Appendix 3

Noise and Vibration Impact Assessment (Updated)

prepared by

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OCTAVE ACOUSTICS

R.W. Corkery
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Monaro Rock Quarry

Noise and Vibration Impact Assessment

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1	18.12.2024	Final issue.	LE	RB
2	30.05.2025	Minor amendments.	LE	RB
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4	04.06.2026	Updated to address EIS advice.	LE	RB
5	24.06.2026	Minor amendments.	LE	RB

Disclaimer

Contents

1. Introduction

Octave Acoustics was engaged by RW Corkery to provide a noise and vibration impact assessment for the proposed open cut Monaro Rock Quarry at Royalla, NSW (Quarry). This report presents the results of site investigations and ambient noise monitoring, identifies applicable noise and vibration criteria, and assesses the potential noise and vibration impacts associated with construction and operation of the Quarry to address the Secretary's Environmental Assessment Requirements.

1.1. Site Context

The Quarry is located on land zoned RU2 – Rural Landscape and C2 – Environmental Conservation. Sensitive receivers potentially affected by noise from the Quarry are spread across both New South Wales and the Australian Capital Territory. For the purposes of this assessment, similarly affected sensitive receivers have been grouped into Noise Catchment Areas (NCAs) as shown in Figure 1. For each NCA, the potentially most affected noise sensitive receiver has been identified for assessment. A list of all potentially affected receivers has been included in Appendix F. Where noise and vibration impacts from the Quarry are determined to comply with the applicable criteria at the most affected receivers, compliance can be expected at all other locations within the associated NCA.

While there are not currently dwellings located at R4, R5, R6, R9, and R10, they are part of a residential subdivision and are therefore considered sensitive receivers for purposes of assessment. R1 is within the property of the quarry and is not a noise sensitive receiver. However, an assessment of noise impacts to R1 has been provided for informative purposes.

In addition to the identified receivers, there is also an undeveloped lot at Lot 151, DP754912, 223A Alderson Place, Tralee abutting the Quarry site to the north-west. While there are not currently any sensitive receivers located on this lot, the lot is identified for consideration under the NSW Government *Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments* (VLAMP).

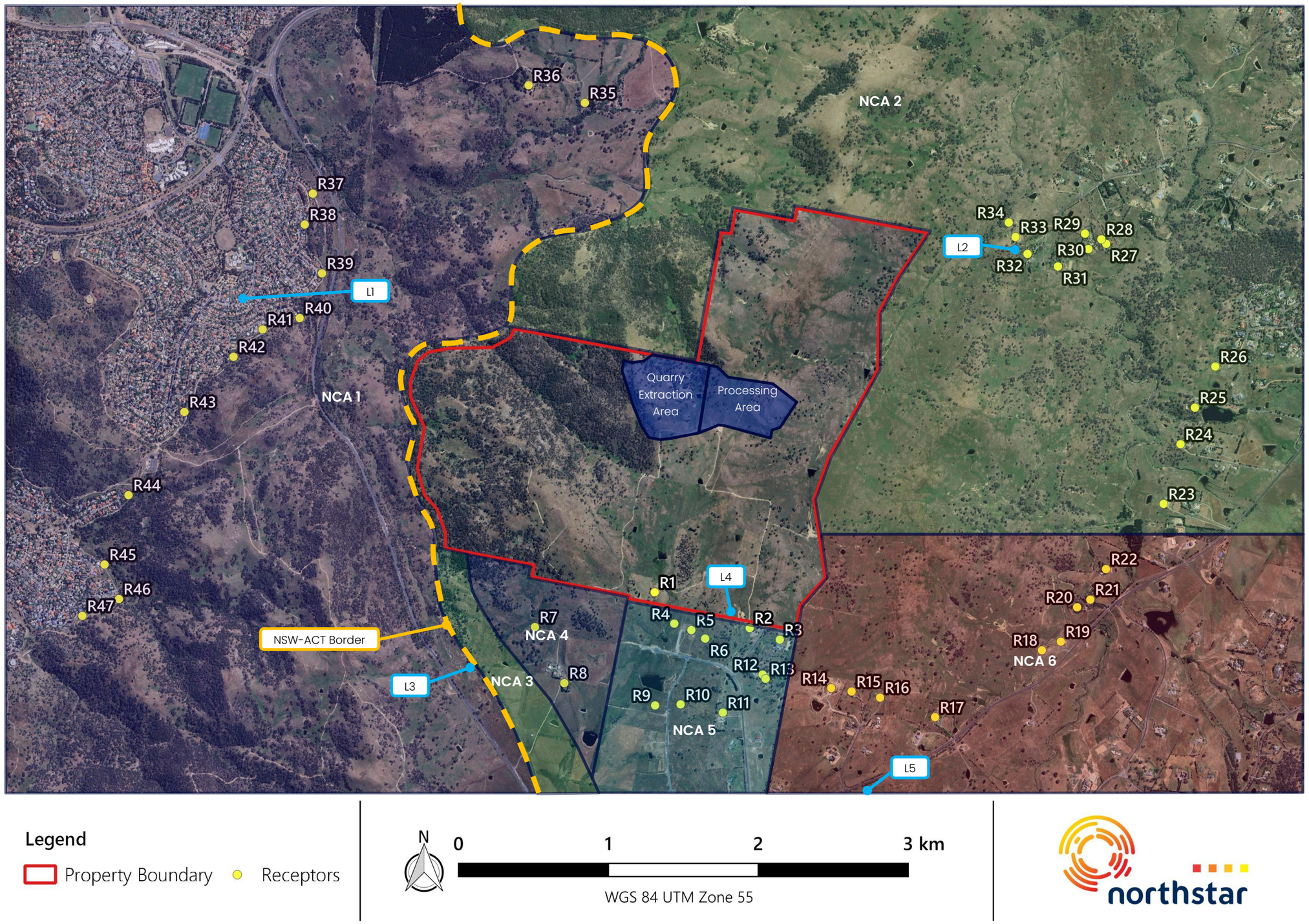


Figure 1 - Noise Monitoring Locations and NCAs

2. Site Assessment

Octave Acoustics attended site on Wednesday the 19th of May 2021 to inspect existing conditions and install five unattended noise monitors. The noise monitors were recovered on Tuesday the 1st of June 2021. The location of each monitor is shown in Figure 1 with details described in Table 1. At Location L1 the microphone of the monitor was located in free field conditions, 1200mm above the roof of the carport. At all other locations, the microphone was located in free field conditions, 1200mm above the ground.

Table 1 – Noise Measurement Locations & Details

Designation	NCA	Duration	Local Noise Environment Description.
Location L1	1	14 days	Suburban Residential
Location L2	2	14 days	Rural open farmland, no obstructions
Location L3	3	14 days	Rural open farmland, no obstructions
Location L4	5	14 days	Rural open farmland, few obstructions
Location L5	6	14 days	Rural open farmland, no obstructions

Monitoring at all locations was conducted using an NTi XL2 sound level meter. Each sound level meter was calibrated before and after the assessment using a Bruel and Kjaer 4320 calibrator. No drift in calibration was detected in any instance. The NTi XL2 complies with the requirements of the IEC 61672-1.2013 Sound Level Meters and is classified as a Class 1 Instrument. The NTi XL2s and calibrator carried current NATA certification.

The resulting noise data were analysed in conjunction with weather data obtained from the Bureau of Meteorology Weather Station located at Tuggeranong, NSW. This facilitated the exclusion of noise data potentially affected by adverse wind and rainfall events, in accordance with the requirements of the NSW Nose Policy for Industry.

A summary of noise monitoring results is presented in Table 2 to Table 6. Full results of unattended noise monitoring are presented in Appendix E.

Table 2 – Summary of Noise Monitoring Results at Location L1

Date	Assessment Background Level, dB L_{A90}		
	Day	Evening	Night
19-May	n/a	40	29
20-May	38	38	29
21-May	36	40	28
22-May	39	37	31
23-May	37	30	27
24-May	37	34	n/a
25-May	n/a	n/a	n/a
26-May	n/a	n/a	n/a
27-May	38	39	n/a
28-May	n/a	n/a	n/a
29-May	n/a	n/a	n/a
30-May	36	38	30
31-May	39	38	30
1-Jun	n/a	n/a	n/a
Overall RBL	38	38	29

Notes: n/a = Invalid data due to Weather/Incomplete measurement period exclusions.

Table 3 – Summary of Noise Monitoring Results at Location L2

Date	Assessment Background Level, dB L_{A90}		
	Day	Evening	Night
19-May	n/a	25	17
20-May	28	20	16
21-May	21	22	16
22-May	19	18	17
23-May	24	21	17
24-May	24	22	n/a
25-May	n/a	n/a	n/a
26-May	n/a	n/a	n/a
27-May	27	24	n/a
28-May	n/a	n/a	n/a
29-May	n/a	n/a	n/a
30-May	20	18	18
31-May	23	22	19
1-Jun	n/a	n/a	n/a
Overall RBL	23	21	17

Notes: n/a = Invalid data due to Weather/Incomplete measurement period exclusions.

Table 4 – Summary of Noise Monitoring Results at Location L3

Date	Assessment Background Level, dB L_{A90}		
	Day	Evening	Night
19-May	n/a	38	17
20-May	41	36	19
21-May	40	38	17
22-May	41	35	21
23-May	41	28	17
24-May	40	24	n/a
25-May	n/a	n/a	n/a
26-May	n/a	n/a	n/a
27-May	42	34	n/a
28-May	n/a	n/a	n/a
29-May	n/a	n/a	n/a
30-May	41	32	18
31-May	40	31	19
1-Jun	n/a	n/a	n/a
Overall RBL	41	34	18

Notes: n/a = Invalid data due to Weather/Incomplete measurement period exclusions.

Table 5 – Summary of Noise Monitoring Results at Location L4

Date	Assessment Background Level, dB L_{A90}		
	Day	Evening	Night
19-May	n/a	26	17
20-May	29	26	18
21-May	27	25	17
22-May	26	22	18
23-May	25	23	17
24-May	23	21	n/a
25-May	n/a	n/a	n/a
26-May	n/a	n/a	n/a
27-May	29	27	n/a
28-May	n/a	n/a	n/a
29-May	n/a	n/a	n/a
30-May	30	21	19
31-May	27	n/a	n/a
1-Jun	n/a	n/a	n/a
Overall RBL	27	23	18

Notes: n/a = Invalid data due to Weather/Incomplete measurement period exclusions.

Table 6 – Summary of Noise Monitoring Results at Location L5

Date	Assessment Background Level, dB LA90		
	Day	Evening	Night
19-May	n/a	29	25
20-May	31	28	25
21-May	30	28	25
22-May	30	28	25
23-May	30	26	25
24-May	28	27	n/a
25-May	n/a	n/a	n/a
26-May	n/a	n/a	n/a
27-May	31	29	n/a
28-May	n/a	n/a	n/a
29-May	n/a	n/a	n/a
30-May	30	27	25
31-May	31	27	25
1-Jun	n/a	n/a	n/a
Overall RBL	30	27	25

Notes: n/a = Invalid data due to Weather/Incomplete measurement period exclusions.

3. Proposed Operation & Staging

This section summarises the proposed activities, hours of operation, and details of staged development of the Quarry.

3.1. Hours of Operation

The proposed hours of operation for the activities which may take place during construction and operation of the Quarry are presented in Table 7 below. Activities may not occur for the entire duration of the hours set out below, but will take place within the range of hours as required.

Table 7 - Proposed Hours of Operation

Activity	Monday – Friday	Saturdays	Sundays and Public Holidays
Construction activities	7am – 6pm	8am – 1pm	Nil
Extraction and processing operations including use of pugmill and concrete recycling	7am – 6pm	7am – 6pm	Nil
Blasting operations	9am – 5pm	Nil	Nil
Product despatch and material importation	5am – 6pm	5am – 6pm	Nil
Concrete / asphalt production	7am – 6pm	8am – 1pm	Nil
Maintenance	24 hours / day	24 hours / day	Nil

3.2. Blasting Operations

Blasting is planned to occur from 9am to 5pm, Monday to Friday. Blasting would be limited to at most weekly events, but may need to be repeated in the rare case of a misfire.

3.3. Staged Development

Development of the Extraction Area, Processing and Stockpiling Area and Visibility Barrier will occur in multiple stages as shown in Figure 2, with staging for each area being independent of other areas. This section provides a summary of the proposed operations for each stage of development.

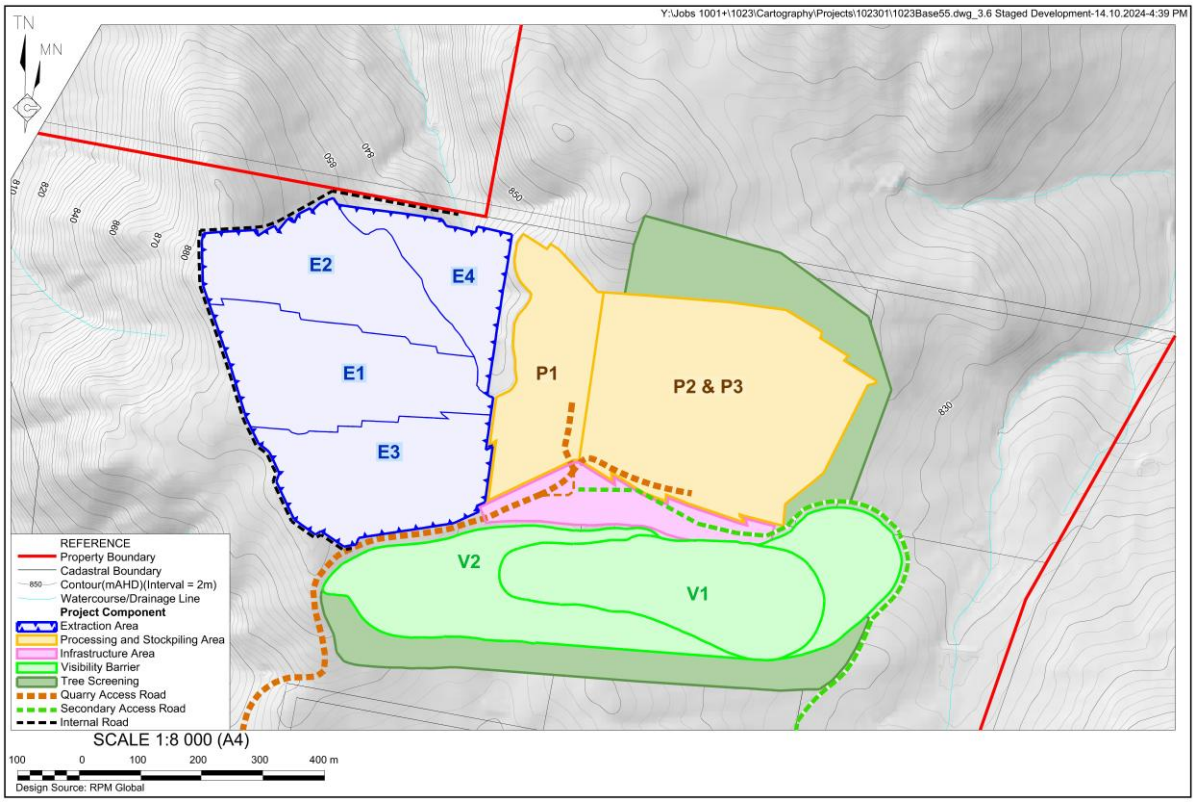


Figure 2 - Staged Development

3.3.1. Site Establishment

Site establishment will involve the following activities:

- Formalisation of the existing Secondary Access Road, which includes widening to a uniform 6m and altering the alignment to intersect directly with Mates Drive. Preliminary Quarry access will be via this road until the main Access Road is completed, at which point the Secondary Access Road will be used for light vehicles only.
- Construction of water management infrastructure, including diversion bunds.
- Vegetation clearing and soil removal from the Stage E1 Extraction Area, Stage P1 Processing Area, and Stage V1 Visibility Barrier. This will involve removing approximately 0.15 to 0.2m of topsoil.
- Construction of the main quarry Access Road.
- Establishment of the Infrastructure Area and Stage P1 Processing Plant area.
- Removal of highly and moderately weathered materials from Stage E1 Extraction Area. This will primarily involve using free dig methods, but some drill-and-blast may be required.
- Commencing development of the Stage V1 Visibility Barrier using highly and moderately weathered material from establishment of the Stage E1 Extraction Area and Stage P1 Processing Area.

3.3.2. Extraction Area Staging

Extraction operations will occur using standard drill and blast, load and haul methods. The extraction area will be developed in the following stages:

- Stage E1: Initial development within a footprint of 6.4 ha and to an elevation of approximately 852.5m AHD.
- Stage E2: Lateral expansion to the north of approximately 5.6 ha and to the same elevation as Stage E1.
- Stage E3: Lateral expansion to the south of approximately 6.0 ha and to the same elevation as Stage E1.
- Stage E4: Widening of the extraction area to the north east to a full extent of 21.1 ha, and development to a final floor elevation of 795m AHD.

3.3.3. Processing and Stockpiling Area Staging

Processing operations will include crushing and screening of raw materials, asphalt and concrete production, and use of the pugmill and concrete recycling plant. The Processing and Stockpiling Area will be developed in the following stages:

- Stage P1: Initial development to support production levels up to approximately 250,000 tpa.
- Stage P2: Further extension of the processing and stockpiling area. Ongoing processing activities using mobile plant. Commence construction of fixed plant, stockpiling area and water management structures to the east.
- Stage P3: Final development to support production up to 1 million tpa. Includes fixed processing plant, increased stockpiling area and the Eastern Dam.

3.3.4. Visibility Barrier Staging

The Visibility Barrier will be constructed in two stages:

- Stage V1: Construction of the initial barrier to commence during site establishment, up to an elevation of 865m AHD.
- Stage V2: Extension of the visibility barrier to the northeast and west to screen expansion of the processing and stockpiling area and extraction area, and increased height to 880m AHD.

4. Secretary's Environmental Assessment Requirements

The Planning Secretary's Environmental Assessment Requirements (SEARs) for Monaro Rock Quarry in relation to noise and vibration are shown in Table 8.

