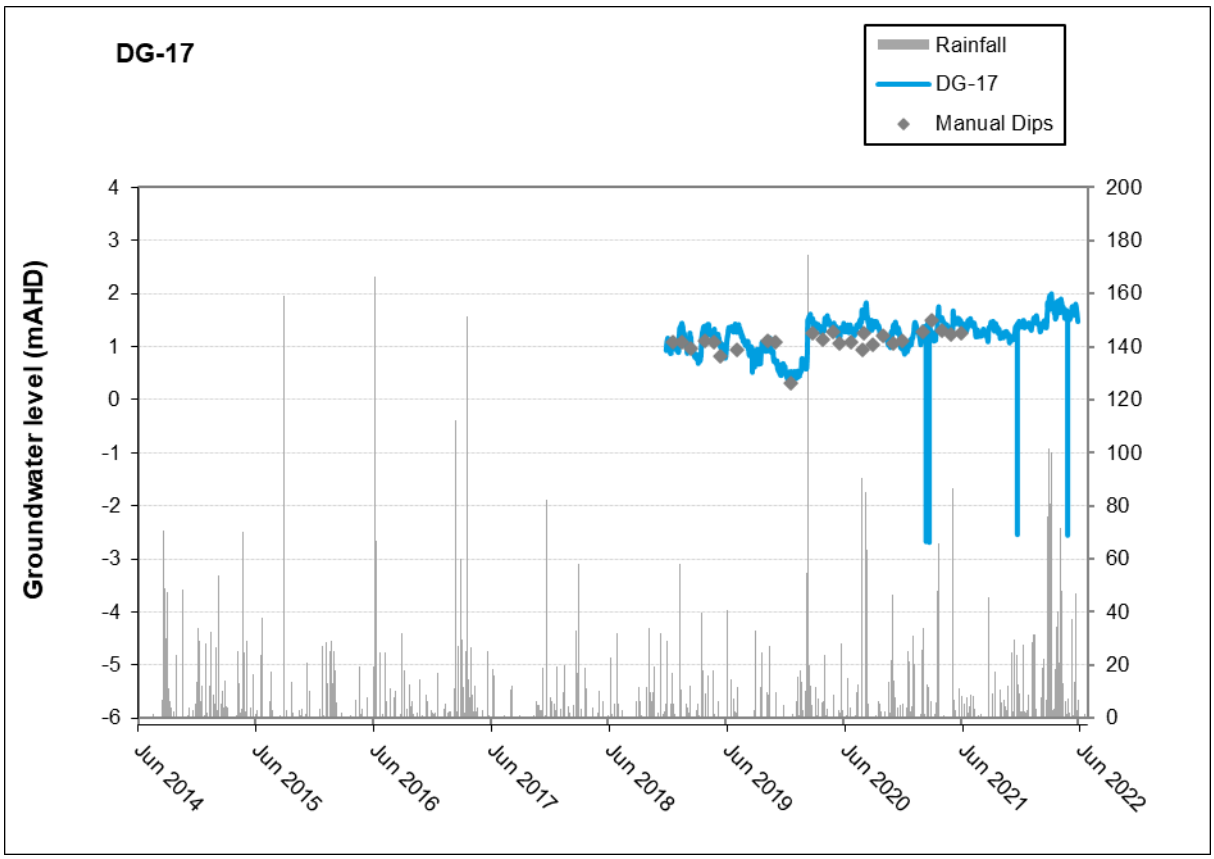
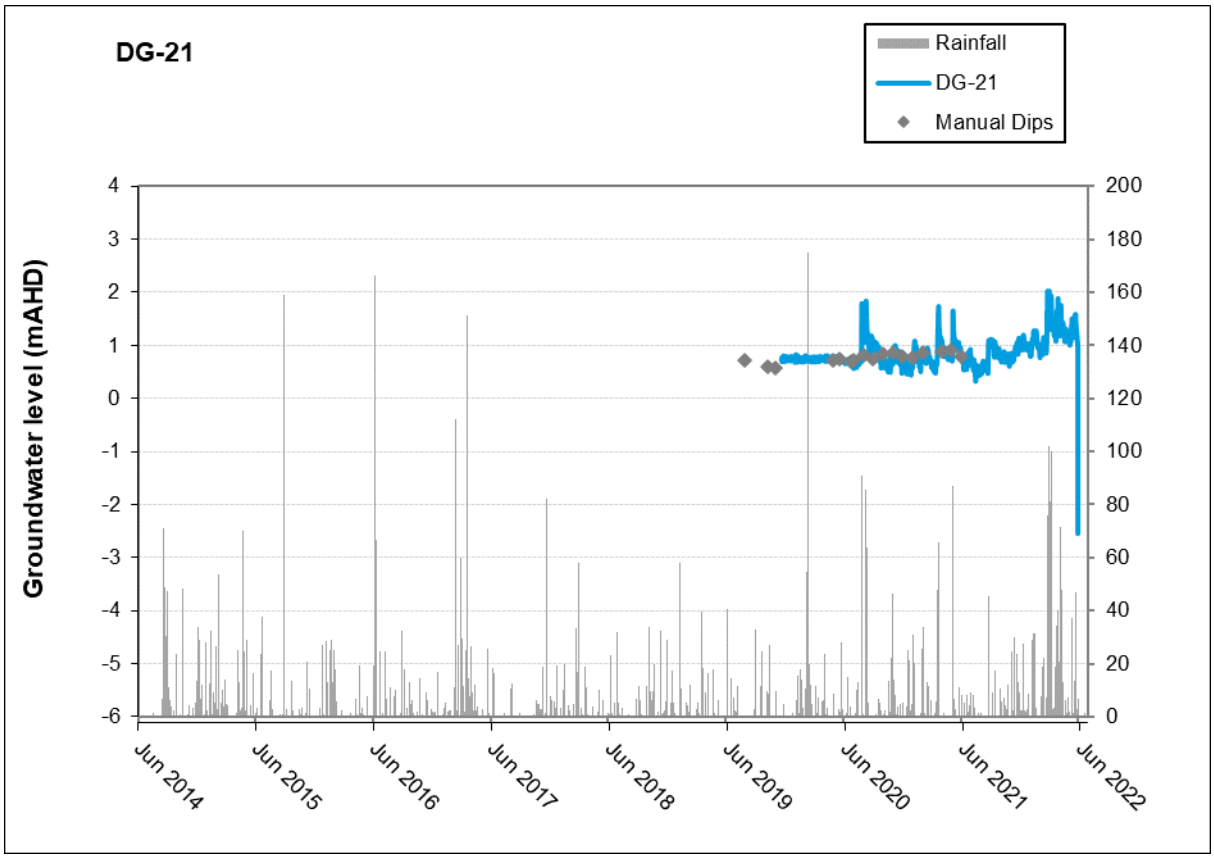

GW1
Rainfall
GW1
Manual Dips
Logger malfunction
Groundwater level (mAHD)
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
200
180
160
140
120
100
80
60
40
20
0
Jun 2014
Jun 2015
Jun 2016
Jun 2017
Jun 2018
Jun 2019
Jun 2020
Jun 2021
Jun 2022

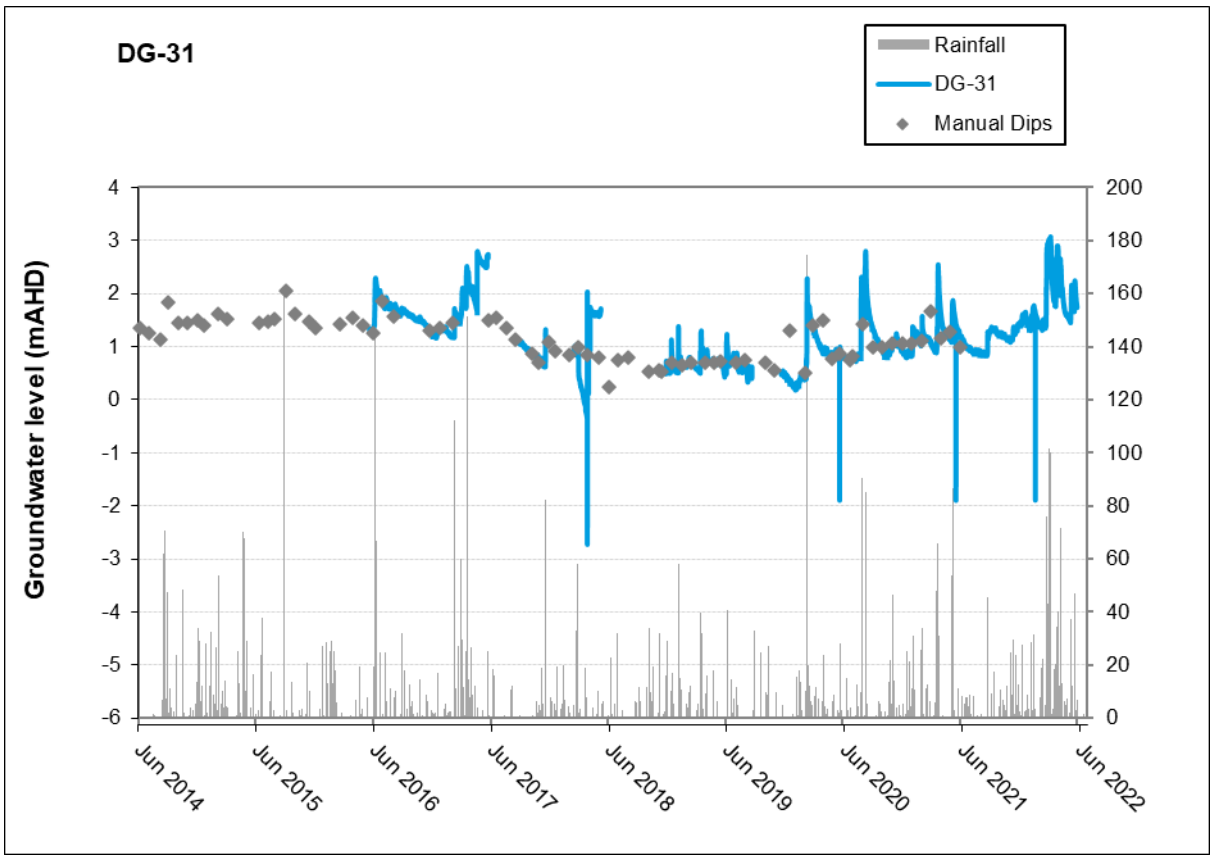

GW2
"Rainfall"
GW2
Manual Dips
Logger malfunction
Groundwater level (mAHD)
130
128
126
124
122
120
118
116
114
112
110
108
106
104
102
100
200
180
160
140
120
100
80
60
40
20
0
Jun 2014
Jun 2015
Jun 2016
Jun 2017
Jun 2018
Jun 2019
Jun 2020
Jun 2021
Jun 2022


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


GW4
"Rainfall"
GW4
Manual Dips
Groundwater level (mAHD)
60
58
56
54
52
50
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


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


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


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

Appendix B
Water quality summary tables

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	Unit	EQL	Field ID	GW1	GW1	GW2	GW2	GW3	GW3	GW4
			Date	16/12/2021	23/06/2022	16/12/2021	23/06/2022	16/12/2021	23/06/2022	23/06/2022
Analytical results – general										
TDS	**mg/L**	10		1,590	-	1,140	-	531	-	-
Electrical Conductivity (Lab)	**µS/cm**	1		2,300	-	1,500	-	723	-	-
pH (Lab)	**-**	0.01		7.71	-	7.87	-	7.27	-	-
Redox Potential (Lab)	**mV**	0.1		186	-	143	-	171	-	-
Analytical results – alkalinity										
Alkalinity (Bicarbonate as $CaCO_3$)	**mg/L**	1		390	413	310	324	235	244	267
Alkalinity (Carbonate as $CaCO_3$)	**mg/L**	1		<1	<1	<1	<1	<1	<1	<1
Alkalinity (Hydroxide) as $CaCO_3$	**mg/L**	1		<1	<1	<1	<1	<1	<1	<1
Alkalinity (total) as $CaCO_3$	**mg/L**	1		390	413	310	324	235	244	267
Analytical results – nutrients										
Ammonia as N	**mg/L**	0.01		0.13	0.06	0.32	0.45	<0.01	0.02	<0.01
Nitrite + Nitrate as N	**mg/L**	0.01		0.02	<0.01	0.03	<0.01	1.42	1.17	<0.01
Kjeldahl Nitrogen Total	**mg/L**	0.1		0.5	3.4	0.9	0.8	0.4	0.3	2.2
Nitrite (as N)	**mg/L**	0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate (as N)	**mg/L**	0.01		0.02	<0.01	0.03	<0.01	1.42	1.17	<0.01
Nitrogen (Total)	**mg/L**	0.1		0.5	3.4	0.9	0.8	1.8	1.5	2.2
Inorganics										
Calcium (filtered)	**mg/L**	1		155	138	50	56	62	66	90
Chloride	**mg/L**	1		365	399	141	155	80	75	186
Silicon as SiO2 (filtered)	**mg/L**	0.1		29.4	29.6	31.9	32.2	37.5	40.5	43.0
Sodium (filtered)	**mg/L**	1		311	313	279	320	48	51	199
Magnesium (filtered)	**mg/L**	1		17	17	10	11	30	30	18
Potassium (filtered)	**mg/L**	1		2	2	3	3	<1	<1	3
Anions Total	**meq/L**	0.01		24.6	25.1	16.6	16.9	7.78	7.53	15.6
Ionic Balance	**%**	0.01		3.92	6.79	3.47	2.16	0.87	2.89	2.88
Cations Total	**meq/L**	0.01		22.7	22.0	15.5	17.7	7.65	7.98	14.7
Sulfate as SO_4 - Turbidimetric (filtered)	**mg/L**	1		311	271	311	293	40	26	240
Metals										
Aluminium (filtered)	**mg/L**	0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic (filtered)	**mg/L**	0.001		0.002	0.001	0.007	0.005	<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
Chromium (III+VI) (filtered)	**mg/L**	0.001		0.001	0.001	0.002	0.002	0.001	<0.001	<0.001
Copper (filtered)	**mg/L**	0.001		<0.001	0.008	<0.001	0.008	0.017	0.009	0.006
Iron (filtered)	**mg/L**	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.12
Manganese (filtered)	**mg/L**	0.001		0.437	0.366	0.157	0.199	0.011	0.016	0.448
Nickel (filtered)	**mg/L**	0.001		<0.001	0.001	0.002	0.002	0.003	<0.001	0.004
Zinc (filtered)	**mg/L**	0.005		<0.005	<0.005	0.031	<0.005	0.013	<0.005	<0.005
NA										
Phosphate total (as P)	**MG/L**	0.01		0.16	6.70	0.22	0.16	0.10	0.05	2.89
pH Redox	**-**	0.01		7.57	-	7.98	-	7.17	-	-

Appendix C
Laboratory reports

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CERTIFICATE OF ANALYSIS

Work Order	: **ES2122671**	Page	: 1 of 4
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: Steve Rocks	Contact	: Sepan Mahamad
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 9524	Telephone	: +61 2 8784 8555
Project	: Dunmore	Date Samples Received	: 17-Jun-2021 16:50
Order number	: J17314	Date Analysis Commenced	: 18-Jun-2021
C-O-C number	: ----	Issue Date	: 24-Jun-2021 15:14
Sampler	: SR		
Site	: ----		
Quote number	: EN/112/20 Primary work		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

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*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

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 Contact 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.

- 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	17-Jun-2021 13:30	17-Jun-2021 12:00	17-Jun-2021 11:00	----	----
Compound	CAS Number	LOR	Unit		ES2122671-001	ES2122671-002	ES2122671-003	--------	--------
					Result	Result	Result	----	----
ED037P: Alkalinity by PC Titrator									
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		**470**	**390**	**266**	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**470**	**390**	**266**	----	----
ED040F: Dissolved Major Anions									
Silicon as SiO2	14464-46-1	0.1	mg/L		**32.5**	**27.7**	**35.6**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**204**	**330**	**28**	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**254**	**141**	**65**	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**172**	**60**	**60**	----	----
Magnesium	7439-95-4	1	mg/L		**15**	**12**	**25**	----	----
Sodium	7440-23-5	1	mg/L		**349**	**299**	**42**	----	----
Potassium	7440-09-7	1	mg/L		**2**	**3**	<1	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Arsenic	7440-38-2	0.001	mg/L		**0.002**	**0.007**	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
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	**0.015**	----	----
Manganese	7439-96-5	0.001	mg/L		**0.344**	**0.223**	**0.010**	----	----
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	**0.008**	----	----
Iron	7439-89-6	0.05	mg/L		**0.08**	<0.05	<0.05	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.08**	**0.53**	<0.01	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.03**	**0.07**	**1.56**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.03**	**0.07**	**1.56**	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	GW1	GW2	GW3	----	----
			Sampling date / time	17-Jun-2021 13:30	17-Jun-2021 12:00	17-Jun-2021 11:00	----	----
Compound	CAS Number	LOR	Unit	ES2122671-001	ES2122671-002	ES2122671-003	--------	--------
				Result	Result	Result	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**1.5**	**0.8**	**0.3**	**----**	**----**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**1.5**	**0.9**	**1.9**	**----**	**----**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**3.38**	**0.18**	**0.06**	**----**	**----**
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**20.8**	**18.6**	**7.73**	**----**	**----**
ø Total Cations	----	0.01	meq/L	**----**	**----**	**7.01**	**----**	**----**
ø Total Cations	----	0.01	meq/L	**25.0**	**17.1**	**----**	**----**	**----**
ø Ionic Balance	----	0.01	%	**----**	**----**	**4.90**	**----**	**----**
ø Ionic Balance	----	0.01	%	**9.26**	**4.41**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2222302**	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	: DUNMORE	Date Samples Received	: 24-Jun-2022 12:00
Order number	: J17314	Date Analysis Commenced	: 25-Jun-2022
C-O-C number	: ----	Issue Date	: 30-Jun-2022 18:23
Sampler	: Quan Bui		
Site	: ----		
Quote number	: EN/112/21		
No. of samples received	: 4		
No. of samples analysed	: 4		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

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*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW

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.