Table 8 - SEARs Requirements

Department	Requirement	Section Addressed
Department of Planning, Housing and Infrastructure	- a detailed assessment of the likely construction, operational and offsite transport noise impacts of the development in accordance with the Interim Construction Noise Guideline, NSW Noise Policy for Industry and the NSW Road Noise Policy respectively, and having regard to the Voluntary Land Acquisition and Mitigation Policy;	Operational Noise Assessment in Section 10 Construction Noise Assessment in Section 12
	- proposed blasting hours, frequency and methods; and	Section 3.2
	- a detailed assessment of the likely blasting impacts of the development (including ground vibrations, overpressure, flyrock, visual and fumes/ odour) on people, animals, buildings/structures, infrastructure and significant natural features, having regard to the relevant guidelines;	Criteria set in Section 8 Assessment in Section 15
Transport for New South Wales	Noise and Vibration Management, including assessment of noise and vibration impacts from construction and operation	Operational Noise Assessment in Section 10 and Management in Section 11 Construction Noise Assessment in Section 12 and Management in Section 13 Vibration Assessment in Section 14
Environmental Protection Authority	The impact of noise and vibration on nearby sensitive receivers in both NSW and ACT residential areas has been identified as a potential issue and requires robust assessment. This includes the development of a quantitative noise assessment including consideration of construction, operation and cumulative noise impacts in accordance with relevant EPA guidelines.	Operational Noise Assessment in Section 10 Construction Noise Assessment in Section 12
	Vibration from all activities (including construction and operation) to be undertaken on the premises should be assessed using the guidelines contained in the Assessing Vibration: a technical guideline (DEC, 2006).	Section 14
	Blast impacts should be demonstrated to be capable of complying with the guidelines contained in Australian and New Zealand Environment Council – Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration (ANZEC, 1990)	Section 15
	The increased traffic movements should also be accounted when assessing potential impacts of noise on sensitive receivers. The EPA	Section 10.2

Department	Requirement	Section Addressed
	emphasises that the Proponent must apply all feasible and reasonable work practices and measures to minimise noise impacts on local receivers to ensure their comfort or repose is not adversely affected	
	Identify all noise sources or potential sources from the development (including both construction and operation phases). Detail all potentially noisy activities including ancillary activities such as transport of goods and raw materials.	Operational Noise Section 9 Construction Noise Section 12
	Specify the times of operation for all phases of the development and for all noise producing activities.	Section 3.1
	For projects with a significant potential traffic noise impact provide details of road alignment (include gradients, road surface, topography, bridges, culverts etc), and land use along the proposed road and measurement locations – diagrams should be to a scale sufficient to delineate individual residential blocks.	N/A
	Identify any noise sensitive locations likely to be affected by activities at the site, such as residential properties, schools, churches, and hospitals. Typically the location of any noise sensitive locations in relation to the site should be included on a map of the locality.	Section 1.1
	Determine the existing background (LA90) and ambient (LAeq) noise levels, as relevant, in accordance with the *NSW Noise Policy for Industry*	Section 2
	Determine the existing road traffic noise levels in accordance with the *NSW Road Noise Policy*, where road traffic noise impacts may occur.	Section 10.2
	The noise impact assessment report should provide details of all monitoring of existing ambient noise levels including: a) details of equipment used for the measurements b) a brief description of where the equipment was positioned c) a statement justifying the choice of monitoring site(s), including the procedure used to choose the site(s), having regards to Fact Sheets A and B of the NSW Noise Policy for Industry. d) details of the exact location of the monitoring site and a description of land uses in surrounding areas e) a description of the dominant and background noise sources at the site f) day, evening and night assessment background levels for each day of the monitoring period g) the final Rating Background Level (RBL) value h) graphs of the measured noise levels for each day should be provided i) a record of periods of affected data (due to adverse weather and extraneous noise), methods used to exclude invalid data and a statement indicating the need for any re-monitoring.	Section 2 and Appendix E
	Determine the project noise trigger levels for the site. For each identified potentially affected receiver, this should include:	ACT criteria in Section 5.1.3

Department	Requirement	Section Addressed
	a) determination of the project intrusive noise level for each identified potentially affected receiver b) selection and justification of the appropriate amenity category for each identified potentially affected receiver c) determination of the project amenity noise level for each receiver d) determination of the appropriate maximum noise level event assessment (sleep disturbance) trigger level.	NSW project trigger levels in Section 5.2.2
	Maximum noise levels during night-time period (10pm-7am) should be assessed to analyse possible affects on sleep. Determine expected noise level and noise character likely to be generated from noise sources during: a) site establishment b) construction c) operational phases d) transport including traffic noise generated by the proposal e) other services. *Note: The noise impact assessment report should include noise source data for each source in 1/1 or 1/3 octave band frequencies including methods for references used to determine noise source levels. Noise source levels and characteristics can be sourced from direct measurement of similar activities or from literature (if full references are provided).*	Section 10.1.3
	Determine the noise levels likely to be received at the reasonably most affected location(s) (these may vary for different activities at each phase of the development).	Section 10.1.1
	The noise impact assessment report should include: a) a plan showing the assumed location of each noise source for each prediction scenario b) a list of the number and type of noise sources used in each prediction scenario to simulate all potential significant operating conditions on the site c) any assumptions made in the predictions in terms of source heights, directivity effects, shielding from topography, buildings or barriers, etc d) methods used to predict noise impacts including identification of any noise models used. e) the weather conditions considered for the noise predictions f) the predicted noise impacts from each noise source as well as the combined noise level for each prediction scenario g) for developments where a significant level of noise impact is likely to occur, noise contours for the key prediction scenarios should be derived h) an assessment of the need to include modification factors as detailed in Fact Sheet C of the *NSW Noise Policy for Industry*.	Methodology in Section 9 Noise contours in Appendix B Modification factors in Section 10.1.1.1 and 10.1.1.2
	Discuss the findings from the predictive modelling and, where relevant noise criteria have not been met, recommend additional feasible and reasonable mitigation measures.	Section 10 and 11
	The noise impact assessment report should include details of any mitigation proposed including the attenuation that will be	Section 11

Department	Requirement	Section Addressed
	achieved and the revised noise impact predictions following mitigation. a) Where relevant noise/vibration levels cannot be met after application of all feasible and reasonable mitigation measures the residual level of noise impact needs to be quantified	
	For the assessment of existing and future traffic noise, details of data for the road should be included such as assumed traffic volume; percentage heavy vehicles by time of day; and details of the calculation process. These details should be consistent with any traffic study carried out in the EIS.	Section 10.2
	Where blasting is intended an assessment in accordance with the *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZECC, 1990) should be undertaken. The following details of the blast design should be included in the noise assessment: a) bench height, burden spacing, spacing burden ratio b) blast hole diameter, inclination and spacing c) type of explosive, maximum instantaneous charge, initiation, blast block size, blast frequency.	Section 15
	Determine the most appropriate noise mitigation measures and expected noise reduction including both noise controls and management of impacts for both construction and operational noise. This will include selecting quiet equipment and construction methods, noise barriers or acoustic screens, location of stockpiles, temporary offices, compounds and vehicle routes, scheduling of activities, etc.	Operational Noise Mitigation in Section 11 Construction Noise Management in Section 13
	For traffic noise impacts, provide a description of the ameliorative measures considered (if required), reasons for inclusion or exclusion, and procedures for calculation of noise levels including ameliorative measures. Also include, where necessary, a discussion of any potential problems associated with the proposed ameliorative measures, such as overshadowing effects from barriers. Appropriate ameliorative measures may include: a) use of alternative transportation modes, alternative routes, or other methods of avoiding the new road usage b) control of traffic (eg: limiting times of access or speed limitations) c) resurfacing of the road using a quiet surface d) use of (additional) noise barriers or bunds e) treatment of the façade to reduce internal noise levels buildings where the night-time criteria is a major concern f) more stringent limits for noise emission from vehicles (i.e. using specially designed 'quite' trucks and/or trucks to use air bag suspension g) driver education h) appropriate truck routes i) limit usage of exhaust brakes j) use of premium muffles on trucks k) reducing speed limits for trucks l) ongoing community liaison and monitoring of complaints m) phasing in the increased road use.	N/A

5. Operational Noise Criteria

The following noise criteria are relevant to the project and where applicable, are taken from established legislation in both the Australian Capital Territory (ACT) and New South Wales (NSW).

5.1. Australian Capital Territory

5.1.1. ACT Environment Protection Act 1997

The ACT Environment Protection Act 1997 (EP Act) sets out the basis for regulations and policies that apply to the protection of the environment within the ACT. The EP Act makes provision for general environmental requirements such that:

> *"A person must take the steps that are practicable and reasonable to prevent or minimise environmental harm or environmental nuisance caused, or likely to be caused, by an activity conducted by that person."*

The EP Act defines environmental nuisance as including noise emissions that cause unreasonable interference to the enjoyment of the public, a section of the public or a person of a place or area.

In the context of the proposed quarry, noise emissions will be generated by activities including excavation, blasting, haulage, crushing, screening and loading. The relevant regulations and policies that have been set to mitigate such noise emissions are discussed below.

5.1.2. ACT Environment Protection Regulation 2005

Section 25 of the ACT Government Environment Protection Regulation 2005 (EP Regulation) establishes a framework to ameliorate impacts of excessive noise that causes environmental harm, in support of the intentions of the EP Act. The regulation states:

> *"Under section 25 (1), noise is not taken to cause environmental harm in an affected place if it is noise mentioned in schedule 2, table 2.3, column 2 and the conditions (if any) mentioned in column 3 for the noise are met."*

Under the regulation, the ACT is divided into 'Noise Zones 'in accordance with land use policies defined by the Territory Plan. 'Noise standards' apply to each Noise Zone, except where otherwise permitted by the regulation. Table 9 and Table 10 identify the applicable ACT Noise Zones and Noise Standards for NCAs surrounding the Quarry.

Table 9 – ACT Applicable Noise Zones

Noise Zone	ACT Land	NSW Land
Zone G	All other land, other than land in the Central National Area (Fairbairn)	All other NSW Land

Table 10 – ACT Applicable Noise Standards

Noise Zone	Monday-Saturday (7am–10pm) Sunday and public holiday (8am – 10pm)	All other times
Zone G	45 dB(A)	35 dB(A)

5.1.3. ACT EPA Noise Environment Protection Policy 2010

The objective of the ACT EPA Noise Environmental Protection Policy (NEPP) is to establish environmental noise limits which are consistent with the requirements of the EP Act and the EP Regulation. Section 7 of the NEPP

outlines how the noise standards and noise zones are employed, and section 9 defines the permitted activities, with some extenuating circumstances set out in Table 2.3 of Schedule 2 of the regulation.

The relevant noise limits applying to the operation of quarry (at ACT receivers only) are summarised in Table 11.

Table 11 – ACT Receiver Operational Noise Limits

Area	Noise Zone	Noise Standard dB(A)[1,2]	
		Day	Night
NCA 1 (R35 – R47)	Zone G	45	35

Notes:
1. *Day is defined as Mon-Sat (07:00-22:00) Sun and public holiday (08:00-22:00).*
2. *Night is defined as Mon-Sat (22:00-07:00) Sun and public holiday (22:00-08:00).*

5.2. New South Wales

5.2.1. Development Control Plan

The Queanbeyan Development Control Plan (Q-DCP-2012) has been reviewed and no relevant criteria applicable to the project were found to apply.

5.2.2. NSW EPA Noise Policy for Industry (NPfI)

The Environmental Protection Authority's (EPA) Noise Policy for Industry (NPfI) applies both intrusive, amenity and maximum noise level assessments to noise emissions from the Quarry. The results of the unattended noise monitoring were used to determine the applicable NPI project noise trigger levels. The applicable project noise trigger levels are the lowest value of the intrusiveness or project amenity noise level after conversion to $L_{Aeq,\ 15minute}$ dB(A).

5.2.2.1. Intrusive Noise Assessment

The intrusiveness of a noise source may generally be considered acceptable if the level of noise from the source (L_{Aeq}), does not exceed the background noise level by more than 5dB when beyond a minimum threshold. The intrusiveness noise level seeks to limit the degree of change a new noise source introduces to an existing environment. The intrusiveness noise level is determined as follows:

$L_{Aeq,\ 15min}$ = Rating Background Noise level + 5dB

Where:

$L_{Aeq,\ 15min}$ represents the equivalent continuous (energy average) A-weighted sound pressure level of the source over 15 minutes.

and

Rating Background Noise Level (RBL) represents the background level to be used for assessment purposes, as determined by the methods outlined in the NPfI; typically being the median LA90 for each period, day, evening and night.

It should be noted that intrusiveness noise levels are not used directly as regulatory limits. They are used in combination with the amenity noise level to assess the potential impact of noise, assess reasonable and feasible mitigation options and subsequently determine achievable noise requirements. Minimum assumed RBL's apply in the NPfI. These result in the applicable intrusiveness noise levels as follows:

Table 12 – NPfI Intrusiveness Noise Levels

Receiver	Time of Day	RBL dB(A)	Intrusiveness Levels ($L_{Aeq,15min}$dB(A))
NCA 2 (L2)	Day	35*	40
	Evening	30*	35
	Night	30*	35
NCA 3 (L3)	Day	41	46
	Evening	34	39
	Night	30*	35
NCA 4 (L4)	Day	35*	40
	Evening	30*	35
	Night	30*	35
NCA 5 (L4)	Day	35*	40
	Evening	30*	35
	Night	30*	35
NCA 6 (L5)	Day	35*	40
	Evening	30*	35
	Night	30*	35

Note: **Actual RBLs are below assumed policy minimums; therefore, adopt assumed minimums.*

5.2.2.2. Amenity Noise Assessment

To limit continuing increases in noise levels from applications of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 13. Note that a -5dB(A) adjustment has not been applied to devise the project amenity criteria as no other industry are present in the area, or are likely to be introduced.

Table 13 – NPfI Project Amenity Noise Levels

Receiver	Noise Amenity Area	Time of Day	$L_{Aeq,}$ dB(A)[1]
All in NSW NCA 2 – NCA 5	C4 - Environmental living	Day[2]	50
		Evening[3]	45
		Night[4]	40

Notes:

1. *Under the NPfI short term, 15 minute assessments should be assessed with respect to the established amenity criteria +3dB(A).*
2. *Day is 7am – 6pm Monday to Saturday*
   8am – 9pm Sundays and public holidays
3. *Evening is 6pm – 10pm*
4. *Night is the remaining periods.*

The applicable amenity noise levels have been devised based on studies that relate industrial noise to annoyance in communities (Miedema and Voss, 2004). They have been subjectively scaled to reflect the perceived differential expectations and ambient noise environments of rural, suburban, and urban communities for residential receivers. They are based on protecting most of the community (90%) from being highly annoyed by industrial noise.

Amenity noise levels are not used directly as regulatory limits. They are used in combination with the project intrusiveness noise level to assess the potential impact of noise, and subsequently determine achievable noise requirements.

The amenity criteria above are to be examined with the project intrusiveness criteria to determine the project noise trigger levels for NSW. This shall be determined by taking the lower of the two applicable criteria at each NCA in NSW. The resultant Noise Trigger Levels can be found in Table 14.

5.2.2.3. Consolidated Industrial Noise Trigger Levels

Consolidated project NPfI noise trigger levels are presented in Table 14 below.

Table 14 – Consolidated NPfI Intrusiveness & Amenity Noise Trigger Levels

NCA	Time of Day	Consolidated PTNLs (L_{eq} dB(A))
NCA 1	Day	45
	Night	35
NCA 2	Day	40
	Evening	35
	Night	35
NCA 3	Day	46
	Evening	39
	Night	35
NCA 4	Day	40
	Evening	35
	Night	35
NCA 5	Day	40
	Evening	35
	Night	35

5.2.2.4. Maximum Noise Level Event

The NPfI requires that the potential for sleep disturbance from maximum noise level events from premises during the night-time period be considered. Sleep disturbance is considered to include both awakenings and disturbance to sleep stages.

Where the subject development/premises night-time noise levels at a residential location exceed:

- L_{Aeq} 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is greater,

A detailed maximum noise level event assessment should be undertaken.

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the NSW Road Noise Policy.

5.2.2.5. Low Frequency Noise

Quarry projects typically require consideration of potential Low Frequency Noise (LFN) emissions in accordance with Fact Sheet C of the NPfI. Where LFN is found to be present, an appropriate modifying factor correction is to be applied to the assessed noise levels from the quarry. Fact Sheet C has two requirements to determine the presence of LFN as follows:

1. A screening test to identify the potential for LFN by assessing whether there is a difference of 15dB or more between C and A-weighted noise, and where this is the case;
2. A detailed evaluation of the 1/3 octave frequencies between 10Hz and 160Hz with respect to the 'low frequency thresholds' set out in Table C2 of Fact Sheet C. Where noise levels are greater than the low frequency thresholds, a modifying factor correction shall be applied to the assessed noise level.

5.2.2.6. Tonality

Fact Sheet C of the NPfI also sets out a test for tonal noise. If noise emissions from the quarry are found to be tonal, then a modifying factor correction should be added to the assessment result. Fact Sheet C states that a modifying factor correction should be added if the level of one third octave band exceeds the level of the adjacent bands on both sides by:

- 5dB or more if the centre frequency of the band containing the tone is in the range 500-10kHz.
- 8dB or more if the centre frequency of the band containing the tone is in the range 160-400Hz.
- 15dB or more if the centre frequency of the band containing the tone is in the range 25-125Hz.

5.2.2.7. Duration Correction

Where a single event noise is continuous for a period of less than two and a half hours in any assessment period, an allowable exceedance of the project noise trigger level at the receptor may be applied to adjust for the limited duration, as shown in Table 15. This adjustment is designed to account for unusual and one-off events, and does not apply to regular and/or routine high noise level events.

Table 15 - Adjustment for Duration

Allowable Duration of Noise (One Event in Any 24-Hour Period)	**Allowable Exceedance of the $L_{Aeq,15min}$ Project Noise Trigger Level, dB(A)**	
	Daytime and evening (7am – 10pm)	Night time (10pm – 7am)
1 to 2.5 hours	2	Nil
15 minutes to 1 hour	5	Nil
6 minutes to 15 minutes	7	2
1.5 minutes to 6 minutes	15	5
Less than 1.5 minutes	20	10

5.2.2.8. Meteorological Conditions

The NPfI defines standard meteorological conditions and noise-enhancing meteorological conditions as shown in Table 16 below.

Table 16 - Standard and Noise-Enhancing Meteorological Conditions

Meteorological Conditions	Meteorological Parameters
Standard meteorological conditions	Day/evening/night: stability categories A–D with wind speed up to 0.5 m/s at 10 m AGL (above ground level).
Noise-enhancing meteorological conditions	Daytime/evening: stability categories A–D with light winds (up to 3 m/s at 10 m AGL). Night-time: stability categories A–D with light winds (up to 3 m/s at 10 m AGL) and/or stability category F with winds up to 2 m/s at 10 m AGL.

Fact Sheet D of the NPfI sets out two options for consideration of meteorological conditions:

1. Adopt the noise-enhancing meteorological conditions for all assessment periods without an assessment of how often these conditions occur – a conservative approach that considers source-to-receiver wind vectors for all receivers and F class temperature inversions with wind speeds up to 2 m/s at night; or
2. Determine the significance of noise-enhancing conditions. This involves assessing the significance of temperature inversions (F and G class stability categories) for the night-time period and the significance of light winds up to and including 3 m/s for all assessment periods during stability categories other than E, F, or G. Significance is based on a threshold of occurrence of 30% determined in accordance with the provisions in this policy. Where noise-enhancing meteorological conditions occur for less than 30% of the time, standard meteorological conditions may be adopted for the assessment.

5.2.3. NSW Road Noise Policy

The NSW DECC *Road Noise Policy* 2011 (RNP) provides noise criteria with the aim to provide protection inside and immediately around sensitive receivers. These noise criteria are consistent with current international practice for managing traffic noise impacts. The criteria applied in the RNP have been set approximately at the point where 90% of residents are not highly annoyed by noise. Table 17 sets out the Traffic Noise assessment criteria for residential land uses.

Table 17 - Road Traffic Noise Assessment Criteria for Residential Land Uses

Road Category	Type of Project/land use	Assessment Criteria – dB(A)	
		Day (7am – 10pm)	Night (10pm – 7am)
Freeway / arterial / sub arterial Roads	Existing residences affected by additional traffic on freeway / arterial / sub arterial Roads generated by land use developments.	$L_{Aeq,\ (15\ hour)}$ 60 (external)	$L_{Aeq,\ (9\ hour)}$ 55 (external)
Local Roads	Existing residences affected by additional traffic on existing local roads generated by land use developments.	$L_{Aeq,\ (1\ hour)}$ 55 (external)	$L_{Aeq,\ (1\ hour)}$ 50 (external)

In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person. As such, the RNP states that where existing noise levels are above the assessment criteria, any increase in the total traffic noise levels at sensitive land uses should be limited to 2 dB above that of the corresponding "no build option".