- 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	GW4	----
			Sampling date / time	23-Jun-2022 00:00	23-Jun-2022 00:00	23-Jun-2022 00:00	23-Jun-2022 00:00	----
Compound	CAS Number	LOR	Unit	ES2222302-001	ES2222302-002	ES2222302-003	ES2222302-004	--------
				Result	Result	Result	Result	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**413**	**324**	**244**	**267**	----
Total Alkalinity as CaCO3	----	1	mg/L	**413**	**324**	**244**	**267**	----
ED040F: Dissolved Major Anions								
Silicon as SiO2	14464-46-1	0.1	mg/L	**29.6**	**32.2**	**40.5**	**43.0**	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**271**	**293**	**26**	**240**	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**399**	**155**	**75**	**186**	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**138**	**56**	**66**	**90**	----
Magnesium	7439-95-4	1	mg/L	**17**	**11**	**30**	**18**	----
Sodium	7440-23-5	1	mg/L	**313**	**320**	**51**	**199**	----
Potassium	7440-09-7	1	mg/L	**2**	**3**	<1	**3**	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Arsenic	7440-38-2	0.001	mg/L	**0.001**	**0.005**	<0.001	**0.002**	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
Chromium	7440-47-3	0.001	mg/L	**0.001**	**0.002**	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L	**0.008**	**0.008**	**0.009**	**0.006**	----
Manganese	7439-96-5	0.001	mg/L	**0.366**	**0.199**	**0.016**	**0.448**	----
Nickel	7440-02-0	0.001	mg/L	**0.001**	**0.002**	<0.001	**0.004**	----
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	**0.12**	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.06**	**0.45**	**0.02**	<0.01	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	**1.17**	<0.01	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	**1.17**	<0.01	----

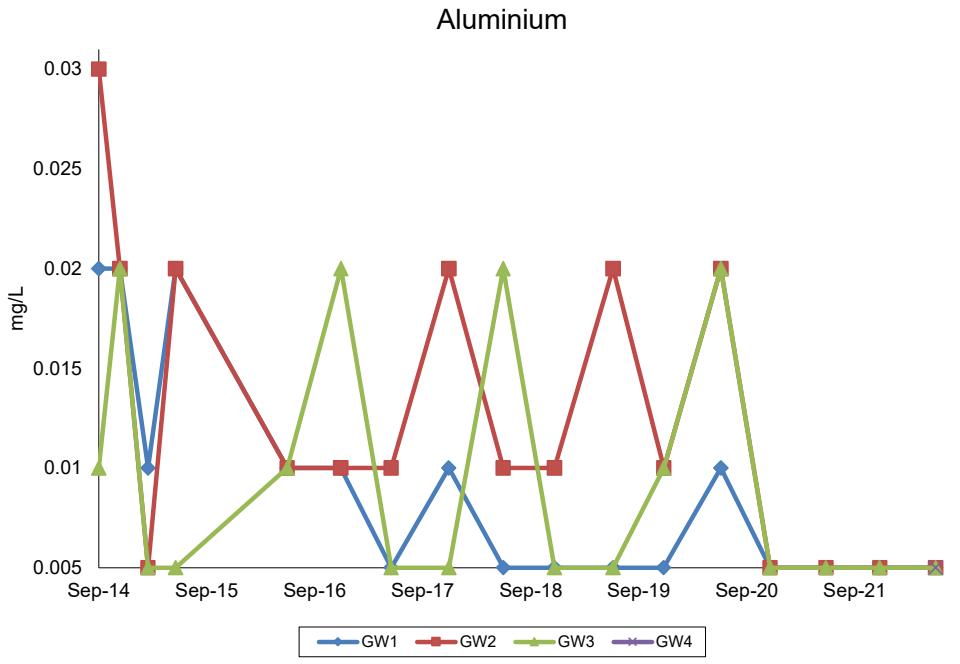
Analytical Results

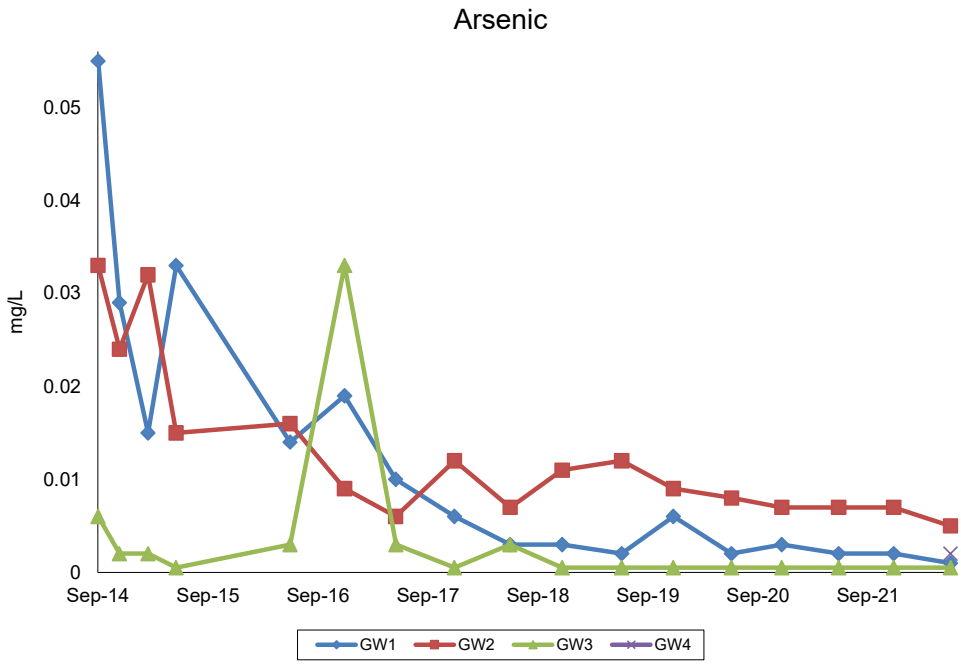
Sub-Matrix: WATER (Matrix: WATER)			Sample ID	GW1	GW2	GW3	GW4	----
			Sampling date / time	23-Jun-2022 00:00	23-Jun-2022 00:00	23-Jun-2022 00:00	23-Jun-2022 00:00	----
Compound	CAS Number	LOR	Unit	ES2222302-001	ES2222302-002	ES2222302-003	ES2222302-004	--------
				Result	Result	Result	Result	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**3.4**	**0.8**	**0.3**	**2.2**	**----**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**3.4**	**0.8**	**1.5**	**2.2**	**----**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**6.70**	**0.16**	**0.05**	**2.89**	**----**
EN055: Ionic Balance								
ø **Total Anions**	----	0.01	meq/L	**25.1**	**16.9**	**7.53**	**15.6**	**----**
ø **Total Cations**	----	0.01	meq/L	**22.0**	**17.7**	**7.98**	**14.7**	**----**
ø **Ionic Balance**	----	0.01	%	**6.79**	**2.16**	**2.89**	**2.88**	**----**

Appendix D

Croome West sites – metals timeseries charts

EMM
creating opportunities





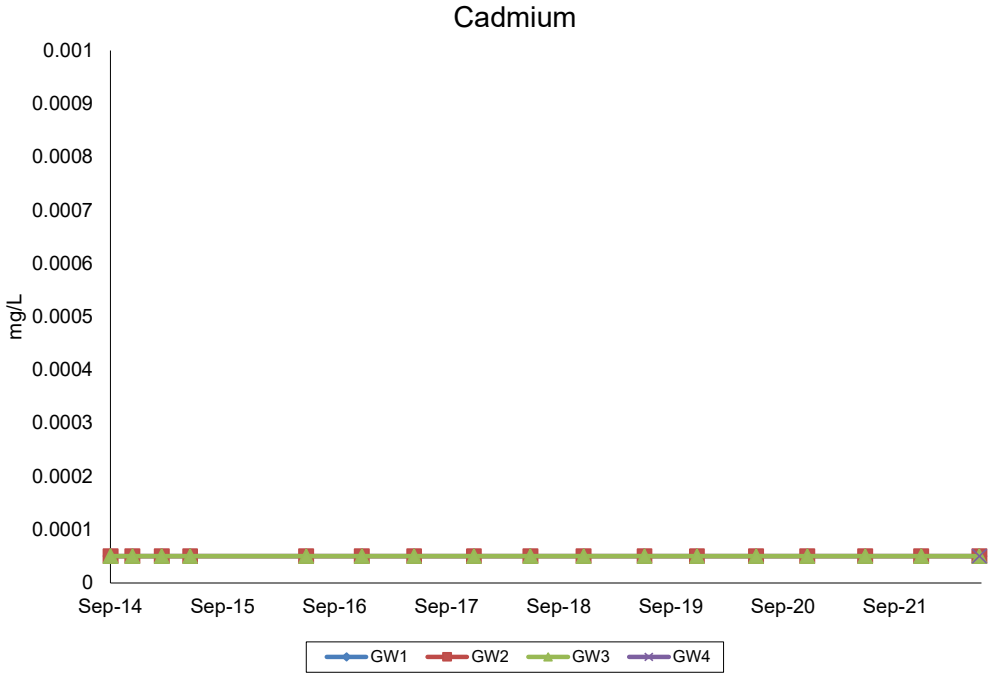
Note: Concentrations below the EQL are presented as half the EQL

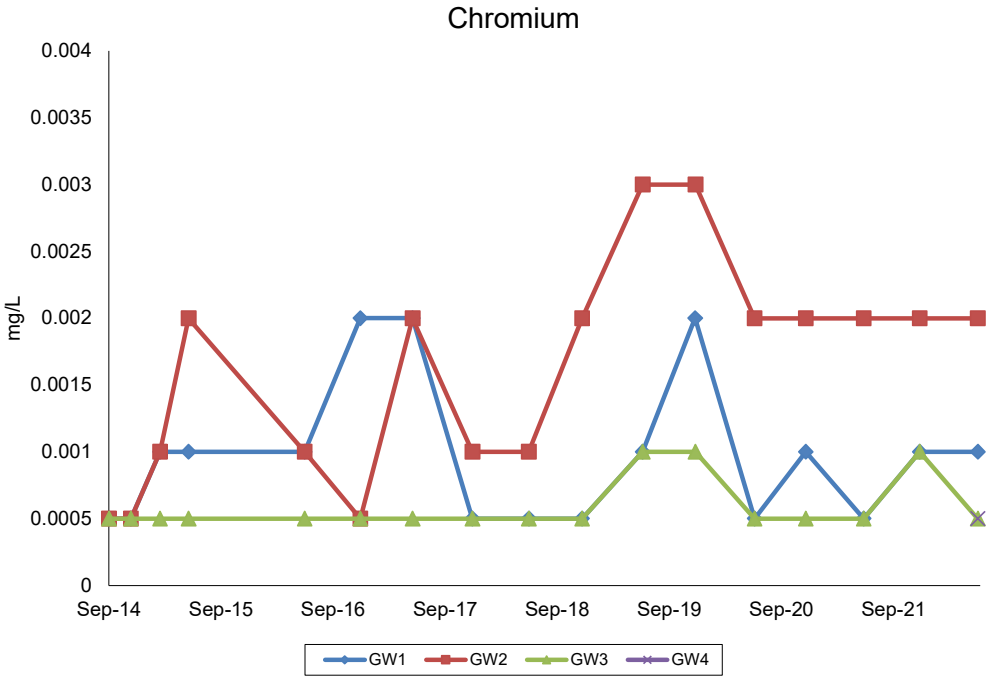
Figure D.1

Annual Groundwater Report

Boral Dunmore

EMM





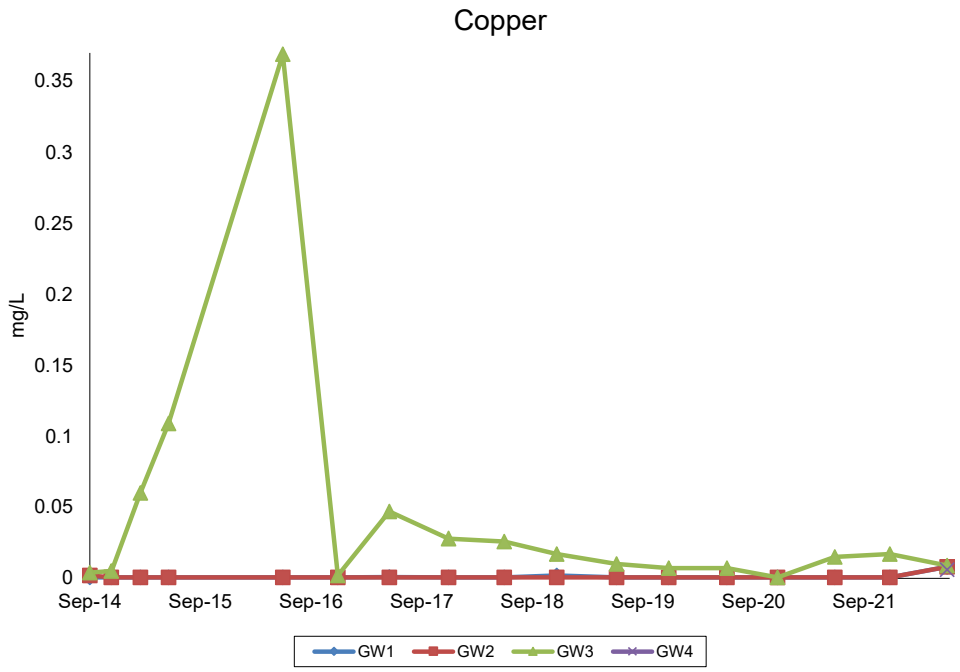
Note: Concentrations below the EQL are presented as half the EQL

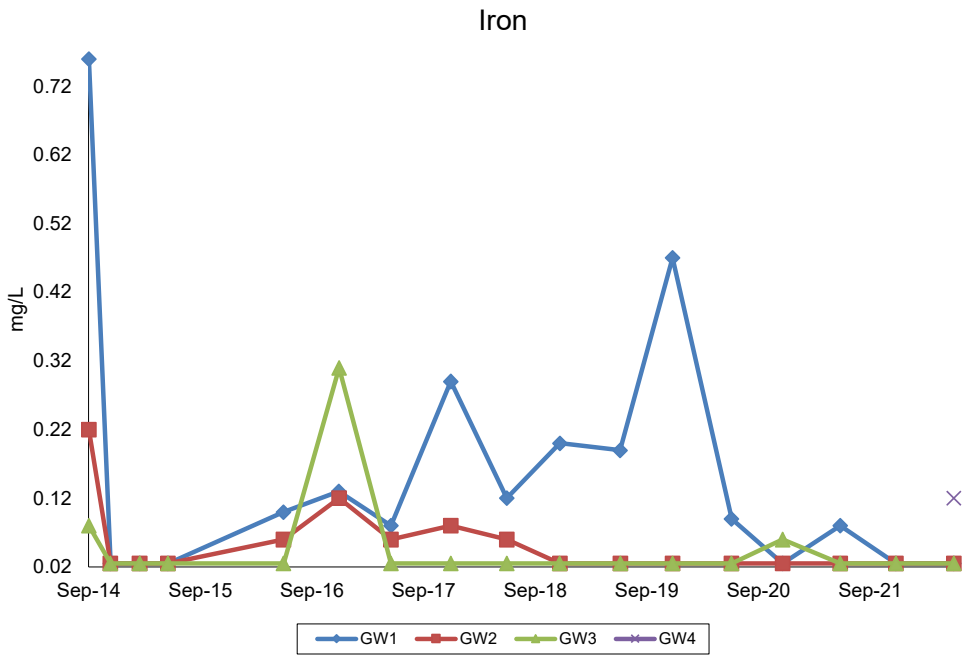
Figure D.2

Annual Groundwater Report

Boral Dunmore

EMM





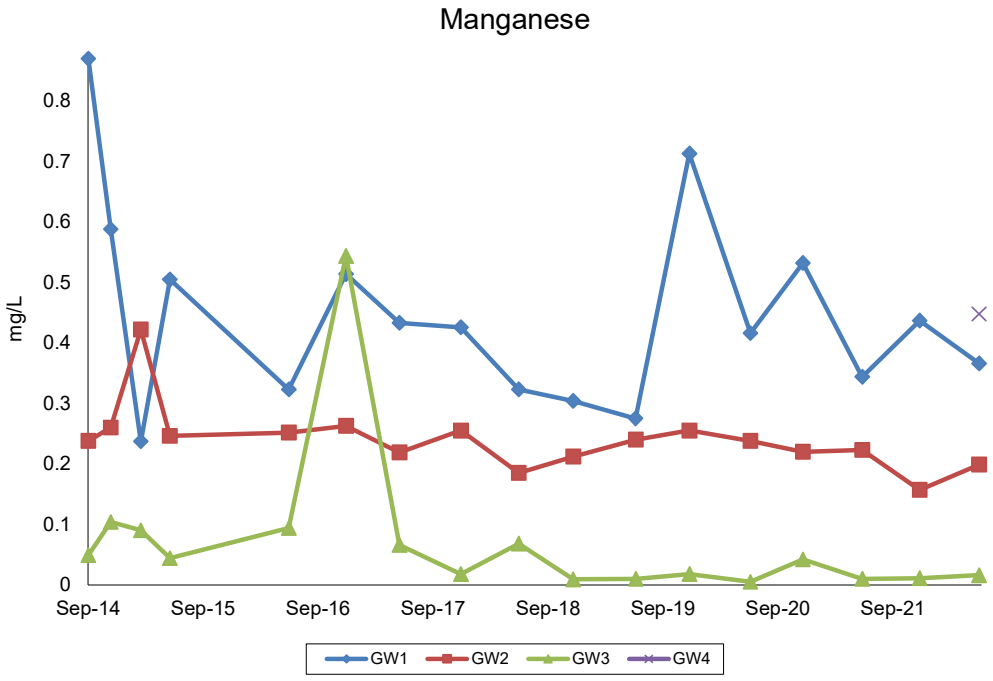
Note: Concentrations below the EQL are presented as half the EQL