5.2.4. Voluntary Land Acquisition and Mitigation Policy

The NSW Government *Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments* (VLAMP) describes policy for voluntary mitigation and land acquisition actions undertaken to address noise and dust impacts from State significant extractive industry developments.

Specific to noise, it requires assessment of impacts of the development in accordance with the:

- *Noise Policy for Industry* (EPA 2017) (NPfI);
- *Rail Infrastructure Noise Guideline* (EPA 2013) (RING);
- *Road Noise Policy* (DECCW 2011) (RNP); and
- *Interim Construction Noise Guideline* (DECC 2009) (ICNG).

A consent authority can apply voluntary mitigation and voluntary land acquisition rights to reduce operational noise impacts of a development on privately owned land. However, voluntary mitigation and voluntary land acquisition rights do not apply to noise impacts due to construction, as these impacts are shorter term and can be controlled, or to noise impacts on the public road or rail network.

Relevant to the proposed development, a consent authority may apply voluntary mitigation rights where, even with the implementation of best practice management at the site:

- The noise generated by the development would meet the requirements in Table 18, such that the impacts would be characterised as marginal, moderate or significant, at any residence on privately owned land; or
- The development would increase the total industrial noise level at any residence on privately owned land by more than 1 dB(A) and noise levels at the residence are already above the recommended amenity noise levels in the Noise Policy for Industry (Table 13).

Relevant to the proposed development, a consent authority may apply voluntary land acquisition rights where, even with the implementation of best practice management:

- The noise generated by the development would be characterised as significant, according to Table 18, at any residence on privately owned land; or
- The noise generated by the development would contribute to exceedances of the Noise Policy for Industry amenity noise levels plus 5 dB(A) (Table 13) on more than 25% of any privately-owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls.

Table 18 summarises the interpretation of the significance of any potential exceedances of the relevant noise assessment criteria, and identifies potential treatments for those exceedances.

Table 18 – VLAMP Characterisation of Noise Impacts and Potential Treatments

Predicted Noise Level Minus Project Trigger Level	Total Cumulative Industrial Noise Level	Characterisation of Impacts	Potential Treatment
All time periods 0 – 2 dB(A)	n/a	Negligible	The exceedances would not be discernible by the average listener and therefore would not warrant receiver based treatments or controls
All time periods 3 – 5 dB(A)	▪ < recommended NPfI amenity noise level; or ▪ > recommended NPfI amenity noise level, but the increase in total cumulative industrial noise resulting from the development is < 1 dB	Marginal	Provide mechanical ventilation / comfort condition systems to enable windows to be closed without compromising internal air quality / amenity.
All time periods 3 – 5 dB(A)	> recommended NPfI amenity noise level, and the increase in total cumulative industrial noise resulting from the development is > 1 dB	Moderate	As for marginal impacts but also upgraded façade elements like windows, doors or roof insulation, to further increase the ability of the building facade to reduce noise levels.
Day and evening > 5 dB(A)	< recommended NPfI amenity noise levels	Moderate	As for marginal impacts but also upgraded façade elements like windows, doors or roof insulation, to further increase the ability of the building facade to reduce noise levels.
Day and evening > 5 dB(A)	> recommended NPfI amenity noise levels	Significant	Provide mitigation as for moderate impacts and see voluntary land acquisition provisions above.
Night > 5 dB(A)	n/a	Significant	Provide mitigation as for moderate impacts and see voluntary land acquisition provisions above.

6. Construction Noise Criteria

The NSW Department of Environment and Climate Change *Interim Construction Noise Guideline* 2009 (ICNG) sets out construction noise management levels for various sensitive uses, and provides guidance on feasible and reasonable work practices to minimise noise impacts.

6.1. Residences

The ICNG provides management levels for noise at residences as presented in Table 19 below.

Table 19 – ICNG Noise Management Levels

Time of Day	Management Level, $L_{Aeq,15min}$	How to Apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Noise affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. ▪ Where the predicted or measured LAeq (15 min) is greater than the affected noise level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. ▪ The proponent should also inform all potentially impacted residences of the nature of the works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dB(A)	The highly noise affected level represented the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences. 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community.

The applicable noise management levels for residential receivers have been determined based on the RBLs outlined in Table 12 and are presented in Table 20 below.

Table 20 – Project Noise Management Levels for Residential Receivers

NCA	Time	RBL, dB L_{A90}	Noise Affected Level, dB $L_{Aeq,15\ min}$	Highly Noise Affected Level, dB $L_{Aeq,15\ min}$
NCA 1	Monday to Friday 7am to 6pm Saturday 8am to 1pm	38	48	75
	Out of hours 'evening'	38	43	-
	Out of hours 'night'	30	35	-
NCA 2 NCA 4 NCA 5 NCA 6	Monday to Friday 7am to 6pm Saturday 8am to 1pm	35	45	75
	Out of hours 'evening'	30	35	-
	Out of hours 'night'	30	35	-

6.2. Other Sensitive Land Uses

Other sensitive land uses, such as schools, typically consider noise from construction to be disruptive when the properties are being used (such as during school times). Table 21 presents management levels for noise at other sensitive land uses based on the principle that the characteristic activities for each of these land uses should not be unduly disturbed. The proponent should consult with noise sensitive land use occupants likely to be affected by noise from the works to schedule the project's work hours to achieve a reasonable noise outcome.

Internal noise levels are to be assessed at the centre of the occupied room. External noise levels are to be assessed at the most affected point within 50 m of the area boundary. Where internal noise levels cannot be measured, external noise levels may be used. The management levels in Table 21 are 5 dB above the corresponding road traffic noise levels in the Environmental Criteria for Road Traffic Noise (EPA 1999) (and the 'maximum' levels in the NSW Industrial Noise Policy (EPA 2000) for commercial and industrial uses) to account for the variable and short-term nature of construction noise.

Table 21 – Project Noise Management Levels for other Sensitive Land Uses

Land Use	Measurement Location	Management Level, dB $L_{Aeq,15min}$ (applies when properties are being used)
Classrooms at schools and other educational institutions	Internal	45
Hospital wards and operating theatres	Internal	45
Places of worship	Internal	45
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion).	External	65
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation).	External	60

Land Use	Measurement Location	Management Level, dB $L_{Aeq,15min}$ (applies when properties are being used)
Community centres	Internal	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS2107 for specific uses.

6.3. Commercial & Industrial Premises

Due to the broad range of sensitivities that commercial or industrial land can have to noise from construction, the process of defining management levels is separated into three categories. The external noise levels should be assessed at the most-affected occupied point of the premises:

- Industrial premises: external $L_{Aeq\ (15\ min)}$ 75 dB(A)
- Offices, retail outlets: external $L_{Aeq\ (15\ min)}$ 70 dB(A)
- Other businesses that may be very sensitive to noise, where the noise level is project specific as discussed below.

Examples of other noise-sensitive businesses are theatres and childcare centres. The proponent should undertake a special investigation to determine suitable noise levels on a project-by-project basis; the recommended 'maximum' internal noise levels in *AS/NZS 2107 Acoustics – Recommended design sound levels and reverberation times for building interiors* may assist in determining relevant noise levels.

The proponent should assess construction noise levels for the project and consult with occupants of commercial and industrial premises prior to lodging an application where required.

During construction, the proponent should regularly update the occupants of the commercial and industrial premises regarding noise levels and hours of work.

6.4. Ground-Borne Noise at Residences

Ground-borne noise is noise generated by vibration transmitted through the ground into a structure. Ground-borne noise caused, for example, by underground works such as tunnelling, can be more noticeable than airborne noise. The following ground-borne noise levels for residences indicate when management actions should be implemented. These levels recognise the temporary nature of construction and are only applicable when ground-borne noise levels are higher than airborne noise levels. The ground-borne noise levels are for evening and night-time periods only, as the objectives are to protect the amenity and sleep of people when they are at home.

- Evening (6 pm to 10 pm) - Internal: $L_{Aeq\ (15\ min)}$ 40 dB(A)
- Night-time (10 pm to 7 am) - Internal: $L_{Aeq\ (15\ min)}$ 35 dB(A)

The internal noise levels are to be assessed at the centre of the most affected habitable room.

Mitigation options to deal with ground-borne noise may include extensive community consultation to determine the acceptable level of disruption and the provision of respite accommodation in some circumstances, not just restriction of work hours. The level of mitigation of ground-borne noise would depend on the extent of impacts and also on the scale and duration of works. Any restriction that the relevant authority (consent, determining or regulatory) may impose on the days when construction work is allowed should take into account whether the community:

- Has identified times of day when they are more sensitive to noise (for example, Sundays or public holidays)
- Is prepared to accept a longer construction duration in exchange for days of respite.

6.5. Sleep Disturbance at Residences

Where construction works are planned to extend over more than two consecutive nights, and a quantitative assessment method is used, the analysis should cover the maximum noise level, and the extent and the number of times that the maximum noise level exceeds the RBL. Some guidance indicating the potential for sleep disturbance is in the NSW Environmental Criteria for Road Traffic Noise (EPA 1999).

Factors that may be important in assessing the extent of impact on sleep include how often high noise events occur at night, the predicted maximum noise levels at night, whether there are times when there is a clear change in the noise environment (such as during early morning shoulder periods), and the degree of maximum noise levels above the background noise level at night.

7. Vibration Criteria

The SEARs requires that vibration from all activities (including construction and operation) is assessed using the guidelines within the Department of Environment and Conservation *Assessing Vibration: a technical guideline* 2006 (Guideline), which provides advice for assessment of vibration potentially affecting human comfort. The Guideline is based on advice contained in British Standard BS6472 *Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz To 80 Hz)* (BS6472).

Criteria for potential impacts of vibration on buildings is adopted from Australian Standard AS2187-2-2006 *Explosives - Storage and Use Part 2* (AS2187) which in turn refers to British Standard BS7385.2 *Evaluation and measurement of vibration in buildings* (BS7385).

7.1. Human Comfort

The Guideline provides human comfort criteria for exposure to continuous and impulsive vibration at residences, as set out in Table 22 below. Continuous vibration is vibration that continues uninterrupted for a defined period, usually throughout the daytime or night-time. Impulsive vibration is a rapid build up to a peak, followed by a damped decay. Impulsive vibration can also consist of sudden application of several cycles at the same amplitude, providing that the duration is short, typically less than 2 seconds. The impulsive vibration criteria presented apply when there are no more than 3 occurrences in an assessment period.

Table 22 - Criteria for Exposure to Continuous and Impulsive Vibration at Residences

Type of Vibration	Time	Assessment Criteria					
		[1]rms acceleration (m/s^2)		[2]rms velocity (mm/s)		[2]Peak velocity (mm/s)	
		Preferred	Max	Preferred	Max	Preferred	Max
Continuous Vibration	Daytime[3]	0.010	0.020	0.20	0.40	0.28	0.56
	Night-time	0.0070	0.014	0.14	0.28	0.20	0.40
Impulsive Vibration	Daytime[3]	0.30	0.60	6.0	12.0	8.6	17.0
	Night-time	0.10	0.20	2.0	4.0	2.8	5.6

Notes:

1. *Values derived from z-axis critical frequency range 4–8 Hz. Where required, a more detailed analysis can be conducted as per BS 6472–1992.*
2. *Values given for the most critical frequency range >8 Hz assuming sinusoidal motion. Where required, a more detailed analysis can be conducted as per AS 2670.2–1990. Sufficient justification should accompany the use of a peak velocity approach if used in an assessment.*
3. *Specific values depend on social and cultural factors, psychological attitudes and expected degree of intrusion.*

The Guideline provides instructions on how to assess the Vibration Dose Value (VDV) for occupants inside buildings. The VDV is used to assess vibration from intermittent sources and is an assessment of the cumulative vibration energy throughout a day or night-time period. There is a low probability of adverse comment or disturbance to building occupants if the VDV values are below the preferred values listed below in Table 23. Adverse comment or disturbance is more probable as levels approach the maximum values.

Table 23 - Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime (7am to 10pm)		Night time (10pm to 7am)	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Residences	0.2	0.4	0.13	0.26

7.2. Building Damage

BS7385 is used to assess the likelihood of building damage associated with vibration. Trigger levels from the standard are given below in Table 24.

Table 24 – BS 7385 Structural Damage Criteria

Group	Type of Structure	Peak Component Particle Velocity, mm/s		
		4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50	50	50
2	Un-reinforced or light framed structures Residential or light commercial type buildings	15 to 20	20 to 50	50

The peak vibration triggers for minimal risk of 'cosmetic' damage are: 15mm/s for un-reinforced or light framed structures, for example residential or light commercial buildings (increasing as the frequency content of the vibration increases) and 50mm/s for reinforced or framed structures, for example industrial and heavy commercial buildings (constant across all frequencies). 'Minor' damage (the formation of cracks or loosening in plaster surfaces, or cracks in brick/concrete blocks) is considered possible at vibration magnitudes which are twice those given for 'cosmetic' and 'major' damage to a building structure may occur at levels greater than four times the 'cosmetic' values.

These values relate to transient vibrations only. Continuous vibration can give rise to dynamic magnifications due to resonances and triggers may need to be reduced by up to 50%. These values have not been established to address potential structural damage associated with vibration induced subsidence.

The levels set by this standard are considered 'safe limits' up to which no damage due to vibration has been observed. Damage comprises minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls.

8. Blast Criteria

Australian Standard AS 2187.2 – 2006 *Explosives – Storage and use, Part 2: Use of explosives* Appendix J provides human comfort and building damage criteria for blast induced ground vibration and airblast overpressure.

8.1. Blast Inducted Vibration

8.1.1. Human Comfort

AS 2187 sets out assessment criteria for blast induced ground vibration effects on human comfort as shown in Table 25.

Table 25 – Blast Induced Ground Vibration Criteria for Human Comfort

Category	Type of Blasting Operation	Peak Component Particle Velocity (mm/s)
Sensitive Site*	Operations lasting for more than 12 months or more than 20 blasts	5 mm/s for 95% blasts per year, 10mm/s maximum unless agreement is reached with the occupier that a higher limit may apply
Sensitive Site*	Operations lasting for less than 12 months or less than 20 blasts	10mm/s maximum unless agreement is reached with occupier that a higher limit may apply.
Occupied non-sensitive sites, such as factories and commercial premises.	All blasting	25 mm/s maximum unless agreement is reached with occupier that a higher limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specification or levels that can be shown to adversely affect the equipment operation.

Note: A sensitive site includes houses and low-rise residential buildings, hospitals, theatres, schools, etc. occupied by people.

8.1.2. Building Damage

Recommended limits for ground vibration for control of damage to structures are provided in Table 26.

Table 26 – Blast Induced Ground Vibration Criteria for Control of Building Damage

Category	Type of Blasting Operation	Peak Component Particle Velocity (mm/s)
Other structures or architectural elements that include masonry, plaster, and plasterboard in their construction.	All Blasting	Frequency dependent damage limits criteria as per Table 24.
Unoccupied structures of reinforced concrete or steel construction.	All Blasting	100mm/s maximum unless agreement is reached with the owner that a higher limit may apply.
Service structures pipelines, powerlines & cables located above ground.	All Blasting	Limit is to be determined by structural design methodology.

8.2. Air Blast Criteria

AS 2187 provides criteria for airblast overpressure. Air blast can cause discomfort to persons and, at high levels, damage to structures and architectural elements, and at very high levels, injury to persons. The air blast levels at which people become annoyed are well below levels at which building damage has been proven to occur. The evaluation of the effects of blasting should separate human response and structural damage effects of air blast.

8.2.1. Human Comfort

Human comfort limits for air blast are linked to the annoyance produced. Several factors contribute to annoyance by impulsive sounds such as air blast. These include the loudness, duration and the nature of the disturbance. Airblast limits for human comfort chosen by some regulatory authorities are provided in Table 27. All the limits are expressed as peak linear sound pressure levels.

Table 27 – Airblast Limits for Human Comfort

Category	Type of Blasting Operation	Peak Sound Pressure Level (dBL)
Sensitive Site*	Operations lasting for more than 12 months or more than 20 blasts	115 dBL for 95% blasts per year. 120 dBL maximum unless agreement is reached with occupier that a higher limit may apply
Sensitive Site*	Operations lasting for less than 12 months or less than 20 blasts	120 dBL for 95% blasts per year. 125 dBL maximum unless agreement is reached with occupier that a higher limit may apply.
Occupied non-sensitive sites, such as factories and commercial premises.	All blasting	125 dBL maximum unless agreement is reached with the occupier that a higher limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specifications or levels that can be shown to adversely affect the equipment operation.

Note: A sensitive site includes houses and low-rise residential buildings, hospitals, theatres, schools, etc., occupied by people.

8.2.2. Building Damage

From Australian and overseas research, damage (even of a cosmetic nature) has not been found to occur at air blast levels below 133dBL. The probability of damage increases as the air blast levels increases above this level. Windows are the building element currently regarded as most sensitive to air blast, and damage to windows is considered as improbable below 140 dBL.

A limit of 133 dBL is recommended as a safe level that will prevent structural/architectural damage from air blast. Recommended building damage criteria are given in Table 28. All the limits are expressed as peak linear sound pressure levels. The classification of type of structure may be difficult and, when in doubt, a more conservative limit from the nearest description in Table 28 shall be applied.

Table 28 – Recommended Airblast Limits for Damage Control

Category	Type of Blasting Operation	Peak sound pressure level (dBL)
Structures that include masonry, plaster and plasterboard in their construction and unoccupied structures of reinforced concrete or steel construction.	All Blasting	133 dBL maximum unless agreement is reached with the owner that a higher limit may apply.
Service structures, such as pipelines, powerlines and cables located above the ground.	All Blasting	Limit to be determined by structural design and methodology.

8.3. ANZEC Blast Guidelines

The Australia and New Zealand Environment Council publication *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZEC Blast Guidelines, 1990) recommend airblast overpressure and ground vibration criteria which align with the AS 2187 criteria at sensitive sites, set out in Section 8.1 and 8.2 above. Additionally, the ANZEC Blast Guidelines recommend the following with respect to times and frequency of blasting:

Times and Frequency of Blasting

- Blasting should generally only be permitted during the hours of 9am – 5pm Monday to Saturday. Blasting should not take place on Sundays or Public Holidays.
- Blasting should generally take place no more than once per day. (This requirement would not apply to minor blasts such as for clearing crushers, feed chutes, etc.)
- The restrictions on times and frequency of blasting referred to above do not apply to:
  - Those premises where the effects of the blasting are not perceived at noise sensitive sites; and
  - Major underground metalliferous mining operations.

Acceptable variations

It is recognised that under some circumstances or at certain mines blasting that cannot comply with the above criteria will have to be carried out. Environmental authorities should apply controls for such blasting with appropriate consideration to the circumstances applying.

9. Noise Modelling Methodology

9.1. Meteorological Conditions

Analysis of meteorological conditions was done using the 2021 CALMET model for the Monaro Rock Quarry site, developed by Northstar. Wind roses for the site using the model data are shown in Figure 3. Prevailing winds on site are from the north-west, south, and east.

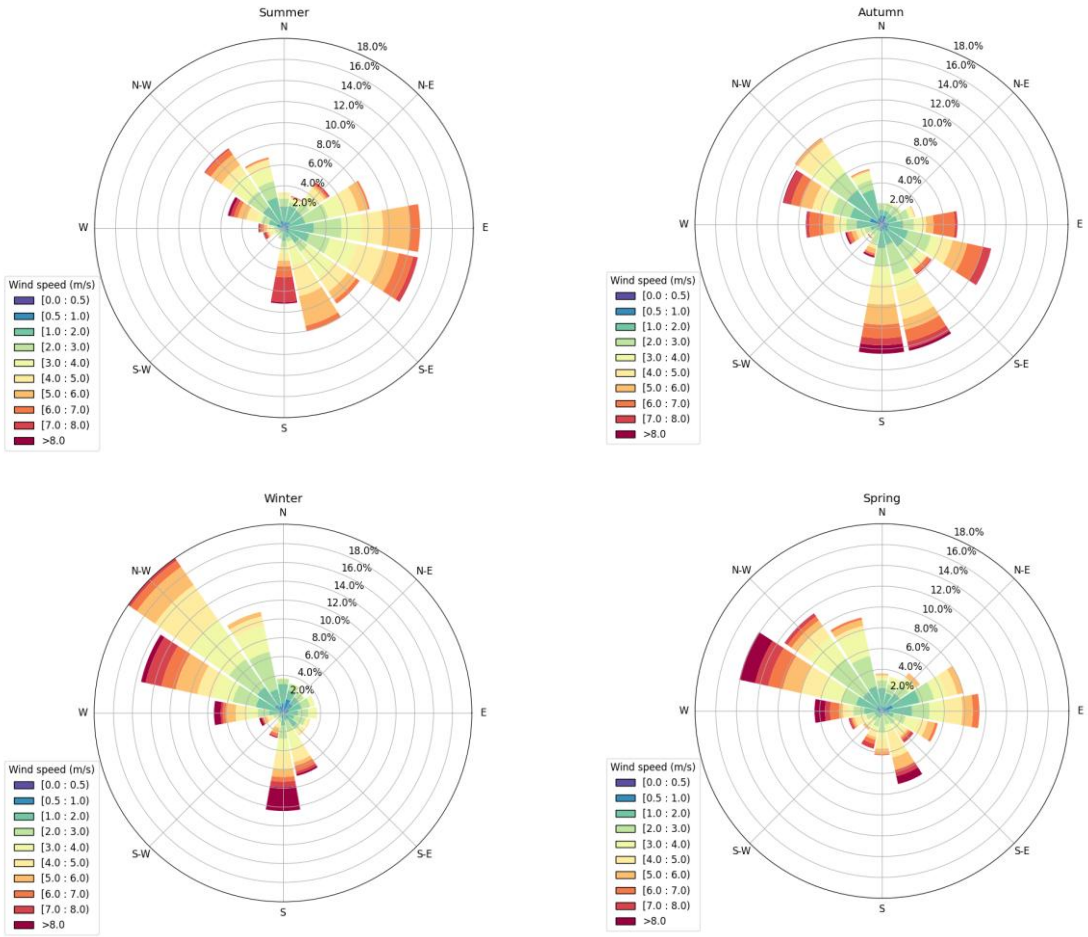


Figure 3 - Monaro Rock Quarry Wind Roses

The meteorological data was analysed to consider noise enhancing conditions during the Quarry hours of operation, as defined by the NSW Noise Policy for Industry (NPfI) in Section 5.2.2.8. This includes downwind conditions from source to receiver within an angle of ±45° and temperature inversions. Prevalence of noise enhancing conditions for each cardinal direction are shown in Table 29, and indicate that during the day, noise enhancing conditions are not a significant feature in any direction. However, at night during Autumn and Winter, noise enhancing conditions exceed the 30% threshold of occurrence and are therefore considered a significant feature.

Table 29 - Meteorological Conditions

Wind Direction	Day (7am – 6pm)			Night (5am – 7am)		
	Noise Enhancing Conditions Occurrence	Standard Conditions Occurrence	Noise Enhancing Assessment Required?	Noise Enhancing Conditions Occurrence	Standard Conditions Occurrence	Noise Enhancing Assessment Required?
Summer						
North	16%	70%	No	16%	82%	No
East	6%	68%	No	24%	67%	No
South	3%	84%	No	14%	57%	No
West	5%	80%	No	13%	87%	No
Autumn						
North	14%	78%	No	42%	57%	Yes
East	7%	80%	No	50%	42%	Yes
South	7%	73%	No	40%	30%	Yes
West	8%	67%	No	47%	48%	Yes
Winter						
North	15%	66%	No	51%	38%	Yes
East	7%	87%	No	48%	51%	Yes
South	4%	80%	No	41%	38%	Yes
West	6%	60%	No	45%	41%	Yes
Spring						
North	14%	71%	No	20%	76%	No
East	5%	82%	No	32%	60%	Yes
South	3%	86%	No	18%	63%	No
West	6%	62%	No	20%	71%	No

9.2. Noise Modelling Algorithms

A 3D computer noise model of the site and surrounds was built in CadnaA software and calculations run implementing the ISO 9613 and CONCAWE algorithms to calculate the propagation of sound between source and receiver.

The ISO 9613 algorithms apply to meteorological conditions favourable to noise propagation, namely receivers downwind from the source with a wind speed between 1 m/s and 5 m/s measured at a height of 3m to 11m above ground. The ISO 9613 equations also hold for a well-developed moderate ground-based temperature inversion, such as commonly occurs on clear, calm nights.

The CONCAWE algorithms calculate the meteorological effect based on the wind speed vector and atmospheric stability, and therefore can be applied to a range of meteorological conditions, from noise-enhancing to noise-

attenuating. CONCAWE defines 6 meteorological categories, with wind speeds ranging from > 3 m/s upwind to > 3 m/s downwind, and Pasquill Stability Category ranging from A-G.

The ISO 9613 and CONCAWE equations also take into account propagation effects associated with:

- Source sound power.
- Geometrical spreading.
- Air absorption.
- Ground absorption (G = 0.0 in the Quarry, G = 0.7 elsewhere)
- Reflection.
- Barrier effects associated with topography and built form, including buildings and fences.

Under noise-enhancing conditions, the ISO 9613 algorithm more appropriately models the attenuation of a wind-blown barrier. The ISO 9613 algorithms were therefore used for calculation under noise-enhancing conditions, and the CONCAWE algorithms were used to model standard conditions (which ISO 9613 does not provide a calculation method for), with wind speed at 0.5 m/s in the worst-case direction and stability category D.

9.3. Operational Noise Sources

9.3.1. Vehicle Movements

Vehicle movements along the Access Road and Secondary Access Road were included in the 3D noise model as line sources, with inputs to the noise model as follows:

- Vehicle type, location, speed, quantity, and hours of operation as set out in Table 30.
- Vehicle sound power levels set according to Table 51 in Appendix D.
- Source heights:
  - Cars: 0.5m
  - Trucks: 0.5m for tyres, 1.5m for engines, 3.6m for exhausts.
- The proportion of sound power assigned to truck tyres included a pavement correction according to the TfNSW Road Noise Model Validation Guideline (August 2022) and gravel correction obtained from Research on Motor Transport Produced Noise on Gravel and Asphalt Roads (Leipus et al. 2010):
  - +0 dB(A) dense graded asphalt correction for the sealed portion of the Access Road (shown in Appendix C).
  - +3 dB(A) gravel correction for the unsealed portion of the Access Road and the Secondary Access Road.

Table 30 – Vehicle Movements on Access Roads

Vehicle	Location	Speed (km/h)	Maximum Number of Movements	Operating During Period		
				Day	Evening	Night
Heavy vehicle (truck-and-dog)[1]	Access Road	60	50 per hour	✓	✗	✓
Concrete agitator	Access Road	60	10 per hour	✓	✗	✗
Utility vehicle	Access Road	60	2 per hour	✓	✗	✓
Utility vehicle	Secondary Access Road	60	1 per hour	✓	✗	✓
Water truck	Unsealed section of Access Road	40	1 per hour	✓	✗	✓
Grader	Unsealed section of Access Road and Secondary Access Road	5	Twice per month	✓	✗	✗

Note: *1. Heavy vehicle movements are limited to a cumulative daily limit of up to 400 movements per day associated with product dispatch, VENM/ENM and concrete import, concrete/asphalt raw material delivery, and asphalt dispatch.*

9.3.2. Operational Scenarios

The staged development of the quarry described in Section 3 was modelled under two operational scenarios. Vehicle movements were included for both scenarios, as shown in Table 30. Noise from the grader was assessed separately, as grading is not considered part of routine operations.

Scenario 1 represents the worst-case noise during the development of the quarry, when operations have expanded, but there may be some drilling near surface level and the visibility barrier is not yet complete. At this stage the mobile processing plant is operating, and the fixed processing plant is being constructed concurrently. The stages of each area were modelled as Stage E3 Extraction Area, Stage P2 Processing Area, and Stage V1 Visibility Barrier. It is understood that regular drilling will start at approximately 6m below ground level, but some drilling may be required closer to surface level. Equipment in the extraction area was therefore modelled working at ground level to represent the worst case. The Quarry layout and locations of equipment operating under Scenario 1 are shown in Figure 4.

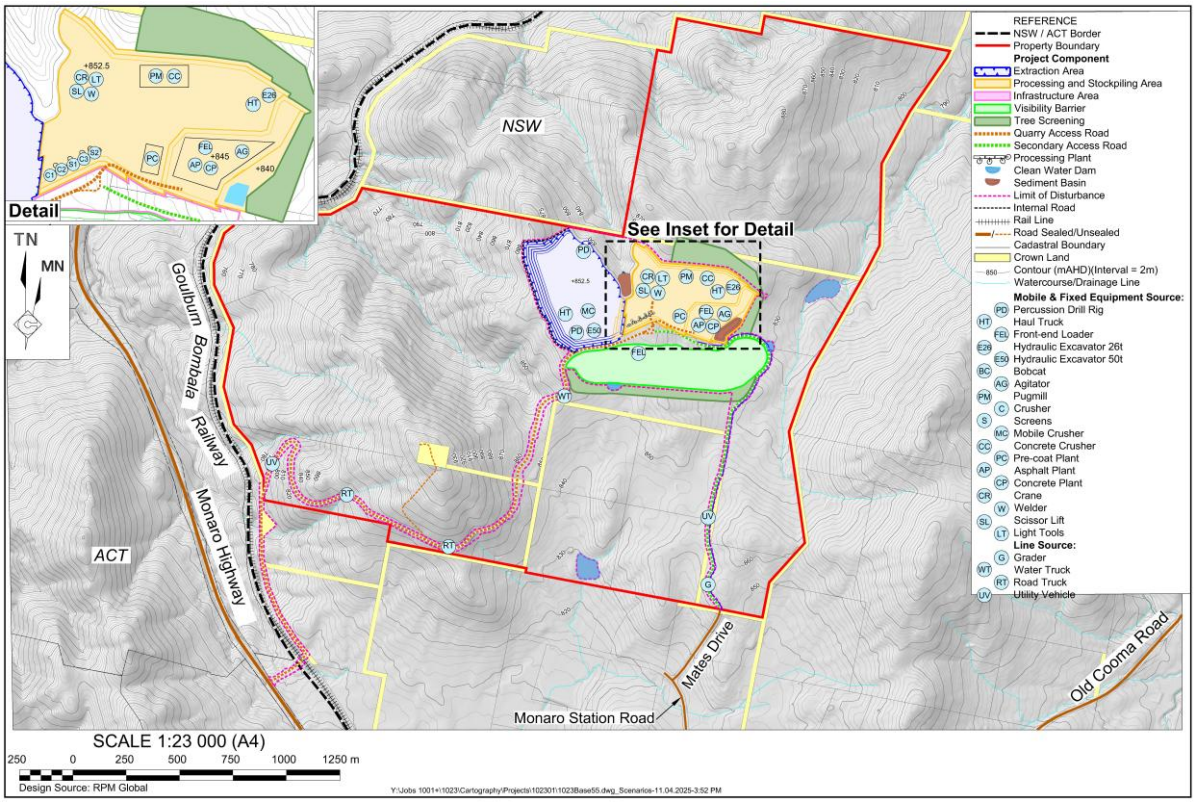


Figure 4 - Operational Scenario 1

Scenario 2 represents ongoing operations at the final stage of development. The stages of each area were modelled as Stage E4 Extraction Area with extraction equipment operating at 852.5m AHD, Stage P3 Processing Area, and Stage V2 Visibility Barrier. Locations of equipment operating under Scenario 2 are shown in Figure 5.

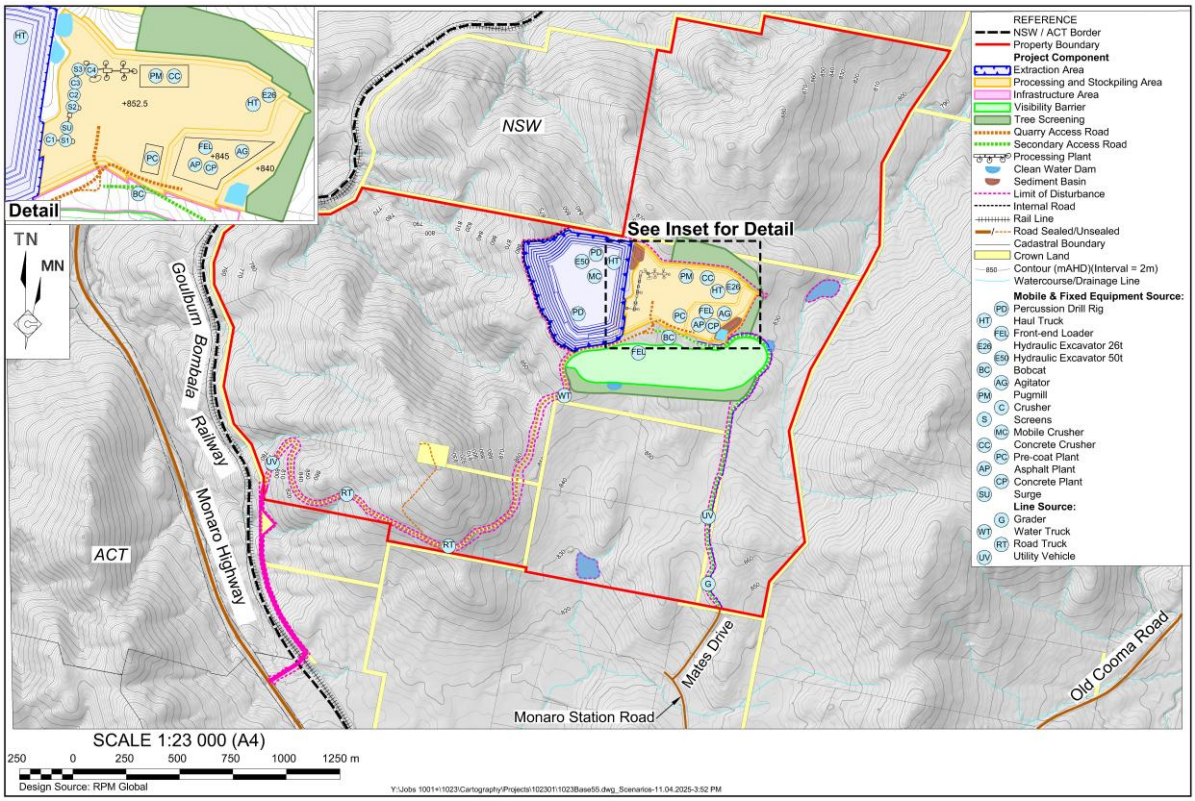


Figure 5 - Operational Scenario 2

A summary of the equipment operating during each scenario and each time period is shown in Table 31. Sound power levels in octave bands for each piece of equipment and details of source heights are provided in Appendix D.

Table 31 – Equipment Summary

Scenario Operating	Equipment	Quantity	SWL	Operating During Period		
				Day	Evening	Night
Extraction Area						
1 & 2	Percussion drill rig	2	116	✓	✗	✗
1 & 2	Mobile crusher	1	112	✓	✗	✗
1 & 2	Hydraulic excavator (50t)	1	115	✓	✗	✗
1 & 2	Haul truck	1	113	✓	✗	✗
Processing Area						
1	Primary jaw crusher (mobile)	1	115	✓	✗	✗
1	Secondary/tertiary cone crusher (mobile)	2	112	✓	✗	✗
1	Quaternary vertical shaft impactor (mobile)	1	103	✓	✗	✗
1	Screen (mobile)	2	109	✓	✗	✗
1 & 2	Crane	1	103	✓	✗	✓
1 & 2	Light tools	1	102	✓	✗	✓
1 & 2	Scissor lift	1	106	✓	✗	✓
1 & 2	Welder	1	101	✓	✗	✓
1 & 2	Pugmill	1	113	✓	✗	✗
1 & 2	Concrete crusher	1	112	✓	✗	✗
1 & 2	Pre-coat plant	1	99	✓	✗	✗
1 & 2	Front end loader (loading truck)	2	110	✓	✗	✓
1 & 2	Front end loader (loading hopper)	1	103	✓	✗	✓
1 & 2	Agitator	1	108	✓	✗	✗
1 & 2	Asphalt plant	1	111	✓	✗	✗
1 & 2	Concrete plant	1	104	✓	✗	✗
1 & 2	Hydraulic excavator (26t)	1	108	✓	✗	✓
1 & 2	Haul truck	2	113	✓	✗	✗
2	Primary jaw crusher (fixed)	1	115	✓	✗	✗
2	Secondary/tertiary cone crusher (fixed)	2	112	✓	✗	✗
2	Quaternary vertical shaft impactor (fixed)	1	103	✓	✗	✗

Scenario Operating	Equipment	Quantity	SWL	Operating During Period		
				Day	Evening	Night
2	Screen (fixed)	5	109	✓	✗	✗
2	Surge	1	110	✓	✗	✗
2	Bobcat	1	103	✓	✗	✓

10. Operational Noise Assessment

10.1. Operational Noise On-Site

The assessment of noise generated on-site by the operation of the Quarry has been carried out with respect to the methodology outlined in Section 9. Operational noise mitigation and management measures have been determined based on the assessment, and are presented in Section 11.

10.1.1. Operational Scenario Results

The noise model was run for each scenario with the noise mitigation measures presented in Section 11 in place. Resultant noise levels at the most affected receiver within each NCA are presented in Table 32 and Table 33. Noise levels at R1 (which is not a sensitive receiver) are presented in Section 10.4. Noise contour maps showing results for each scenario are provided in Appendix B, and full results at all potentially affected sensitive receivers are provided in Appendix G. To account for significant meteorological conditions, the noise model was run under standard conditions for the day period assessment, and both standard and noise enhancing conditions for the night period assessment. Results indicate that compliance with the relevant noise limits will be achieved during all periods.