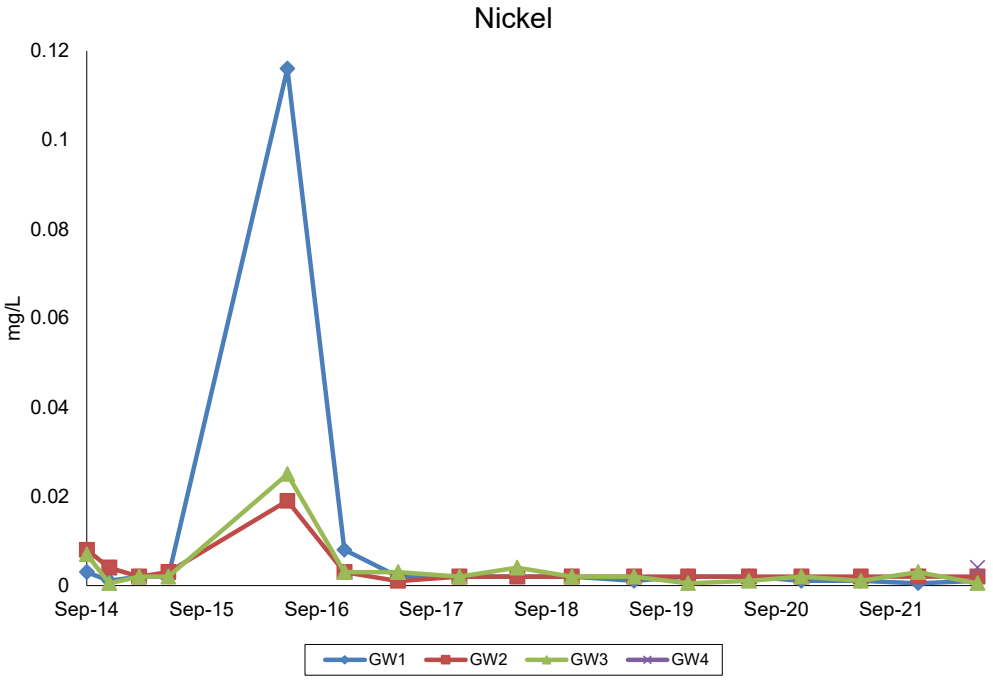
Figure D.3

Annual Groundwater Report

Boral Dunmore

EMM





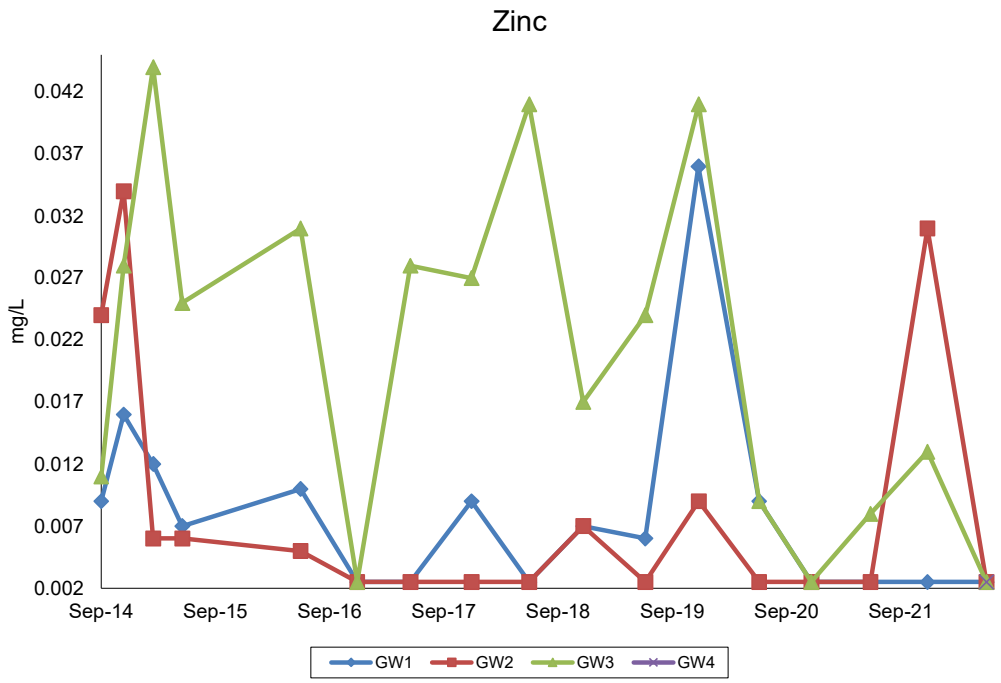
Note: Concentrations below the EQL are presented as half the EQL

Figure D.4

Annual Groundwater Report

Boral Dunmore

EMM



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

Figure D.5

Annual Groundwater Report

Boral Dunmore

EMM

Australia

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St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE
Level 3 175 Scott Street
Newcastle NSW 2300
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Canberra City ACT 2601

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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 2021 – AUGUST 2022

REPORT PREPARED BY: MARCUS BURGESS AND TANITA GORDON

DATE COMPLETED: 12TH AUGUST 2022

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

Table of Contents

Good Bush Pty Ltd

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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 2021 to August 2022.

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

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 Noxious Weeds, 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, regeneration and planting
- Assist natural regeneration by removing significant weed species using bush regeneration techniques and methods
- Monitor works, progress and completing using visual based documentation

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

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Summary of Works for All Zones

A total of 757 hours have been carried out within the three zones during the period from September 2021 to August 2022. 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	366 hours
Zone 3 Compensatory Habitat Area	391 hours
Total	**757 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 to assist regeneration of the threatened species Illawarra Zieria (*Zieria granulata*) with the Melaleuca armiallaris Tall Shrubland covering approximately 2,150m². The latter readily regenerating within areas where weed control works were carried out.

Zone 1 Remnant Conservation Area

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.

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 COVID 19 restricting access and disruption due to cattle access to areas of treatment.			

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.
- Large amounts of Gorse (*Ulex europaeus*) is thriving in the paddocks surrounding this zone. Illawarra District Weeds Authority (IDWA) will need to be notified of this and will likely treat the infestation as part of their Gorse control program.

Work Areas Map

Vegetation Condition Assessment

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

*The photo point markers (1.2m hardwood stake) were lost. Presumably knocked over by cattle

Photo Point	**RVCA1**		
Commencement of works date	September 2021		
Completion of works date	August 2022		
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 *Solanum mauritianum**	20% native cover 80% weed cover	0% native cover 0% weed cover
Shrub layer	The shrub layer surrounding this photo point is dominated by *Lantana camara** *Ulex europaeus**	0% native cover 100% 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 *Lantana camara** *Bidens pilosa** *Pellaea falcata*	60% native cover 30% weed cover	70% native cover 30% weed cover

Photo Point	**RVCA2**		
Commencement of works date	September 2021		
Completion of works date	August 2022		
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 *Solanum mauritianum**	20% native cover 80% weed cover	0% native cover 0% weed cover
Shrub layer	The shrub layer surrounding this photo point is dominated by *Lantana camara** *Ulex europaeus**	0% native cover 100% 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 *Lantana camara** *Bidens pilosa** *Pellaea falcata*	60% native cover 30% weed cover	70% native cover 30% weed cover

Zone 1 Photographs

RVCA1 Photo point prior to primary weed control November 2019 (photo point marker was removed)

Similar area after primary weed control, September 2020

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RVCA2 Photo point prior to primary weed control November 2019 (photo point marker was removed)

Similar area after primary weed control, September 2021

Good Bush Pty Ltd

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Flowering Gorse (*Ulex europaeus*)

Large amounts of Gorse requiring treatment within the paddock adjacent to Zone 1

Zone 2 Offset Area Works

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

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Summary of Works

This contract period bush regeneration works focused on secondary and primary weed control within the woodland remnants and the rainforest ecotone at the eastern extent of this zone. Rainfall has been adequate this year compared to prior years and regeneration of weeds and natives has become more widespread. Mass regeneration of rainforest pioneer species has been a positive sign and several additional local native plants have appeared within this area over the past 12 months.

Extensive 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 (m^2)
27/08/2021	49	Maintenance works through all previously worked areas through Illawarra Lowlands Grassy Woodland remnant Target Araujia sericifera, Passiflora subpeltata, Delairea odorata emerging Cassia, Lantana camara and African Olive using the cut and paint, frill and hand removal methods Raft Cape Ivy stems at ground layer to prevent further spread from potential flowering after treatment	-
24/09/2021	56	Continue primary weed treatment on Lantana and Olive heading East from the previously worked areas. Cut and paint Lantana bases, process materials onsite.Cut and paint several large African Olive. During the process of Lantana removal, several species of local native shrubs and trees (Alectryon, Streblis, Notelea, Wattle, Flame Tree, White Cedar, Clerodendron) were uncovered which will help establish canopy connectivity to previously worked areas	200m^2

2/12/2022	63	Commence maintenance and primary weed control activities through Illawarra Lowlands Grassy Woodland remnant prioritising work at the eastern end Target ascending *Araujia sericifera, Passiflora subpeltata, Delairea odorata* emerging Cassia, *Lantana camara* and African Olive using the cut and paint, frill and hand removal methods Process materials onsite assisting with the natural decomposition of materials. Primary weed control covering an approximate 300m²	300m²
25/01/2022	56	Commence maintenance weed control activities in all recently worked areas through *Melaleuca armillaris* shrubland and Illawarra Lowlands Grassy Woodland communities Target ascending *Araujia sericifera, Passiflora subpeltata, Delairea odorata*, *Lantana camara, Conyza sumatrensis,* Cotton Bush and African Olive using the cut and paint and hand removal methods Raft vine stems to prevent regrowth onsite and process woody weed material providing mulch Isolate natives to encourage native recruitment and regeneration Hand remove *Bidens pilosa, Tagetes minuta,* Fleabane, Cape Ivy and Cotton Bush	
15/02/2022	63	Secondary weed control targeting resprouting Lantana camara and Solanum mauriatanum seedlings at the south eastern extremity of previously worked areas. Primary weed control targeting Lantana camara pushing eastwards. Approximately 550sqm	550m²
11/03/2022	49	Continue primary Lantana removal on the south eastern woodland remnant. Cut and paint Lantana bases, process all material on site. Lots of natural regeneration uncovered including Breynia, Streblus, Notelaea, Alectryon. Complete approx. 600m^2 primary Lantana removal	600m²
18/03/2022	43	Continue primary removal of Lantana through most recently worked areas, heading north east to square off area worked on previous visit. Cut and paint Lantana bases, process all materials on site. Approximately 500m^2 Lantana removed, left one plume as a Bower was found beneath it. Drop down into rainforest for a secondary/maintenance sweep, targeting ascending Moth and Cape vine, hand removal of juvenile Tobacco and Lantana	500m²

11/05/2022	22	Maintenance completed in Illawarra Grassy Woodland nearest creek crossing where staff park for the day (across from Greenhoods). Sweep targeted the removal and rafting of Cape Ivy (almost flowering/spread season) and hand weeding of Lantana seedlings.	-
29/07/2022	34	Maintenance work including primary and secondary woody weed control in dry rainforest ecotone on the southern side of Rocklow Creek adjacent to the Eastern Woodland Remnant. Cut and paint control of Lantana (Lantana camara) and Wild Tobacco processing materials onsite to serve as mulch, and pushing back encroaching Lantana boundaries to accommodate regeneration. Hand removal of Lantana, and other woody weed seedlings as found. Species include African Olive and Senna. Hand removal and rafting of Cape Ivy. Hand removal of annual and perennial herbaceous weeds including Pitchforks, Mistflower, Fireweed, Black Nightshade.	-
12/08/2022	43	Secondary weed control in revegetated Melaleuca armillaris and in previously worked remnant dry rainforest areas. Approximate area treated 1000m^2. Cut and paint treatment of Lantana regrowth, and emerging Inkweed, Cape Gooseberry, Wild Tobacco. Scrape and paint control of Green Cestrum. Hand removal of ascending Cape Ivy, Moth Vine and White Passionflower.	
TOTAL	**366**		**2150 m^2**

Work Areas Map

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

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Vegetation Condition Assessment

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

Zone 2a: Melaleuca armillaris Tall Shrubland

Photo Point	**A1, A3**		
Commencement of works date	September 2021		
Completion of works date	August 2022		
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

Zone 2b: Illawarra Subtropical Rainforest

Photo Point	**B1**		
Commencement of works date	September 2021		
Completion of works date	August 2022		
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	40% native cover 60% weed cover	90% native cover 10% weed cover

* indicates exotic plant species

Zone 2c: Illawarra Grassy Woodland

Photo Point	**A2**		
Commencement of works date	September 2021		
Completion of works date	August 2022		
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 2022

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A3 Photo point prior to commencement of works in 2017

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

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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

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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

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

Regionally rare Homalanthus stillingifolius regenerating in the rainforest and woodland ecotone

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Zone 3 Compensatory Habitat Area

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:

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:

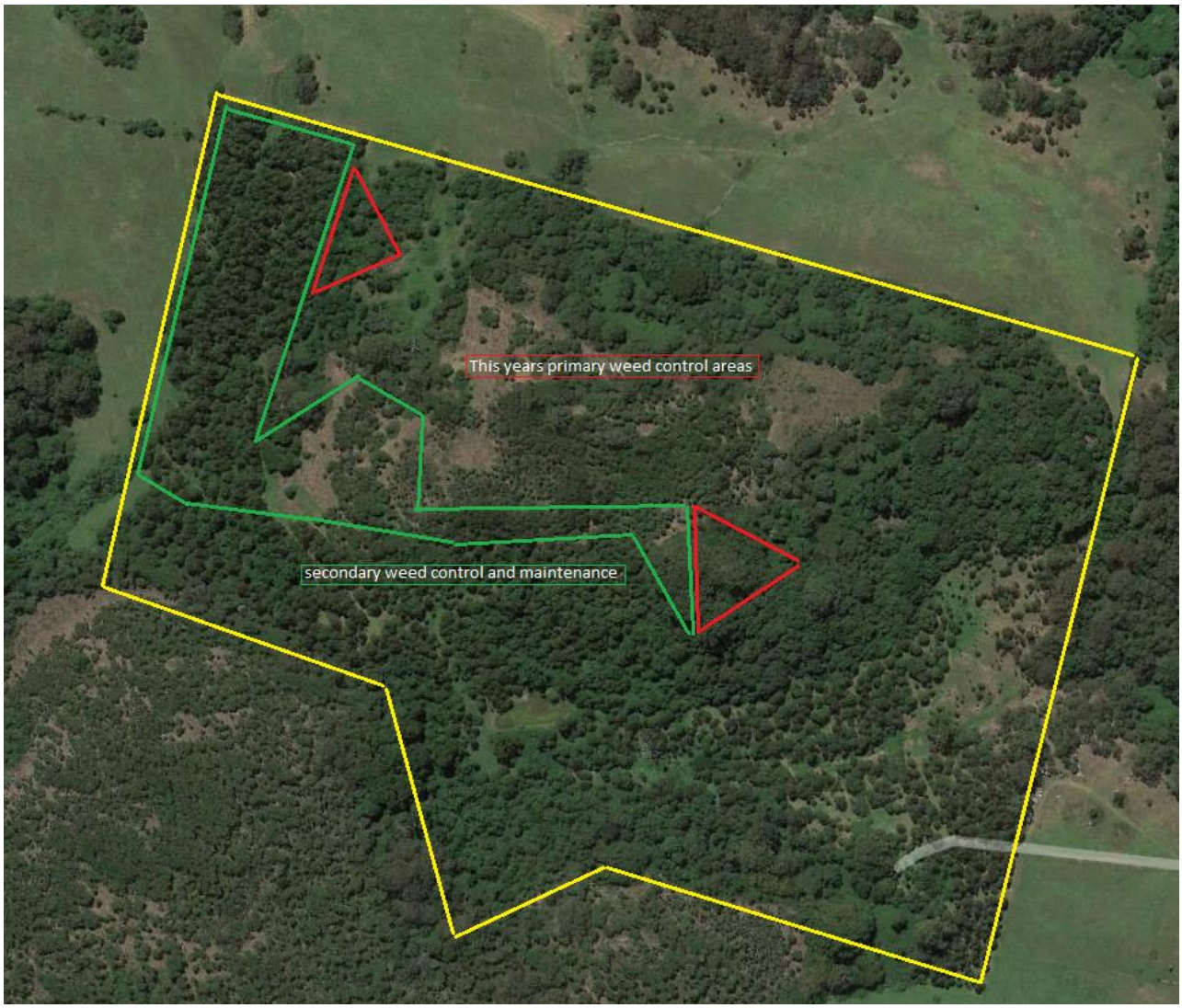
Date	Hrs	Weed Control	Primary (m^2)
20/08/21	49	Commence maintenance weed control east of the rock wall in previously worked areas through Melaleuca armillaris and Zieria granulata shrubland and Illawarra Dry Rainforest, towards the Figs Target Araujia sericifera, Passiflora subpeltata, Delairea odorata, Lantana camara and African Olive using the hand removal, cut and paint and frill methods	300m^2
2/09/21	59	Commence maintenance weed control activities through established revegetation prioritising the southern areas (near the Daphnandra johnsonii plants) and sweeping northwards toward northern boundaries Target ascending Araujia sericifera, Passiflora subpeltata, Delairea odorata emerging Lantana camara, Solanum mauritianum and Phytolacca octandra using cut and paint and hand removal methods	-
30/09/21	91	Commence maintenance weed control activities through established revegetation adjacent to the big Fig Tree and rainforest remnantTarget ascending *Araujia sericifera, Passiflora subpeltata, Delairea odorata* emerging *Lantana camara, Solanum mauritianum* and *Phytolacca octandra* using cut and paint and hand removal methodsPrimary weed control targeting Lantana moving downslope from the big Fig to assess regeneration potentialPrimary weed control covering approximately 300m^2	300m^2
26/10/21	84	Primary starting at the Fig link in Melaleuca armillaris and Zieria granulata shrubland and Illawarra Dry Rainforest communities	600m^2