Table 32 - Scenario 1 Noise Levels at the Most Affected Receivers, dB $L_{Aeq,15min}$

NCA	Receiver	Day (7am – 6pm)		Night (5am – 7am)			Complies?
		Standard Conditions	Criteria	Standard Conditions	Noise Enhancing Conditions	Criteria	
NCA 1	R35	26	45	13	26	35	✓
NCA 2	R33	28	40	18	28	35	✓
NCA 4	R7	33	40	32	33	35	✓
NCA 5	R4	36	40	31	34	35	✓
NCA 6	R16	34	40	23	29	35	✓

Table 33 - Scenario 2 Noise Levels at the Most Affected Receivers, dB $L_{Aeq,15min}$

NCA	Receiver	Day (7am – 6pm)		Night (5am – 7am)			Complies?
		Standard Conditions	Criteria	Standard Conditions	Noise Enhancing Conditions	Criteria	
NCA 1	R35	28	45	12	25	35	✓
NCA 2	R33	25	40	19	28	35	✓
NCA 4	R7	33	40	32	33	35	✓
NCA 5	R4	33	40	31	32	35	✓
NCA 6	R16	27	40	21	29	35	✓

10.1.1.1. Low Frequency Noise

Due to the large distances between source and receivers and increased atmospheric and ground attenuation at high frequencies, the difference between the L_{eq} dB(C) and L_{eq} dB(A) levels from quarry noise sources at sensitive receivers may be greater than 15 dB, indicating the potential for an unbalanced frequency spectrum. To determine whether a low-frequency noise correction applies, assessment is required of noise levels at sensitive receivers against the third-octave band threshold values from 10 Hz to 160 Hz, presented in Table C2 of the NPfI.

At this stage, data with sufficient resolution or frequency range to carry out this assessment is not typically available. Data for quarry noise sources was primarily obtained from the UK Department for Environment Food and Rural Affairs *Update of noise database for prediction of noise on construction and open sites* 2005 & 2006 (DEFRA Database), which provides sound pressure data in octave-bands starting at 63 Hz. Additionally, the ISO 9613 and CONCAWE noise calculation algorithms do not provide methods for modelling sound propagation below the 63 Hz octave-band.

Assessment at this stage was therefore performed as a risk-assessment to indicate the likelihood that a low-frequency noise correction may be required. The predicted octave-band levels at the most potentially affected receivers were interpolated to third-octave bands. The values were then extrapolated down to 10 Hz using the low-frequency spectrum of haul trucks at a distance from Parnell, 2015[1]. Results of the assessment are presented in Table 34 below, and indicate that a low frequency noise correction is not required at any receivers.

Due to the uncertainty associated with assessing low-frequency noise at this stage, it is recommended that a detailed assessment of low frequency noise is conducted as part of the compliance monitoring, as described in Section 11.

Table 34 - Low Frequency Noise Assessment

NCA	Period	Conditions	dB(C) – dB(A) ≥ 15	LF Threshold Exceedance	Correction Required?
NCA 1	Day	Standard	Yes	No	No
	Night	Noise Enhancing	Yes	No	No
NCA 2	Day	Standard	Yes	No	No
	Night	Noise Enhancing	Yes	No	No
NCA 4	Day	Standard	Yes	No	No
	Night	Noise Enhancing	Yes	No	No
NCA 5	Day	Standard	No	No	No
	Night	Noise Enhancing	Yes	No	No
NCA 6	Day	Standard	No	No	No
	Night	Noise Enhancing	Yes	No	No

10.1.1.2. Tonality

The NPfI requires a tonality correction where the level of a third-octave band exceeds the level of the adjacent bands on both sides by a frequency-dependent threshold value. As discussed in Section 10.1.1.1 above, sound source data is not available at this stage in sufficient resolution to carry out a full assessment of tonality.

Quarry sound sources are typically broadband in character, and tonality is not generally an issue at sensitive receivers located adjacent quarries. It is expected that a tonality correction will not be required. However, to

[1] Parnell, J. 2015, *Acoustic Signature of Open Cut Coal Mines*, Acoustics 2015 Hunter Valley.

ensure that tonality is not an issue, it is recommended that an assessment of tonality is conducted as part of the compliance monitoring, as described in Section 11.

10.1.2. Grading Access Roads

Grading for maintenance of the unsealed sections of the main Access Road and the Secondary Access Road is planned to occur a maximum of two days per month during the day period. To reduce noise impacts to the receivers nearest the Secondary Access Road in NCA 5, it is recommended to seal the first 120m of the Secondary Access Road as shown in Appendix C.

Graders along the unsealed portion of both access roads were included in the 3D noise model, with the sound power level of the grader set at 108 dB(A) and octave-band levels as shown in Table 51 of Appendix D. The cumulative noise levels at the most affected sensitive receiver within each NCA due to grader operation on the access roads and Scenario 1 day period operations have been calculated, and are presented in Table 35. Results indicate the noise levels will comply with NPfI daytime trigger levels at all nearby sensitive receivers.

Table 35 - Cumulative Noise Levels with Grading and Scenario 1 Operations

NCA	Receiver	Noise Level, dB $L_{Aeq,15min}$	Criteria, dB $L_{Aeq,15min}$	Complies?
NCA 1	R35	26	40	Yes
NCA 2	R33	28	40	Yes
NCA 4	R7	33	40	Yes
NCA 5	R2	40	40	Yes
NCA 6	R16	34	40	Yes

10.1.3. Maximum Noise Level Assessment

The maximum noise sources with the greatest potential to cause sleep disturbance to nearby sensitive receivers are trucks using the Access Road between 5am and 7am. Maximum sound pressure levels for road trucks are provided in the DEFRA database, with the highest maximum noise level being from an empty road truck. The maximum sound power of the empty road truck was calculated based on this sound pressure level, and is shown in Table 36.

Table 36 - Maximum Sound Power Levels, dB re 10^{-12} W

Equipment	L_{Wmax} dB(A)	Octave Band Centre Frequency (Hz)							
		63	125	250	500	1000	2000	4000	8000
Road Truck (Empty)	111	125	113	109	111	104	99	97	92

The empty road truck L_{Amax} source was included at the worst-case location for each NCA, and the noise model run to calculate the resultant maximum sound pressure levels under noise-enhancing conditions at night at the most affected sensitive receivers. Results show that maximum noise levels generated by Quarry operations are not expected to cause sleep disturbance at any nearby sensitive receivers.

Table 37 - Maximum Noise Levels at the Most Affected Receivers

NCA	Receiver	Noise Level, dB L_{AFmax}	Criteria, dB L_{AFmax}	Further Consideration Required?
NCA 1	R40	27	52	No
NCA 2	R33	25	52	No
NCA 4	R7	40	52	No
NCA 5	R4	40	52	No
NCA 6	R14	31	52	No

10.2. Road Traffic Noise

10.2.1. Main Access Road

The proposed main Access Road for the Quarry intersects with Monaro Highway, and will generate a maximum of 400 road truck movements and 100 concrete agitator truck movements per day. Additionally, up to 40 additional light vehicle movements per day are expected from a development with up to 20 full time employees.

A traffic survey was conducted at Monaro Highway from 27 May 2021 to 9 June 2021, which measured a minimum existing traffic volume of 7,323 vehicles per day. The existing proportion of heavy vehicles along Monaro Highway was measured during peak periods, and averaged 8%. The minimum traffic volume was used in order to provide a conservative assessment from the perspective of relative change. The existing proportion of heavy vehicles used is also conservative, as heavy vehicles are likely to avoid peak hour delays where possible.

The United Kingdom Department of Transport Welsh Office *Calculation of Road Traffic Noise*, 1988 prediction algorithm (CoRTN) was used to calculate the noise level increase due to the additional traffic volumes and the increased proportion of heavy vehicles generated by the Quarry. Results of the assessment are shown below in Table 38, and indicate that the change in noise level will be below the 2 dB relative increase criterion set by the NSW Road Noise Policy. No further consideration of noise due to traffic generated by use of the main Access Road is therefore required.

Table 38 – Noise Level Increase due to Additional Road Traffic from Main Access Road

Road	Existing Traffic Volumes	Existing Heavy Vehicle %	Additional Heavy Vehicles	Additional Light Vehicles	Predicted Noise Level Increase, dB	Relative Increase Criterion, dB	Further Consideration Required?
Monaro Highway	7,323 per day	8%	+ 500 per day	+ 40 per day	+ 1.1	2	No

10.2.2. Secondary Access Road

While no heavy vehicles will use the Secondary Access Road for product transport, light vehicles may use the Secondary Access Road, which will generate additional traffic on local roads. The most potentially affected residence is 7 Mates Drive, with the façade of the residence located approximately 58m from the road at the closest point. As a worst-case scenario, 20 vehicle movements per hour were modelled to represent all employees arriving to site via the Secondary Access Road. As Mates Drive is a cul-de-sac, it was assumed that existing traffic volumes are negligible. Traffic noise levels generated on Mates Drive were calculated using the UK *Calculation of Road Traffic Noise*, 1988 (CoRTN) algorithms. Results are presented in Table 45, and are compared against the RNP criteria applying to the more sensitive "night" period, as workers arrive to site prior to 7am. Results show that noise levels are expected to comfortably comply with the RNP criteria.

Table 39 – Noise Levels due to Traffic on Secondary Access Road

Receiver	Additional Light Vehicles	Predicted Noise Level, $L_{eq,1hr}$ dB(A)	Night Criteria (10pm – 7am), $L_{eq,1hr}$ dB(A)	Complies?
7 Mates Drive	+ 20 per hour	41	50	Yes

10.3. Voluntary Land Acquisition and Mitigation Policy

Sections 10.1, 10.2, and 12 address VLAMP requirements to assess noise impacts to nearby sensitive receivers with respect to the NSW EPA *Noise Policy for Industry* 2017, the NSW DECC *Road Noise Policy* 2011, and the NSW DECC *Interim Construction Noise Guideline* 2009. Assessment showed that with noise mitigation measures implemented per Section 11, operational noise impacts will comply with NPfI trigger levels, and therefore voluntary mitigation rights and voluntary land acquisition rights will not apply at nearby sensitive receivers.

In addition to assessment of noise impacts at nearby sensitive receivers, VLAMP also applies voluntary land acquisition rights where the noise generated by the development would contribute to exceedances of Noise Policy for Industry amenity noise levels plus 5 dB(A) on more than 25% of any privately-owned land where a dwelling could be built under existing planning controls.

The nearest potentially affected privately-owned land is the undeveloped lot located at Lot 151, DP754912, 223A Alderson Place, Tralee, which does not have any existing dwellings. Under the planning controls of the *Queanbeyan-Palerang Regional Local Environmental Plan* 2022, development of a dwelling is not prohibited on land zoned C2 – Environmental Conservation. An assessment of the proportion of land exceeding the VLAMP criteria has therefore been conducted based on the noise contours shown in Appendix B, and is presented in Table 40. Results of the assessment show that noise from operation of the Quarry will not exceed amenity noise levels plus 5 dB(A) on more than 25% of the lot at any time. It is therefore not expected that voluntary land acquisition rights will apply at this lot.

Table 40 - VLAMP Assessment at Lot 151, DP754912, 223A Alderson Place, Tralee

Scenario	Period	Amenity Level, dB(A)	Criteria, Amenity Level + 5 dB(A)	Proportion of Land Exceeding Criteria	VLAMP Threshold	Voluntary Land Acquisition Rights Triggered?
Scenario 1	Day	50	55	10%	25%	No
	Night (noise enhancing)	40	45	1%	25%	No
Scenario 2	Day	50	55	11%	25%	No
	Night (noise enhancing)	40	45	<1%	25%	No

10.4. Noise Levels at R1

Noise levels at R1 are not required to comply with the criteria for sensitive receivers, as it is located on land owned by the proponent of the quarry and is not a sensitive receiver. Nonetheless, noise levels at R1 for each scenario have been calculated for informative purposes, and are presented in Table 41 below.

Table 41 - Noise Levels at R1

Scenario	Metric	Day (7am – 6pm)	Night (5am – 7am)	
		Standard Conditions	Standard Conditions	Noise Enhancing Conditions
Scenario 1	$L_{Aeq,15min}$ dB	39	35	37
Scenario 2	$L_{Aeq,15min}$ dB	36	35	36
Grading & Scenario 1	$L_{Aeq,15min}$ dB	41	-	-
Maximum Noise Levels	L_{Amax} dB	-	-	44

11. Operational Noise Mitigation and Management

To minimise operational noise impacts from Monaro Rock Quarry to sensitive receivers, the following mitigation and management measures are recommended.

11.1. Acoustic Barrier

To mitigate noise transmission from truck movements on the Access Road to sensitive receivers within NCA 4, it is proposed that a 3.0m high acoustic barrier be installed along the sealed section of the Access Road on the side closest to NCA 4. The acoustic barrier is to be installed to the extent shown in Appendix C, and is to meet the following requirements:

- Acoustic barrier may be constructed using lapped timber paling, fibre cement sheeting, lightweight aerated concrete, transparent acrylic panels, glass or profiled sheet cladding, as long as the selected material/s have a surface density of at least 12 kg/m^2.
- The barrier shall have no gaps or holes in it, or the likelihood of such occurring through natural causes or deformations, thus allowing noise to pass through.
- Where an opening in the barrier is required to allow movement of fauna, overlapping barriers shall be used to maintain acoustic performance. The overlap shall be at least 3-4 times the width of the opening (see Appendix H).
- It is preferable that the selected cladding is prefabricated to be jointed with an overlap or rebated joint (e.g., ship lapped).
- Where the above requirement cannot be met, any butt joints shall be sealed with a suitable weatherproof mastic or an overlapping piece of material meeting the mass requirement of 12 kg/m^2 (minimum 35mm each side of the butt joint).
- Where acoustic timber palings are installed, all palings should overlap by a minimum of 35mm.
- Where multiple cladding layers are used (e.g., FC sheeting over timber paling screen), joints in the cladding materials shall not coincide.

11.2. Quarry Operation

Quarry equipment and operation shall be consistent with the following parameters of this assessment:

- The sound power levels of equipment generating significant noise shall not exceed the overall sound power levels set out in Table 51 in Appendix D. To this end:
  - Internal roads shall be well-maintained to minimise body noise from empty trucks.
  - All vehicles, plant, and equipment shall be regularly maintained and serviced in accordance with the manufacturer's specifications.
  - Reversing alarms fitted to quarry equipment shall be broadband instead of tonal (beeper) alarms.
- The hours of operation of the quarry are to be per Table 7.

11.3. Compliance Noise Monitoring

Compliance noise monitoring shall be conducted at the most potentially affected sensitive receivers, in accordance with the following recommendations:

- Initial noise monitoring shall be conducted following commencement of each stage of operations, after which monitoring shall be conducted at least once per year.
- Annual noise monitoring shall be conducted during the autumn or winter months, where noise-enhancing conditions are more frequent.
- The noise monitoring duration shall be at least 7 days.

- Attended noise measurements may be used to supplement unattended monitoring results. The quarry equipment operating during each attended noise measurement shall be recorded.
- The monitoring locations shall be at the potentially most affected sensitive receivers, or at suitable alternative locations where the receiver does not grant permission for placement of the monitor. At a minimum, monitoring locations at R7 (NCA 4), R4 (NCA 5), and R33 (NCA 2) shall be selected. Supplementary monitoring or measurements may be carried out at R35 (NCA 1) and R16 (NCA 6).
- If permission is not granted for placement of the noise monitor within the receiver's property, an alternative location which provides noise levels representative of the levels at the receiver may be selected. If required, noise modelling may be used to calculate noise levels at the receiver based on the levels measured at the alternative location.
- The noise monitor shall be configured to capture L_{eq} noise levels in third-octave bands with a frequency range of at least 10 Hz to 10 kHz, as required for assessment of low-frequency noise and tonality in accordance with Fact Sheet C of the NPfI.
- Monitoring shall comply with the relevant legislation and guidelines in each State, including:
  - NSW EPA *Noise Policy for Industry* 2017
  - NSW EPA *Approved methods for the measurement and analysis of environmental noise in NSW*
  - ACT EPA *Noise Environment Protection Policy* 2010
  - ACT EPA *Noise Measurement Manual* 2024

12. Construction Noise Assessment

Construction operations at the Quarry site are planned to occur within standard construction hours during the day period. It is anticipated that site establishment and construction will take approximately 6 months, with the widening of the Secondary Access Road occurring in Month 1, the construction of the main Access Road in Months 2-4, and site establishment works for the Extraction Area, Processing Area, and Visibility Barrier occurring in Months 1-6.

It is anticipated that construction of the Access Road barrier will occur in Months 2-4, and that construction of the Stage V1 Visibility Barrier will occur in Month 5. It is understood that transport of saleable product will commence after the Access Road is complete, upon which the NPfI operational noise criteria in Table 14 will apply. It is considered that the Scenario 1 operational noise assessment (Table 32) is representative of site establishment works occurring in Months 5-6, and therefore compliance with NPfI criteria is expected for works in Months 5-6 following completion of the Access Road.

As a worst-case, cumulative construction noise from site establishment works and access road construction has been assessed under two construction scenarios:

- Month 1: Construction of the Secondary Access Road, in conjunction with site establishment works for the Extraction Area and Processing Area, and Visibility Barrier.
- Month 2-4: Construction of the main Access Road, in conjunction with site establishment works for the Extraction Area, Processing Area, and Visibility Barrier.

The equipment previously modelled for Scenario 1 operational noise (Table 31) was adopted as a conservative representation of site establishment works occurring during the construction stages. The Scenario 1 operational noise model was modified to exclude the visibility barrier, and was run to calculate noise levels at the most affected receivers within each NCA due to site establishment works.

Typical sound power levels of construction equipment which it is expected may be used for the access road construction works were obtained from Table A1 in Appendix A of Australian Standard AS 2436 *Guide to Noise and Vibration Control on Construction, Demolition, and Maintenance Sites* (Table 42). Note that these are sound power levels for generic construction equipment, which may differ from the sound power levels for the specific equipment used in quarry operation.

Table 42 – Typical Sound Power Levels of Construction Equipment

Plant description	Sound Power re 10^{-12} W	Sound pressure at 10m, dB(A)
Asphalt paver	108	80
Bulldozer	108	80
Excavator	107	79
Front end loader	113	85
Grader	110	82
Hand tools (electric)	102	74
Rock breaker	118	90
Roller (vibratory)	108	80
Spreader	95	67
Truck (>20 tonne)	107	79
Truck (dump)	117	89

Sound transmission from the access road works to each NCA was calculated based on distance attenuation at the minimum possible, average, and maximum working distances from each NCA. The location of the access road construction works at the minimum assumed working distances for each construction scenario are shown in Appendix J. It is noted that this is a conservative methodology, as:

- Attenuation effects such as air absorption and barrier attenuation due to topography or built form are not included.
- All equipment is assumed to operate continuously and concurrently. In practice, construction equipment will typically operate intermittently, and it is unlikely all equipment will be operating at once.

Results are shown in Table 43 and Table 44, and indicate that total construction noise levels will remain below the Highly Noise Affected Level at all nearby sensitive receivers for construction at any location along the access roads. Additionally, the use of most construction equipment will not exceed the noise affected level at average distances from sensitive receivers.

Total noise levels from construction on the Secondary Access Road were calculated to exceed the noise affected level at sensitive receivers within NCA 5 at average distances, and NCA 6 at the minimum distance. Total noise levels from construction of the main Access Road were calculated to exceed the noise affected level within NCA 4 and NCA 5 at average distances, and NCA 6 at the minimum distance. It is therefore recommended that feasible and reasonable construction noise mitigation and management practices are adopted for the works, as presented in Section 13 and Appendix I:.

Table 43 - Month 1: Noise Levels due to Construction of Secondary Access Road and Site Establishment Works, dB(A)

NCA	NCA 1			NCA 2			NCA 4			NCA 5			NCA 6		
Equipment	**Min (2500m)**	**Avg (3600m)**	**Max (4600m)**	**Min (2000m)**	**Avg (2700m)**	**Max (3400m)**	**Min (1350m)**	**Avg (1700m)**	**Max (2100m)**	**Min (70m)**	**Avg (1000m)**	**Max (1900m)**	**Min (600m)**	**Avg (1500m)**	**Max (2300m)**
Asphalt paver	29	26	24	31	28	26	34	32	31	60	36	31	41	33	30
Bulldozer	29	26	24	31	28	26	34	32	31	60	37	31	41	33	30
Excavator	28	25	23	30	27	25	33	31	30	59	36	30	40	32	29
Front end loader	34	31	29	36	33	31	39	37	36	65	42	36	46	38	35
Grader	31	28	26	33	30	28	36	34	33	62	39	33	43	35	32
Hand tools (electric)	23	20	18	25	22	20	28	26	25	54	31	25	35	27	24
Roller (vibratory)	29	26	24	31	28	26	34	32	31	60	37	31	41	33	30
Spreader	16	13	11	18	15	13	21	19	18	47	24	18	28	20	17
Truck (>20 tonne)	28	25	23	30	27	25	33	31	30	59	36	30	40	32	29
Secondary Access Road Construction Total	39	36	34	41	38	36	44	42	40	70	46	41	51	43	40
Site Establishment Works		26			28			33			37			35	
Total (Secondary Access Road Construction and Site Establishment Works)	**39**	**36**	**34**	**41**	**39**	**37**	**45**	**43**	**41**	**70**	**47**	**43**	**51**	**44**	**41**
Noise affected level (Day)	48			45			45			45			45		
Highly noise affected level	75			75			75			75			75		

Table 44 – Month 2-4: Noise Levels due to Construction of Main Access Road and Site Establishment Works, dB(A)

NCA	NCA 1			NCA 2			NCA 4			NCA 5			NCA 6		
Equipment	**Min (1700m)**	**Avg (2900m)**	**Max (4000m)**	**Min (2700m)**	**Avg (4100m)**	**Max (5500m)**	**Min (350m)**	**Avg (1000m)**	**Max (1700m)**	**Min (550m)**	**Avg (1400m)**	**Max (2200m)**	**Min (1600m)**	**Avg (3000m)**	**Max (4400m)**
Asphalt paver	32	28	25	28	25	22	46	37	32	42	34	30	33	27	24
Bulldozer	32	28	25	28	25	22	46	37	32	42	34	30	33	27	24
Excavator	31	27	24	27	24	21	45	36	31	41	33	29	32	26	23
Front end loader	37	33	30	33	30	27	51	42	37	47	39	35	38	32	29
Grader	34	30	27	30	27	24	48	39	34	44	36	32	35	29	26
Hand tools (electric)	26	22	19	22	19	16	40	31	26	36	28	24	27	21	18
Rock breaker	42	38	35	38	35	32	56	47	42	52	44	40	43	37	34
Roller (vibratory)	32	28	25	28	25	22	46	37	32	42	34	30	33	27	24
Spreader	19	15	12	15	12	9	33	24	19	29	21	17	20	14	11
Truck (>20 tonne)	31	27	24	27	24	21	45	36	31	41	33	29	32	26	23
Truck (dump)	41	37	34	37	34	31	55	46	41	51	43	39	42	36	33
Main Access Road Construction Total	47	42	39	43	39	37	61	51	47	57	48	45	47	42	39
Site Establishment Works		26			28			33			37			35	
Total (Main Access Road Construction and Site Establishment Works)	**47**	**42**	**40**	**43**	**39**	**37**	**61**	**51**	**47**	**57**	**49**	**45**	**48**	**43**	**40**
Noise affected level (Day)		48			45			45			45			45	
Highly noise affected level		75			75			75			75			75	

12.1. Construction Traffic

Prior to construction of the main Access Road, construction vehicles will utilise the Secondary Access Road for transport of mobile equipment and construction materials. This will generate additional road traffic on local roads, including Mates Drive, Monaro Station Road, and Old Cooma Road. The most potentially affected residence is 7 Mates Drive, with the façade of the residence located approximately 58m from the road at the closest point. Traffic noise levels generated by construction traffic have been calculated using the UK *Calculation of Road Traffic Noise*, 1988 (CoRTN) algorithms, based on the maximum expected hourly traffic volumes provided by the Client. As Mates Drive is a cul-de-sac, it was assumed that existing traffic volumes are negligible. Results are presented in Table 45, and are compared against the RNP criteria applying to the more sensitive "night" period, as workers arrive to site for a 7am start. Results show that noise levels are expected to comfortably comply with the RNP criteria.

Table 45 - Construction Traffic on Secondary Access Road

Receiver	Additional Heavy Vehicles	Additional Light Vehicles	Predicted Noise Level, $L_{eq,1hr}$ dB(A)	Night Criteria (10pm – 7am), $L_{eq,1hr}$ dB(A)	Complies?
7 Mates Drive	+ 2 per hour	+ 20 per hour	42	50	Yes

13. Construction Noise Mitigation & Management

Construction noise impacts may exceed the noise affected level where construction of the access roads approaches sensitive receivers, and consequently, all feasible and reasonable noise mitigation and management measures should be applied to minimise noise. Noise level emissions and potential annoyance depend significantly on the condition of the equipment, the type of operation, its duration and the time of day it is conducted. The following specific mitigation and management measures are recommended to be implemented where feasible and reasonable to minimise construction noise impacts:

- Where practical, stage construction of the acoustic barrier so that it can act as a barrier to noise generated by construction of the main access road. This is expected to provide approximately a 5 dB(A) noise reduction where works are carried out behind the barrier.
- Prioritise using low power equipment where available and practical. A noise reduction of approximately 5 dB(A) may be expected where a low power model is used instead of a typical model.
- Fit all equipment with "residential grade" exhaust silencers. This is expected to provide a 5-10 dB(A) reduction in exhaust noise emissions compared to a standard "industrial grade" silencer.
- Regularly inspect and maintain equipment to ensure it is in good working order and is not generating excessive noise. This will ensure equipment noise levels do not materially exceed the noise levels set out in Table 42, and that equipment does not generate excessive tonal noise.
- Minimise use of engine brakes where safe to do so, and ensure there are no extended periods of unnecessary engine idling. This will minimise the number of maximum noise events due to engine braking, and reduce average noise levels generated by engines.
- Locate laydown areas as far as practical away from sensitive receivers. This will minimise noise from construction vehicles travelling and materials handling.
- Use broadband (non-tonal) background-adjusting reversing alarms. This will minimise the degree to which reversing alarms are audible above ambient background levels at sensitive receivers.
- Conduct community consultation and provide notification for potentially affected residences, and provide a dedicated contact phone number for enquiries or complaints.

In addition to the above specific measures, details of best-practice construction noise and vibration mitigation and management measures are provided in Appendix I, and are to be implemented where feasible and reasonable.

14. Vibration Assessment

The Transport for NSW *Construction Noise and Vibration Strategy* (V4.1 2019) sets out recommended minimum working distances for vibration intensive plant from sensitive receivers. The largest source of vibration provided is a large vibratory roller, for which the minimum working distance is 100m for compliance with human comfort criteria. It is noted that typical sources of vibration during operation (hammer drill rig operation and truck movements on the Access Road) generate lower vibration levels than a large vibratory roller.

The nearest sensitive receivers are all greater than 100m from vibration sources associated with equipment used during quarry construction and operation, with the exception of the nearest dwelling at R2, which is approximately 92m from the limit of disturbance at the Secondary Access Road.

Further assessment of potential vibration impacts to the dwelling at R2 was conducted based on vibration levels generated by a vibratory roller working at the nearest point on the Secondary Access Road. Results indicate that compliance with human comfort and cosmetic building damage criteria is expected to be achieved for both steady-state and start-up and run-down operating conditions of a typical vibratory roller.

Table 46 - Assessment of Vibration Impacts to R2

Plant Description	Operating Condition	Typical Peak Particle Velocity at 7.6m (mm/s)[1]	Peak Particle Velocity at Receiver (mm/s)[2]	Human Comfort Criteria (Day), mm/s PPV	Cosmetic Building Damage Criteria, mm/s PPV	Complies with Both?
Vibratory roller	Steady state	5.3	0.13	0.28	15	Yes
	Start-up and run-down	5.3	0.21	0.28	15	Yes

Note:

1. *Via US FTA Transit Noise and Vibration Impact Assessment Manual, 2018.*
2. *Vibration attenuation during steady state operation of the vibratory roller was calculated according to Transport Research Laboratory Report 429 Groundborne vibration caused by mechanised construction works, 2000 as* $v = v_{7.6m}(7.6/d)^{1.5}$ *for steady state operation and* $v = v_{7.6m}(7.6/d)^{1.3}$ *for start-up and run-down.*

It is therefore expected that vibration impacts due to construction and operation of the quarry will comply with human comfort and cosmetic building damage criteria at all nearby sensitive receivers.

15. Blasting Assessment

15.1. Vibration

Australian Standard AS 2187.2:2006 *Explosives – Storage and use, Part 2: Use of explosives* Appendix J Equation J7.3(1) provides a method for calculation of ground vibration levels due to blasting. Typical ground vibration levels due to blasting within the Extraction Area were calculated at the most affected sensitive receiver within each NCA according to standard, using the largest planned Maximum Instantaneous Charge mass (MIC) of 126 kg.

AS 2187.2 states that due to variations in ground conditions and other factors, the resulting ground vibration levels can vary from two-fifths to four times the typical values. This range of potential vibration levels was calculated, with results presented in Table 47 below and compared against the criteria for human comfort. Results indicate that the worst-case ground vibration will comfortably comply with the established criteria at all potentially affected sensitive receivers.

Table 47 - Blast Vibration Impacts at Closest Receivers – Human Comfort Assessment

NCA	Receiver	Distance (m)	Typical Vibration[1] (PPV mm/s)	Vibration Range (PPV mm/s)	Criteria (PPV mm/s)	Complies?
NCA 1	R35	1750	0.35	0.14 - 1.41	5	Yes
NCA 2	R34	2250	0.24	0.09 - 0.95	5	Yes
NCA 4	R7	1500	0.45	0.18 - 1.81	5	Yes
NCA 5	R4	1200	0.65	0.26 - 2.59	5	Yes
NCA 6	R14	1900	0.31	0.12 - 1.24	5	Yes

Note: 1. Site constant K_g = 1140 and site exponent B = 1.6 were used, which are provided by AS 2187 as typical for free face average conditions.

While blast vibration levels are not required to comply at R1 as it is not a sensitive receiver and is owned by the proponent of the quarry, blast vibration levels have been calculated at this receiver for informative purposes. The typical vibration levels at R1 were calculated to be 0.94 mm/s PPV, with a range of potential vibration from 0.38 – 3.76 mm/s PPV, which complies with the 5 mm/s human comfort criteria.

15.2. Airblast

AS 2187.2 Appendix J also provides a calculation method for airblast overpressure. It states that for confined blasthole charges, the site constant (K_a) is commonly in the range of 10 to 100, with a site exponent (a) of -1.45. The airblast peak pressure levels were calculated for the upper and lower values of the site constant range, with a MIC of 126 kg. Results indicated that blasts at the upper site constant would exceed human comfort criteria at sensitive receivers, and so a more detailed assessment is appropriate.

The Terrock model (summarised in Richards & Moore 2006, *Airblast Control Techniques in Open Cut Mines*, International Society of Explosives Engineers) was used to conduct a detailed assessment of airblast overpressure. The Terrock model allows for specific blast parameters to be included in the calculation, including stem height, face burden, and hole diameter. These parameters were provided by the blast engineer, and are detailed in Table 48 for the largest planned MIC. To calculate airblast overpressure levels at the nearest sensitive receivers, the recommended site exponent from AS 2187.2 was used to model the attenuation rate of the airblast.

Table 48 – Terrock Model Parameters for Largest MIC

Parameter	Receiver Location	Value
Site constant[1], k_b	Front of face	250
Site constant[2], k_s	Behind face	180
Charge mass per delay, m		126 kg
Blast hole diameter		102 mm
Face burden		3300 mm
Stem height		3200 mm
Site exponent, a		-1.45

Note:

1. *The highest airblast in front of the face is produced by burden-controlled blasts. The site constant k_b applies to burden-controlled blasts, which typically ranges from 150-250 (Richards & Moore 2006). The upper value of 250 was adopted to provide a conservative assessment.*
2. *The highest airblast produced behind the face is produced by stem-controlled blasts. The site constant k_s applies to stem-controlled blasts, which typically ranges from 80-180 (Richards & Moore 2006). The upper value of 180 was adopted to provide a conservative assessment.*

Airblast overpressure levels were calculated at the closest receivers for both the front of face and behind face conditions. It is noted that this assessment is conservative, as:

- The upper site constant was adopted for both front of face and behind face conditions.
- The distance assessed is the closest distance from the receiver to the extraction area, at which point the receiver would be located behind the quarry face.

The results of this assessment (presented in Table 49 below) indicate that airblast overpressure levels will comply with human comfort criteria for both the front of face and behind face conditions at all sensitive receivers. As compliance is predicted with the more stringent human comfort criteria, it is implicit that airblast levels will comfortably comply with the applicable building damage criteria.

Table 49 – Airblast Impacts at Closest Receivers – Human Comfort Assessment

NCA	Receiver	Distance (m)	Peak Pressure Level (dBL)		Criteria (dBL)	Complies?
			Front of Face	Behind Face		
NCA 1	R35	1750	111	101	115	Yes
NCA 2	R34	2250	107	98	115	Yes
NCA 4	R7	1500	113	103	115	Yes
NCA 5	R4	1200	115	106	115	Yes
NCA 6	R14	1900	110	100	115	Yes

While R1 is not a sensitive receiver, airblast levels have been calculated at this location for informative purposes. At a distance of 950m from the blast, peak pressure levels at R1 were calculated to be 118 dBL in front of the face, and 109 dBL behind the face. The predicted peak pressure level in front of the quarry face marginally exceeds the human comfort criteria, but comfortably complies with the building damage criteria.

15.3. ANZEC Blast Guidelines

Results of the assessment above indicate that ground vibration and airblast overpressure due to quarry blasting operations will comply with the ANZEC Blast Guidelines. The hours of operation and frequency of the proposed blasting operations set out in Section 3.2 are in accordance with the recommendations of the ANZEC Blast Guidelines.

16. Assessment Summary

A summary of the assessments undertaken, results, and recommendations is provided in Table 50 below.

Table 50 - Assessment Summary

Section	Assessment	Results	Recommendations
10.1	Operational Noise On-Site	Compliance with NSW NPfI trigger levels and ACT NEPP noise limits during all periods.	Noise mitigation and management measures are implemented as detailed in Section 11, which include an acoustic barrier along the Access Road, maximum sound power levels of equipment, standard operation times, and compliance noise monitoring.
10.2	Road Traffic Noise	The increase in road traffic noise on Monaro Highway due to the Access Road is below the relative increase criterion of the NSW RNP. The calculated noise levels due to the Secondary Access Road are below the RNP criteria.	No additional mitigation is required.
10.3	VLAMP	Voluntary mitigation rights and voluntary land acquisition rights will not apply to nearby land.	The recommendations for industrial noise control are implemented per Section 11.
12	Construction Noise	Noise from all construction operations will not exceed the Highly Noise Affected Level. Noise from site establishment operations will not exceed the Noise Affected Levels. Noise from access road works may exceed the ICNG Noise Affected Levels at some sensitive receivers.	Feasible and reasonable noise management practices are implemented as outlined in Section 13 and Appendix I.
12.1	Construction Traffic Noise	The calculated noise levels due to the Secondary Access Road are below the RNP criteria.	No additional mitigation is required.
14	Vibration	Vibration levels from construction and operation will be below human comfort and cosmetic building damage criteria at all nearby sensitive receivers.	No additional mitigation is required.
15	Blasting	Ground vibration and airblast overpressure due to blasting will comply with human comfort and building damage criteria at all nearby sensitive receivers.	No additional mitigation is required.

17. Conclusion

Octave Acoustics was engaged by RW Corkery to carry out a detailed noise and vibration impact assessment for Monaro Rock Quarry to address the Secretary's Environmental Assessment Requirements for noise and vibration generated during construction and operation of the Quarry.

Detailed noise surveys were undertaken at five locations proximate to the nearest sensitive receivers. The applicable criteria for assessment of noise impacts to sensitive receivers located within NSW and the ACT was established based on the results of the noise surveys. Noise Catchment Areas of similar sensitive receivers were established, and noise impacts to the most affected sensitive receiver within each catchment area were assessed with respect to the relevant criteria.

Assessment of operational noise generated by the Quarry operations indicated that with the mitigation measures outlined in Section 11, compliance would be achieved with NSW *Noise Policy for Industry* trigger levels and ACT EPA *Noise Environment Protection Policy* noise limits during all periods. Additionally, noise generated by additional traffic on Monaro Highway and Mates Drive from use of the main Access Road and Secondary Access Road were calculated to remain below the criteria of the NSW *Road Noise Policy*. As compliance is predicted with NPfI trigger levels and VLAMP requirements, the Quarry will not trigger voluntary land acquisition and mitigation rights.

Results of the assessment of construction noise impacts showed that construction of the main Access Road and widening of the Secondary Access Road had the potential to exceed Noise Affected Levels at the nearest sensitive receivers. It is recommended that feasible and reasonable measures are employed to minimise construction noise impacts during these works, as outlined in Section 13 and Appendix I. Assessment of noise generated by construction traffic on local roads indicated compliance with the NSW *Road Noise Policy* criteria.

Assessment of potential vibration impacts during construction and operation of the Quarry indicated compliance with human comfort and cosmetic building damage criteria at all nearby sensitive receivers.

Ground vibration and airblast overpressure due to blasting operations were assessed with respect to the criteria for human comfort and building damage set out in the ANZEC Blast Guidelines and AS 2187. Results of the assessment of ground vibration indicated that worst-case vibration levels will comfortably comply with the established criteria at all nearby sensitive receivers. Assessment of airblast overpressure showed compliance with human comfort criteria, and comfortable compliance with building damage criteria.

Potential noise and vibration impacts associated with construction and operation of the proposed Quarry have been assessed in accordance with the requirements of the SEARs. Overall, noise and vibration impacts from the operation of the Quarry are predicted to comply with the requirements of the SEARs at all nearby sensitive receivers. Noise impacts from construction activities have the potential to exceed noise affected levels at some sensitive receivers, and should be managed by employing suitable construction noise management practices.

Appendix A: Glossary of Terms

'A' Frequency Weighting

The 'A' frequency weighting roughly approximates to the Fletcher-Munson 40 phon equal loudness contour. The human loudness perception at various frequencies and sound pressure levels is equated to the level of 40 dB at 1 kHz. The human ear is less sensitive to low frequency sound and very high frequency sound than midrange frequency sound (i.e. 500 Hz to 6 kHz). Humans are most sensitive to midrange frequency sounds, such as a child's scream. Sound level meters have inbuilt frequency weighting networks that very roughly approximates the human loudness response at low sound levels. It should be noted that the human loudness response is not the same as the human annoyance response to sound. Here low frequency sounds can be more annoying than midrange frequency sounds even at very low loudness levels. The 'A' weighting is the most commonly used frequency weighting for occupational and environmental noise assessments. However, for environmental noise assessments, adjustments for the character of the sound will often be required.