		Target Araujia sericifera, Passiflora subpeltata, Delairea odorata, Lantana camara and African Olive using the hand removal, cut and paint and frill methods	
4/11/21	49	Primary weed control work completed in compensatory habitat Zone rockwall opening closest to field 'parking' area and further along rockwall towards daphnandra pushing from canopy zones and good bush into denser lantana, leaving a vegetation boarder from grassy openings.Primary works included; cut and paint/processing Lantana, dropping weedy vines, cut and paint on Africa Olives.Primary works covering roughly 800m2.	800m².
24/11/21	73	Maintenance and primary weed control activities through established revegetation prioritising the southern areas (near the *Daphnandra johnsonii* plants) and eastern Dry Rainforest remnant pocketsTarget ascending *Araujia sericifera, Passiflora subpeltata, Delairea odorata* emerging *Lantana camara, Solanum mauritianum* and *Phytolacca octandra* using cut and paint and hand removal methodsRaft vine materials to prevent from regrowing onsiteProcess materials on site providing mulch and assisting with natural decomposition of materialsPrimary weed control covering an approximate 300m²	300m²
11/05/22	18	Maintenance completed in Daphnandra pocket to the South of the compensatory habitat Zone; including cut/paint woody weeds such as Lantana and Tobacco, Skirting and removal of invasive vines such as Cape Ivy and Moth Vine. Isolation of native plants and removal of vectors of ascension.	-
12/08/22	38	Secondary weed control conducted in last years primary works under the 'Big Fig'. Targeting Lantana, Green Cestrum, Inkweed, Wild tobacco and other annual/woody weeds.	-

TOTAL	**391**		**2300 m²**

Work Areas Map

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



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Previous years' work areas map:

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		
Completion of works date	August 2022		
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		
Completion of works date	August 2022		
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		
Completion of works date	August 2022		
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*	60% native cover 30% weed cover	80% native cover 20% weed cover

Photo Point	**3D**		
Commencement of works date	September 2021		
Completion of works date	August 2022		
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

3A Photo point prior to commencement of works

The same view after primary and secondary weed control works, August 2022

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3A Photo point prior to commencement of works

The same view after primary and secondary weed control works, August 2022

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3B Photo point prior to commencement of works

The same view after primary and secondary weed control works, August 2022

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3B Photo point prior to commencement of works

The same view after primary and secondary weed control works, August 2022

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3C Photo Point before primary weed control August 2020

3C Photo point after primary weed control August 2022

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3D Photo point prior to commencement of works August 2020

3D Photo after primary weed control, August 2022

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3D Photo point prior to commencement of works August 2020

3D Photo after primary weed control, August 2022

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Melaleuca armiallaris tall shrubland community worked area showing regeneration of Zieria granualata

Subtropical Rainforest regeneration area above the rock wall

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Appendix 1 Vegetation Monitoring Field Sheets

Good Bush Monitoring Survey sheet		Site: Boral Zone 3 (west of creek)	
Date: 02/09/2021		Plot No: 3A Post Assessment	
Recorder: Billie Vincent and Tanita Gordon		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			WEED		
Botanical Name	Abundance	% Cover	Botanical Name	Abundance	% Cover
Accacia maidenii	U	<5%	*Ageratina riparia*	U	<5%
Acmena smithii	U	<5%	*Araujia sericifera*	C	50%
Breynia oblongifolia	C	5%	*Bidens pilosa*	O	1%
Carex longibrachiata	U	5%	*Cirsium vulgare*	U	1%
Celastrus australis	U	<5%	*Delairea odorata*	U	<5%
Commelina cyanea	O	10%	*Erharta erecta*	O	20%
Eucalyptus quadrangulata	U	<5%	*Lantana camara*	U	1%
Eucalyptus saligna	U	5%	*Modiola caroliniana*	U	1%
Ficus coronata	U	5%	*Olea europaea subsp. cuspidata*	U	<5%
Geitonoplesium cymosum	O	5%	*Sida rhombifolia*	C	50%
Glycine sp.	U	1%	*Solanum maruitianum*	U	<5%
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:	Deer or goat tracks within creekline
Significant Species:	N/A

Good Bush Monitoring Survey sheet		Site: Boral Zone 3 (west of creek)	
Date: 12/08/2022		Plot No: 3A Post Assessment	
Recorder: Marcus Burgess and Tanita Gordon		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			WEED		
Botanical Name	Abundance	% Cover	Botanical Name	Abundance	% Cover
Accacia maidenii	U	<5%	*Ageratina riparia*	U	<5%
Acmena smithii	U	<5%	*Araujia sericifera*	C	50%
Aneilema acuminatum	O	<5%	*Bidens pilosa*	U	1%
Breynia oblongifolia	C	5%	*Delairea odorata*	U	<5%
Carex longibrachiata	U	5%	*Erharta erecta*	O	20%
Celastrus australis	U	<5%	*Lantana camara*	U	1%
Commelina cyanea	O	10%	*Modiola caroliniana*	U	1%
Eucalyptus quadrangulata	U	<5%	*Sida rhombifolia*	C	50%
Eucalyptus saligna	U	5%	*Solanum maruitianum*	U	<5%
Ficus coronata	U	5%			
Geitonoplesium cymosum	O	5%	**Natives Continued**		
Glycine sp.	U	1%	*Notelaea venosa*	O	10%
Guoia semiglauca	U	<5%	*Oplismenus imbecillis*	C	50%
Hakea salicifolia	U	5%	*Pandorea pandorana*	O	10%
Hibbertia scandens	U	5%	*Pittosporum multiflorum*	U	10%
Hibiscus heterophyllus	O	7%	*Plectranthus parvifolus*	U	5%
Maclura cochinchinensis	U	5%	*Sicyos australis*	I	<1%
Melaleuca armilaris	U	5%	*Sigesbeckia orientalis*	O	5%
Melicope micrococca	I	1%	*Toona ciliata*	I	5%

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Vegetation Condition:	Degraded revegetation, annual flush of woody and herbaceous weeds, vines.
Fauna Evidence:	Deer or goat tracks within creek line
Significant Species:	N/A

Good Bush Monitoring Survey sheet		Site: Boral Zone 3 (east of creek)	
Date: 02/09/2021		Plot No: 3B Post Condition Assessment	
Recorder: Billie Vincent and Tanita Gordon		Plot Size: 20 x 20m	
GPS Northing	6166983	GPS Easting	299805
GPS Accuracy	+-7m	GPS Elevation	64m
Vegetation Community: Established Revegetation with Rainforest Understorey			

NATIVE			WEED		
Botanical Name	Abundance	% Cover	Botanical Name	Abundance	% Cover
Accacia maidenii	U	<5%	*Bidens pilosa*	C	15%
Acmena smithii	U	<5%	*Solanum mauritianum*	I	1%
Breynia oblongifolia	U	<5%	*Erharta erecta*	O	20%
Carex longibrachiata	U	5%	*Cirsium vulgare*	U	<5%
Cayratia clematidea	U	<5%	*Delairea odorata*	U	<5%
Geijera salicifolia	U	1%	*Sida rhombifolia*	C	10%
Dodonea viscosa	U	<5%	*Ageratina riparia*	U	<5%
Elaeodendron australe	U	5%	*Olea europaea subsp. cuspidata*	U	<5%
Eucalyptus saligna	U	<5%	*Araujia sericifera*	C	10%
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%			

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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:	Cattle damage, numerous cattle scat examples on site
Significant Species:	N/A

Good Bush Monitoring Survey sheet		Site: Boral Zone 3 (east of creek)	
Date: 12/08/2022		Plot No: 3B Post Condition Assessment	
Recorder: Marcus Burgess and Tanita Gordon		Plot Size: 20 x 20m	
GPS Northing	6166983	GPS Easting	299805
GPS Accuracy	+-7m	GPS Elevation	64m
Vegetation Community: Established Revegetation with Rainforest Understorey			

NATIVE			WEED		
Botanical Name	Abundance	% Cover	Botanical Name	Abundance	% Cover
Accacia maidenii	U	<5%	*Bidens pilosa*	U	<5%
Acmena smithii	U	<5%	*Solanum mauritianum*	I	1%
Breynia oblongifolia	U	<5%	*Erharta erecta*	U	5%
Carex longibrachiata	U	5%	*Delairea odorata*	U	<5%
Cayratia clematidea	U	<5%	*Sida rhombifolia*	C	10%
Geijera salicifolia	U	1%	*Ageratina riparia*	U	<5%
Dodonea viscosa	U	<5%	*Araujia sericifera*	C	10%
Elaeodendron australe	U	5%			
Eucalyptus saligna	U	<5%	**Natives continued**		
Ficus coronata	U	<5%	*Oplismenus imbecillis*	C	10%
Geitonoplesium cymosum	O	5%	*Pandorea pandorana*	O	10%
Geranium homeanum	U	<5%	*Passiflora herbertiana*	U	1%
Glochidion ferdinandii	U	<5%	*Pittosporum multiflorum*	U	10%
Glycine sp.	U	<1%	*Pittosporum revolutum*	U	1%
Guoia semiglauca	U	<5%	*Planchonella australis*	U	1%
Hakea salicifolia	U	<5%	*Plectranthus parvifolus*	U	5%
Hibbertia scandens	U	<5%	*Streblus brunonianus*	U	<5%
Hibiscus heterophyllus	O	7%	*Toona ciliata*	U	<5%
Maclura cochinchinensis	U	<5%	*Aneilema acuminatum*	C	20%
Melaleuca armillaris	U	<5%			