AMBIENT NOISE

The ambient noise level at a particular location is the overall environmental noise level caused by all noise sources in the area, both near and far, including all forms of traffic, industry, lawnmowers, wind in foliage, insects, animals, etc. Usually assessed as an energy average over a set time period 'T' (LAeq,T).

AUDIBLE

Audible refers to a sound that can be heard. There are a range of audibility grades, varying from "barely audible", "just audible" to "clearly audible" and "prominent".

BACKGROUND NOISE LEVEL

Total silence does not exist in the natural or built-environments, only varying degrees of noise. The Background Noise Level is the minimum repeatable level of noise measured in the absence of the noise under investigation and any other short-term noises such as those caused by all forms of traffic, industry, lawnmowers, wind in foliage, insects, animals, etc. It is quantified by the noise level that is exceeded for 90 % of the measurement period 'T' (LA90,T). Background Noise Levels are often determined for the day, evening and night time periods where relevant. This is done by statistically analysing the range of time period (typically 15 minute) measurements over multiple days (often 7 days). For a 15-minute measurement period the Background Noise Level is set at the quietest level that occurs at 1.5 minutes.

'C' FREQUENCY WEIGHTING

The 'C' frequency weighting approximates the 100 phon equal loudness contour. The human ear frequency response is more linear at high sound levels and the 100 phon equal loudness contour attempts to represent this at various frequencies at sound levels of approximately 100 dB.

DECIBEL

The decibel (dB) is a logarithmic scale that allows a wide range of values to be compressed into a more comprehensible range, typically 0 dB to 120 dB. The decibel is ten times the logarithm of the ratio of any two quantities that relate to the flow of energy (i.e. power). When used in acoustics it is the ratio of the square of the sound pressure level to a reference sound pressure level, the ratio of the sound power level to a reference sound power level, or the ratio of the sound intensity level to a reference sound intensity level. See also Sound Pressure Level and Sound Power Level. Noise levels in decibels cannot be added arithmetically since they are logarithmic numbers. If one machine is generating a noise level of 50 dB, and another similar machine is placed beside it, the level will increase to 53 dB (from 10 $\log_{10}(10^{(50/10)} + 10^{(50/10)})$ and not 100 dB. In theory, ten similar machines placed side by side will increase the sound level by 10 dB, and one hundred machines increase the sound level by 20 dB. The human ear has a vast sound-sensitivity range of over a thousand billion to one, so the logarithmic decibel scale is useful for acoustical assessments.

dBA – See 'A' frequency weighting

dBC – See 'C' frequency weighting

EQUIVALENT CONTINUOUS SOUND LEVEL, LAeq

Many sounds, such as road traffic noise or construction noise, vary repeatedly in level over a period of time. More sophisticated sound level meters have an integrating/averaging electronic device inbuilt, which will display the energy time-average (equivalent continuous sound level - LAeq) of the 'A' frequency weighted sound pressure level. Because the decibel scale is a logarithmic ratio, the higher noise levels have far more sound energy, and therefore the LAeq level tends to indicate an average which is strongly influenced by short-term, high level noise events. Many studies show that

human reaction to level-varying sounds tends to relate closer to the LAeq noise level than any other descriptor.

'F'(FAST) TIME WEIGHTING

Sound level meter design-goal time constant which is 0.125 seconds.

FREE FIELD

In acoustics a free field is a measurement area not subject to significant reflection of acoustical energy. A free field measurement is typically not closer than 3.5 metres to any large flat object (other than the ground) such as a fence or wall or inside an anechoic chamber.

FREQUENCY

The number of oscillations or cycles of a wave motion per unit time, the SI unit is the hertz (Hz). 1 Hz is equivalent to one cycle per second. 1000 Hz is 1 kHz.

LOUDNESS

The volume to which a sound is audible to a listener is a subjective term referred to as loudness. Humans generally perceive an approximate doubling of loudness when the sound level increases by about 10 dB and an approximate halving of loudness when the sound level decreases by about 10 dB.

MAXIMUM NOISE LEVEL, LAFmax

The root-mean-square (rms) maximum sound pressure level measured with sound level meter using the 'A' frequency weighting and the 'F' (Fast) time weighting. Often used for noise assessments other than aircraft.

MAXIMUM NOISE LEVEL, LASmax

The root-mean-square (rms) maximum sound pressure level measured with sound level meter using the 'A' frequency weighting and the 'S' (Slow) time weighting. Often used for aircraft noise assessments.

NOISE

Noise is unwanted, harmful or inharmonious (discordant) sound. Sound is wave motion within matter, be it gaseous, liquid or solid. Noise usually includes vibration as well as sound.

OFFENSIVE NOISE

Reference: Dictionary of the NSW Protection of the Environment Operations Act 1997).

"Offensive Noise means noise:

(a) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:

(i) is harmful to (or likely to be harmful to) a person who is outside the premise from which it is emitted, or

(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or

(b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances prescribed by the regulations."

'S' (SLOW) TIME WEIGHTING

Sound level meter design-goal time constant which is 1 second.

SOUND ATTENUATION

A reduction of sound due to distance, enclosure or some other devise. If an enclosure is placed around a machine, or an attenuator (muffler or silencer) is fitted to a duct, the noise emission is reduced or attenuated. An enclosure that attenuates the noise level by 20 dB reduces the sound energy by one hundred times.

SOUND EXPOSURE LEVEL (LAE)

Integration (summation) rather than an average of the sound energy over a set time period. Use to assess single noise events such as truck or train pass by or aircraft flyovers. The sound exposure level is related to the energy average (LAeq,T) by the formula $LAeq,T = LAE - 10 \log_{10} T$. The abbreviation (SEL) is sometimes inconsistently used in place of the symbol (LAE).

SOUND PRESSURE

The rms sound pressure measured in pascals (Pa). A pascal is a unit equivalent to a newton per square metre (N/m^2).

SOUND PRESSURE LEVEL, Lp

The level of sound measured on a sound level meter and expressed in decibels (dB). Where $LP = 10 \log_{10}(Pa/Po)^2$ dB (or $20 \log_{10}$ (Pa/ Po) dB) where Pa is the rms sound pressure in Pascal and Po is a reference sound pressure conventionally chosen is 20 µPa (20×10^{-6} Pa) for airborne sound. Lp varies with distance from a noise source.

SOUND POWER

The rms sound power measured in watts (W). The watt is a unit defined as one joule per second. A

measures the rate of energy flow, conversion or transfer.

SOUND POWER LEVEL, Lw

The sound power level of a noise source is the inherent noise of the device. Therefore, sound power level does not vary with distance from the noise source or with a different acoustic environment. Lw = Lp + 10 $\log_{10}$ 'a' dB,

re: 1pW, (10^{-12} watts) where 'a' is the measurement noise-emission area (m2) in a free field.

SOUND TRANSMISSION LOSS

The amount in decibels by which a random sound is reduced as it passes through a sound barrier. A method for the measurement of airborne Sound Transmission Loss of a building partition is given in Australian Standard AS1191 - 2002.

STATISTICAL NOISE LEVELS, Ln

Noise which varies in level over a specific period of time 'T' (standard measurement times are often 15-minute periods) may be quantified in terms of various statistical descriptors with some common examples:

The noise level, in decibels, exceeded for 1% of the measurement time period, when 'A' frequency weighted and 'F' time weighted is reference to as LAF1,T. This may be used for describing short-term noise levels such as could cause sleep arousal during the night.

The noise level, in decibels, exceeded for 10% of the measurement time period, when 'A' frequency weighted and 'F' time weighted is reference to as LAF10,T. In most countries the LAF10,T is measured over periods of 15 minutes, and is used to describe the average maximum noise level.

The noise level, in decibels, exceeded for 90% of the measurement time period, when 'A' frequency weighted and 'F' time weighted is reference to as LAF90,T. In most countries the LAF90,T is measured over periods of 15 minutes, and is used to describe the average minimum or background noise level.

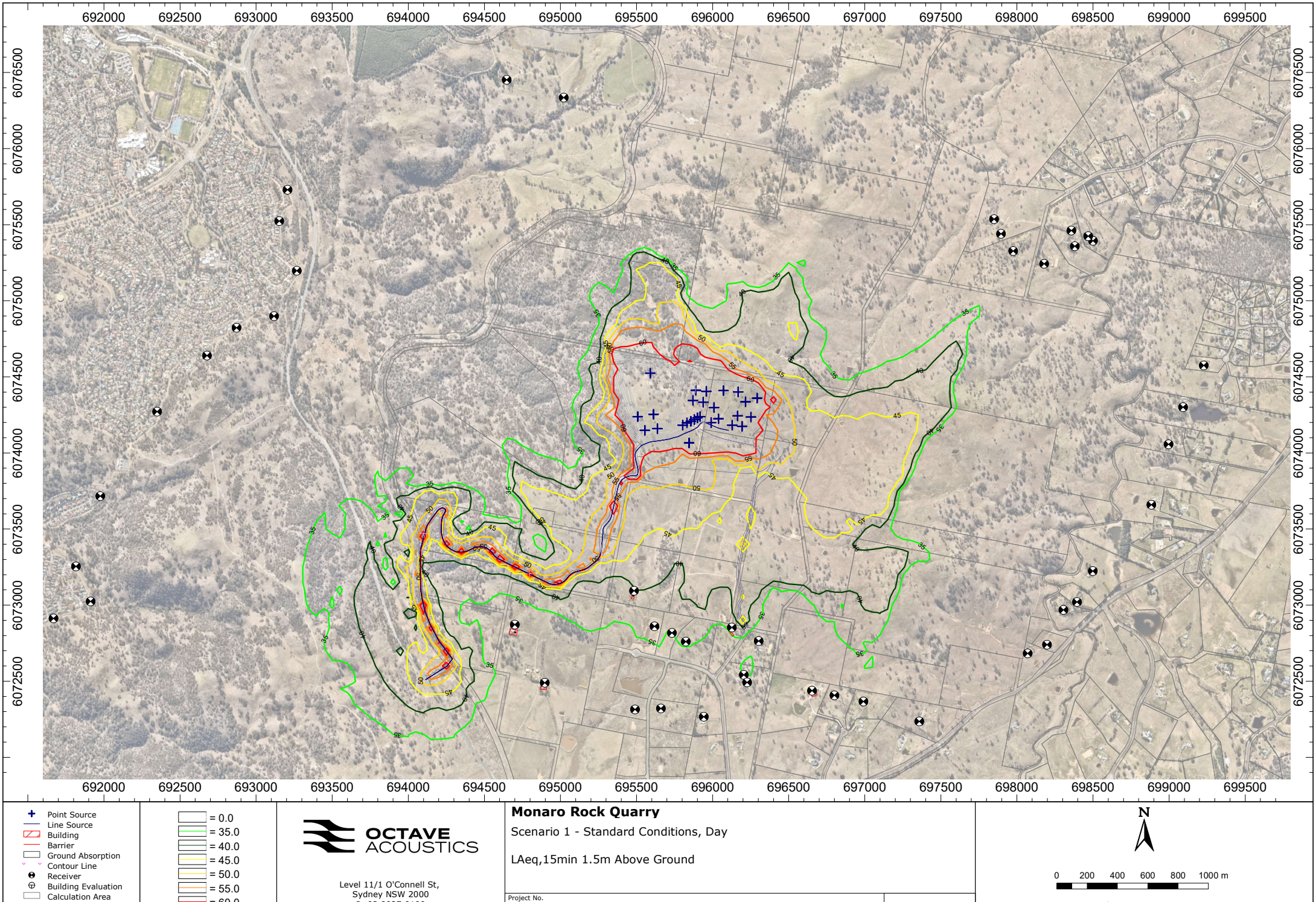
WEIGHTED SOUND REDUCTION INDEX, Rw

This is a single number rating of the airborne sound insulation of a wall, partition or ceiling. The sound reduction is normally measured over a frequency range of 100 Hz to 3.150 kHz and averaged in accordance with ISO standard weighting curves (Refer AS/NZS 1276.1:1999). Internal partition wall Rw+C ratings are frequency weighted to simulate insulation from human voice noise. The Rw+C is similar in value to the STC rating value. External walls, doors and windows may be Rw+Ctr rated to simulate insulation from road traffic noise. The spectrum adaptation term Ctr adjustment factor takes account of low frequency noise. The weighted sound reduction index is normally similar or slightly lower number than the STC rating value.

'Z' FREQUENCY WEIGHTING

The 'Z' (Zero) frequency weighting is 0 dB within the nominal 1/3 octave band frequency range centred on 10 Hz to 20 kHz. This is within the tolerance limits given in AS IEC 61672.1-2004: 'Electroacoustics - Sound level meters – Specifications'.

Appendix B: Noise Contours



Point Source
Line Source
Building
Barrier
Ground Absorption
Contour Line
Receiver
Building Evaluation
Calculation Area
Vertical Grid

= 0.0
= 35.0
= 40.0
= 45.0
= 50.0
= 55.0
= 60.0

OCTAVE ACOUSTICS

Level 11/1 O'Connell St,
Sydney NSW 2000
P: 02 8027 0100

Monaro Rock Quarry

Scenario 1 - Standard Conditions, Day

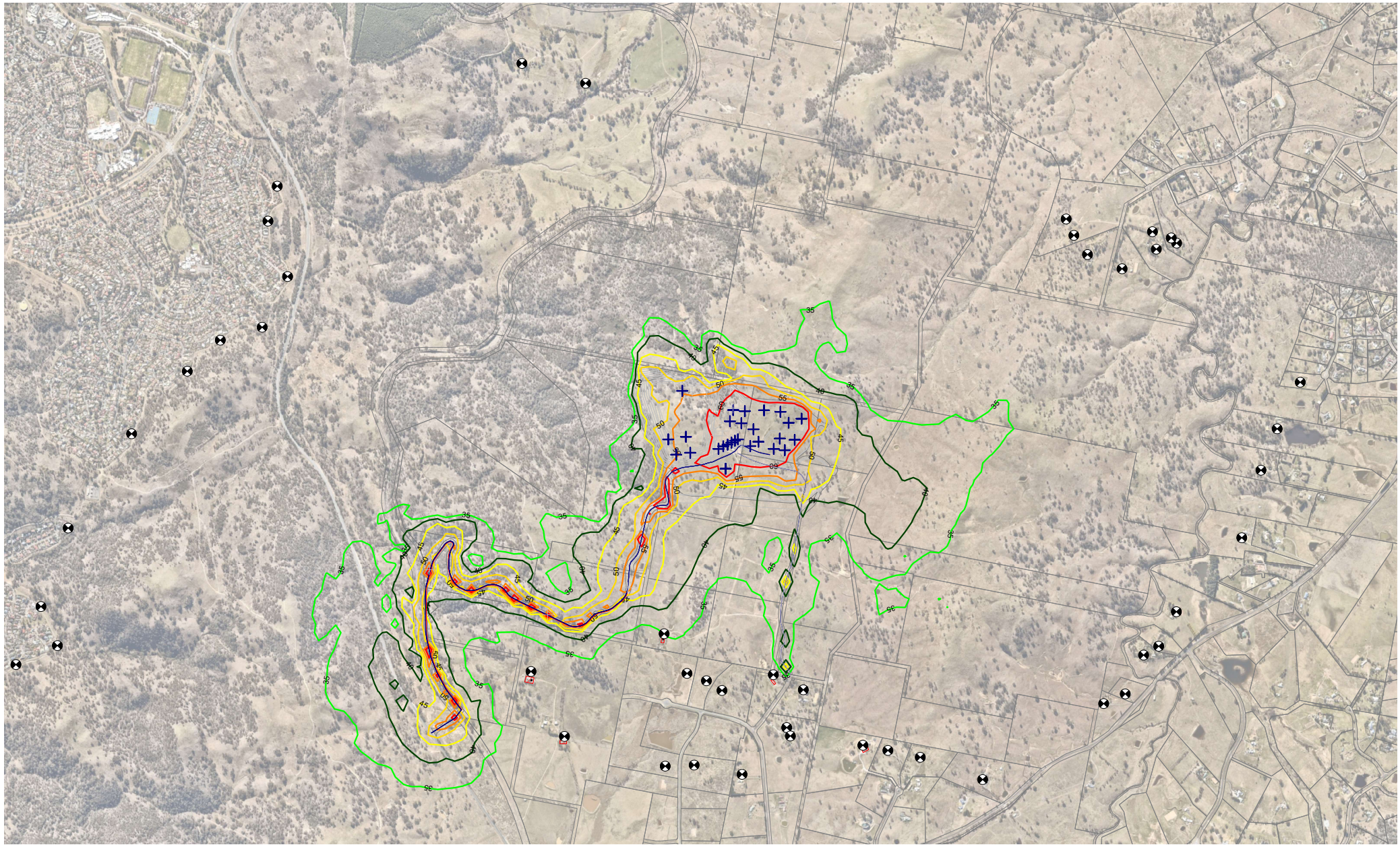
LAeq,15min 1.5m Above Ground

Project No.		
	AB270SE	03.06.26

N

0 200 400 600 800 1000 m

Scale: 1:30000 at A4



Point Source
Line Source
Building
Barrier
Ground Absorption
Contour Line
Receiver
Building Evaluation
Calculation Area
Vertical Grid