Melaleuca decora	U	<5%			
Myrsine variabilis	U	5%			
Myrsine howittianna	U	<5%			

Vegetation Condition:	15 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: 02/09/2021		Plot No: 3C Post Assessment	
Recorder: Billie Vincent and Tanita Gordon		Plot Size: 20 x 20m	
GPS Northing	6166725	GPS Easting	0299937
GPS Accuracy	+-8m	GPS Elevation	87m
Vegetation Community: Ecotone Rainforest and Melaleuca armillaris Tall Shrubland			

NATIVE			WEED		
Botanical Name	Abundance	% Cover	Botanical Name	Abundance	% Cover
Accacia maidenii	U	7%	*Delairea odorata*	O	10%
Alphitonia excelsa	U	<5%	*Erharta erecta*	O	5%
Aneilema biflorum	U	<5%	*Modiola caroliniana*	I	<1%
Asplenium flabellifoium	C	<5%	*Sida rhombifolia*	I	1%
Breynia oblongifloia	C	<5%	*Solanum maruitianum*	O	<5%
Carex appressa	U	2%	*Senecio madagascariensis*	U	<5%
Cheilanthes tenuifolia	U	<5%	*Oxalis sp.*	I	<1%
Clerodendrum tomentosum	O	<5%	*Stellaria media*	U	<5%
Commelina cyanea	O	10%	*Lantana camara*	U	5%
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%			

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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:	Extensive cattle damage, kangaroo/wallaby scat on site, kangaroo with joey
Significant Species:	*Zieria granulata*

Good Bush Monitoring Survey sheet		Site: Zone 3 Mel armillaris Shrubland	
Date: 12/08/2022		Plot No: 3C Post Assessment	
Recorder: Marcus Burgess and Tanita Gordon		Plot Size: 20 x 20m	
GPS Northing	6166725	GPS Easting	0299937
GPS Accuracy	+-8m	GPS Elevation	87m
Vegetation Community: Ecotone Rainforest and Melaleuca armillaris Tall Shrubland			

NATIVE			WEED		
Botanical Name	Abundance	% Cover	Botanical Name	Abundance	% Cover
Accacia maidenii	U	7%	*Delairea odorata*	O	10%
Alphitonia excelsa	U	<5%	*Erharta erecta*	O	5%
Aneilema biflorum	U	<5%	*Modiola caroliniana*	I	<1%
Asplenium flabellifoium	C	<5%	*Sida rhombifolia*	I	1%
Breynia oblongifloia	C	<5%	*Solanum maruitianum*	O	<5%
Carex appressa	U	2%	*Senecio madagascariensis*	U	<5%
Cheilanthes tenuifolia	U	<5%	*Oxalis sp.*	I	<1%
Clerodendrum tomentosum	O	<5%	*Stellaria media*	U	<5%
Commelina cyanea	O	10%			
Croton verreauxii	U	<5%	**Natives continued**		
Cryptocarya microneura	I	1%	*Pandorea pandorana*	U	5%
Dichondra repens	U	<5%	*Parsonsia straminea*	O	<5%
Ehretia acuminata	U	<5%	*Pellaea falcata*	C	<5%
Einadia hastata	U	<5%	*Phyllanthus gunnii*	U	<5%
Eustrephus latifolius	I	1%	*Pittosporum multiflorum*	C	<5%
Gahnia aspera	I	<5%	*Planchonella australis*	I	<5%
Geitonoplesium cymosum	O	<5%	*Plectranthus graveolens*	O	10%
Glycine sp.	U	<5%	*Plectranthus parviflorus*	O	10%
Guoia semiglauca	U	<5%	*Poa labillardierei*	C	5%

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Gymnostachys anceps	I	1%	*Pseudoranthemum var.*	C	<5%
Hibiscus heterophyllus	U	<5%	*Sarcopetalum harveyanum*	I	1%
Maclura cochinchinensis	U	5%	*Streblus brunonianus*	O	5%
Melaleuca armillaris	O	7%	*Trophis scandens*	U	<5%
Notelaea venosa	U	<5%	*Xerochrysum bracteatum*	I	1%
Oplismenus imbecillis	C	<5%	*Zieria granulata*	U	5%
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:	Kangaroo seem on site
Significant Species:	*Zieria granulata*

Good Bush Monitoring Survey sheet		Site: Zone 3 Subtropical RF Big Fig Area	
Date: 02/09/2021		Plot No: 3D Post Assessment	
Recorder: Billie Vincent and Tanita Gordon		Plot Size: 20 x 20m	
GPS Northing	6166719	GPS Easting	0300124
GPS Accuracy	+- 10m	GPS Elevation	55m
Vegetation Community: Remnant Subtropical Rainforest			

NATIVE			WEED		
Botanical Name	Abundance	% Cover	Botanical Name	Abundance	% Cover
Alchornea ilicifolia	C	20%	*Lantana camara*	U	<5%
Ficus macrophylla	O	90%	*Cestrum parquii*	O	<1%
Pittosporum multiflorum	C	5%	*Solanum maruitianum*	U	1%
Maclura cochinchinensis	C	5%	*Delairea odorata*	U	<5%
Alectryon subcinereus	O	<5%	*Passiflora subpeltata*	U	1%
Claoxylon australe	O	5%	*Araujia sericifera*	O	<5%
Notelaea venosa	O	5%	*Bidens pilosa*	U	<1%
Breynea oblongifolia	O	5%	*Solanum psuedocapsicum*	U	<1%
Diploglottis australis	C	15%	*Ehrharta erecta*	U	1%
Brachychyton acerifolia	O	<5%	*Phytolaca octandra*	I	<1%
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%			

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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:	Kangaroo on site, extensive cattle damage, European Honey Bee hive in larg F. macrophylla, cattle scat and flock of pigeons
Significant Species:	*Actephila lindleyi*

Good Bush Monitoring Survey sheet		Site: Zone 3 Subtropical RF Big Fig Area	
Date: 12/08/2022		Plot No: 3D Post Assessment	
Recorder: Marcus Burgess and Tanita Gordon		Plot Size: 20 x 20m	
GPS Northing	6166719	GPS Easting	0300124
GPS Accuracy	+- 10m	GPS Elevation	55m
Vegetation Community: Remnant Subtropical Rainforest			

NATIVE			WEED		
Botanical Name	Abundance	% Cover	Botanical Name	Abundance	% Cover
Alchornea ilicifolia	C	20%	*Lantana camara*	U	<5%
Ficus macrophylla	O	90%	*Cestrum parquii*	O	<5%
Pittosporum multiflorum	C	5%	*Solanum maruitianum*	U	1%
Maclura cochinchinensis	C	5%	*Delairea odorata*	U	<5%
Alectryon subcinereus	O	<5%	*Passiflora subpeltata*	I	<1%
Claoxylon australe	O	5%	*Araujia sericifera*	O	<5%
Notelaea venosa	O	5%	*Solanum psuedocapsicum*	U	<1%
Breynea oblongifolia	O	5%	*Ehrharta erecta*	U	1%
Diploglottis australis	C	15%			
Brachychyton acerifolia	O	<5%			
Streblus brunonianus	C	10%			
Clerodendrum tomentosum	O	<5%	**Natives Continued**		
Elaeodendron austral	O	5%	*Croton verreauxii*	O	5%
Melicytus dentatus	O	<5%	*Trophis scandens*	C	<5%
Geitonoplesium cymosum	C	<5%	*Aneilema biflorum*	C	<5%
Eustrephus latifloius	C	<5%	*Plectranthus parviflorus*	C	<5%
Pandorea pandorana	C	<5%	*Aphanopetalum resinosum*	C	<5%
Parsonsia straminea	C	<5%	*Sigesbeckia orientalis*	C	<5%
Nyssanthes erecta	C	<5%	*Sarcomelicope simplicifolia*	U	<5%
Wilkea huegliana	O	<5%	*Morinda jasminoides*	C	<5%

Gymnostachys anceps	I	1%	*Cayratia clematidea*	O	<5%
Oplismenus imbecillis	C	<5%	*Melia azedarach*	U	<5%
Pseudoranthemum var.	C	<5%	*Urtica incisa*	O	<5%
Pallea falcata	C	<5%	*Phylanthus gunnii*	O	<5%
Asplenium flabelifolium	C	<5%	*Actephila lindleyi*	U	<5%
Parietarea debelis	O	<5%	*Dendrocnide excelsa*	U	<5%

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*

Photo Reference

Cover Image:
Greenhood Orchid (*Pterostylis curta*) within Zone 1, September 2019

All Image of checkpoint photos:
Taken on September 2nd 2021 and August 12th 2022 by Marcus Burgess.