= 0.0
= 35.0
= 40.0
= 45.0
= 50.0
= 55.0
= 60.0

OCTAVE ACOUSTICS

Level 11/1 O'Connell St,
Sydney NSW 2000
P: 02 8027 0100

Monaro Rock Quarry

Scenario 1 - Standard Conditions, Night

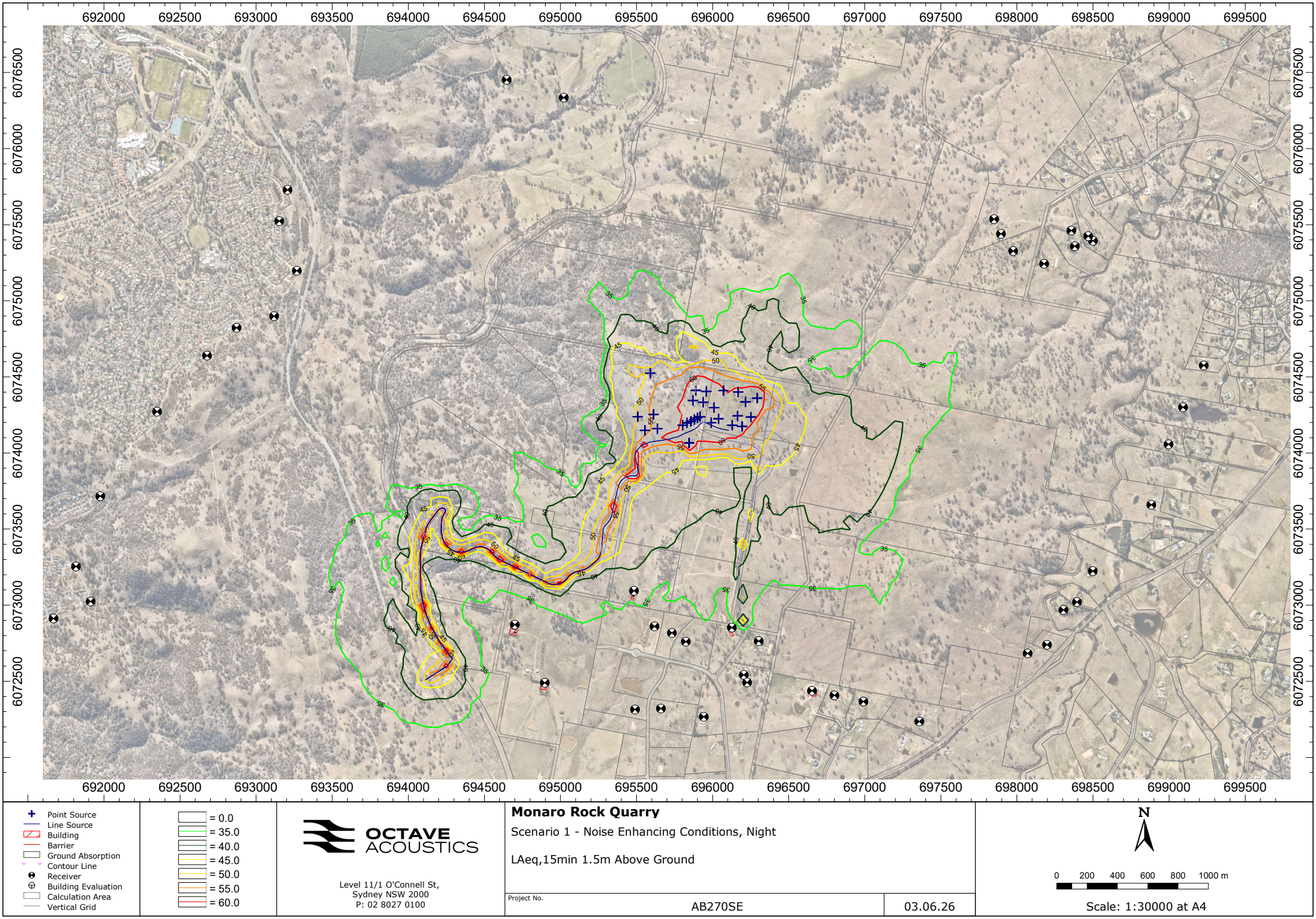
LAeq,15min 1.5m Above Ground

Project No.	
AB270SE	03.06.26

N

0 200 400 600 800 1000 m

Scale: 1:30000 at A4



Point Source
Line Source
Building
Barrier
Ground Absorption
Contour Line
Receiver
Building Evaluation
Calculation Area
Vertical Grid

= 0.0
= 35.0
= 40.0
= 45.0
= 50.0
= 55.0
= 60.0

OCTAVE ACOUSTICS

Level 11/1 O'Connell St,
Sydney NSW 2000
P: 02 8027 0100

Monaro Rock Quarry

Scenario 1 - Noise Enhancing Conditions, Night

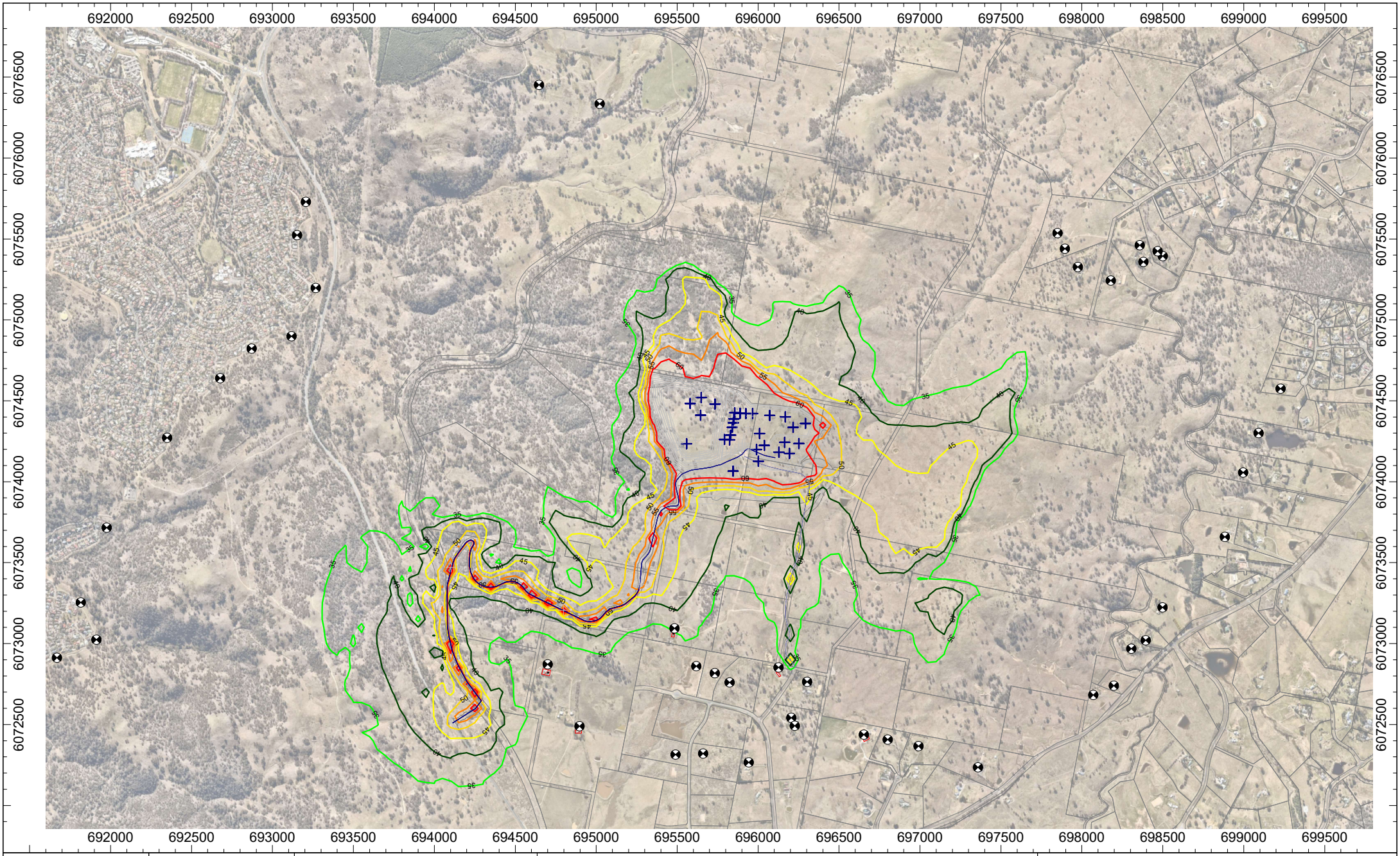
LAeq,15min 1.5m Above Ground

Project No.		
	AB270SE	03.06.26

N

0 200 400 600 800 1000 m

Scale: 1:30000 at A4



Point Source
Line Source
Building
Barrier
Ground Absorption
Contour Line
Receiver
Building Evaluation
Calculation Area
Vertical Grid

= 0.0
= 35.0
= 40.0
= 45.0
= 50.0
= 55.0
= 60.0

OCTAVE ACOUSTICS

Level 11/1 O'Connell St,
Sydney NSW 2000
P: 02 8027 0100

Monaro Rock Quarry

Scenario 2 - Standard Conditions, Day

LAeq,15min 1.5m Above Ground

Project No.		
	AB270SE	03.06.26

N

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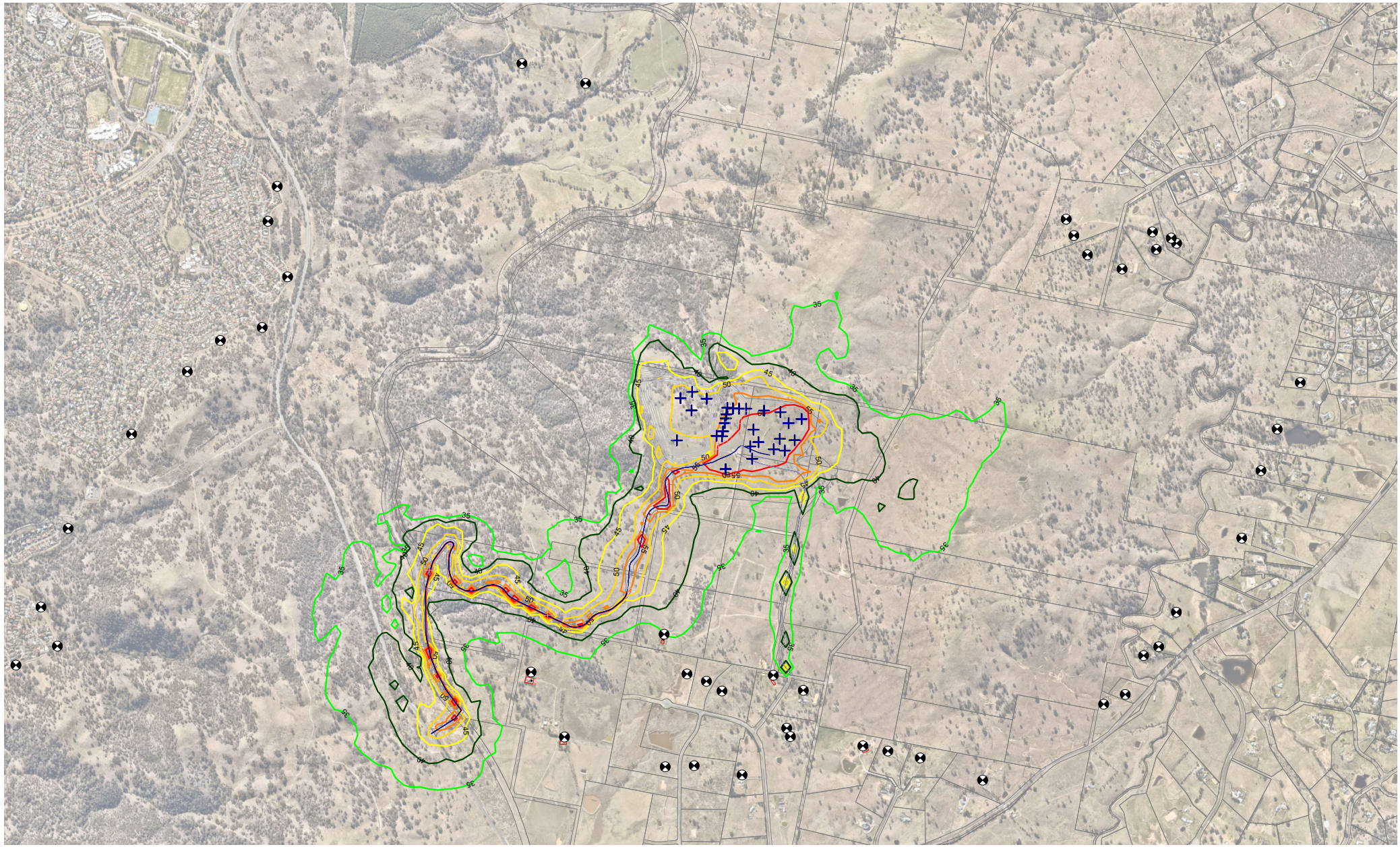
Scale: 1:30000 at A4



Point Source
Line Source
Building
Barrier
Ground Absorption
Contour Line
Receiver
Building Evaluation
Calculation Area
Vertical Grid

= 0.0
= 35.0
= 40.0
= 45.0
= 50.0
= 55.0
= 60.0

OCTAVE ACOUSTICS

Level 11/1 O'Connell St,
Sydney NSW 2000
P: 02 8027 0100

Monaro Rock Quarry

Scenario 2 - Standard Conditions, Night

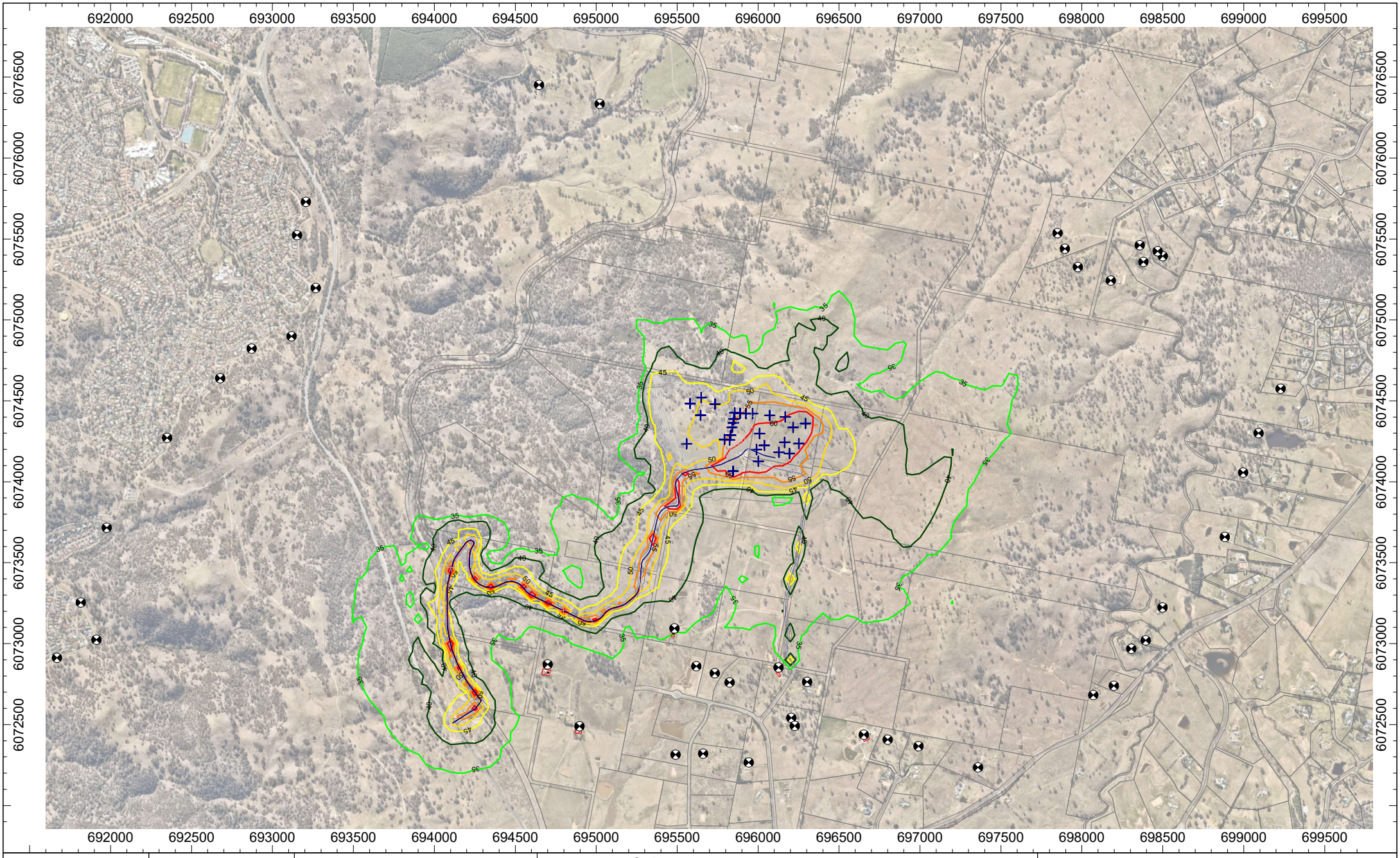
LAeq,15min 1.5m Above Ground

Project No.	
AB270SE	03.06.26

N

0 200 400 600 800 1000 m

Scale: 1:30000 at A4



Point Source
Line Source
Building
Barrier
Ground Absorption
Contour Line
Receiver
Building Evaluation
Calculation Area
Vertical Grid

= 0.0
= 35.0
= 40.0
= 45.0
= 50.0
= 55.0
= 60.0

OCTAVE ACOUSTICS

Level 11/1 O'Connell St,
Sydney NSW 2000
P: 02 8027 0100

Monaro Rock Quarry

Scenario 2 - Noise Enhancing Conditions, Night

LAeq,15min 1.5m Above Ground

Project No.		
	AB270SE	03.06.26

N

0 200 400 600 800 1000 m

Scale: 1:30000 at A4

Appendix C: Quarry Access Road Sealing and Noise Barrier

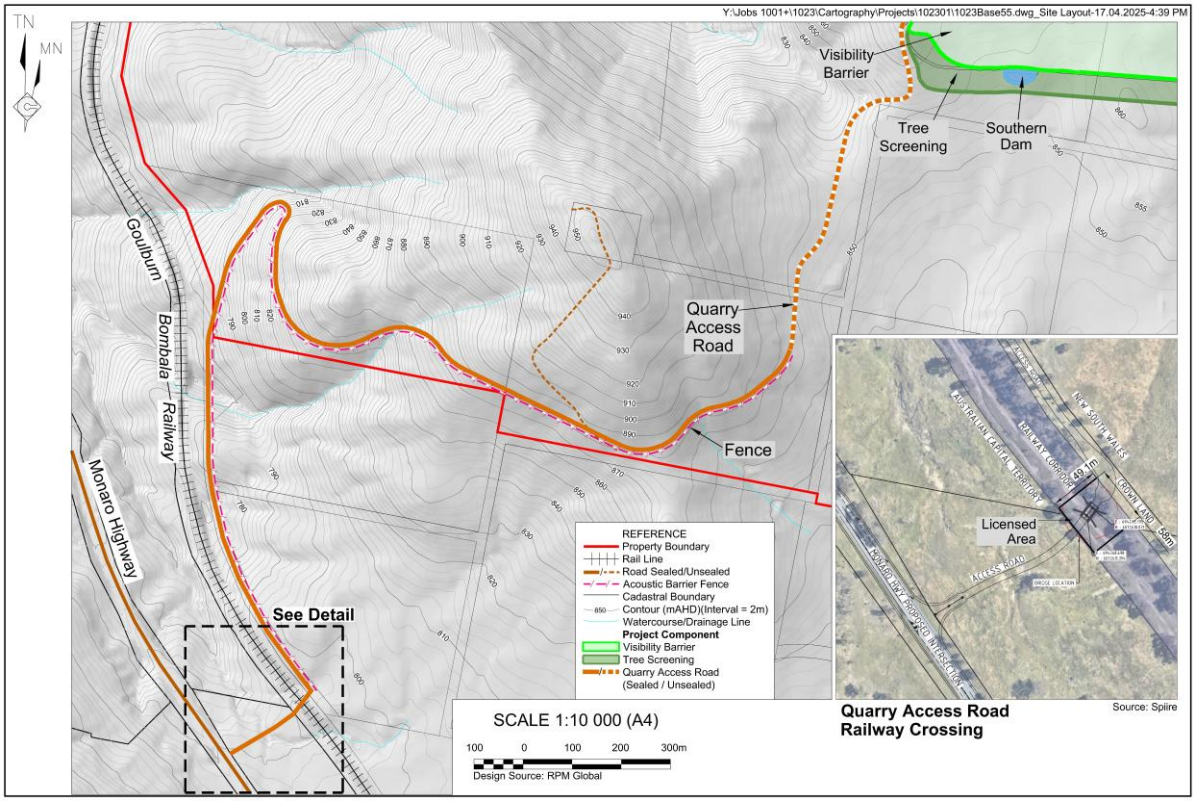


Figure 6 - Main Access Road Sealing and Noise Barrier

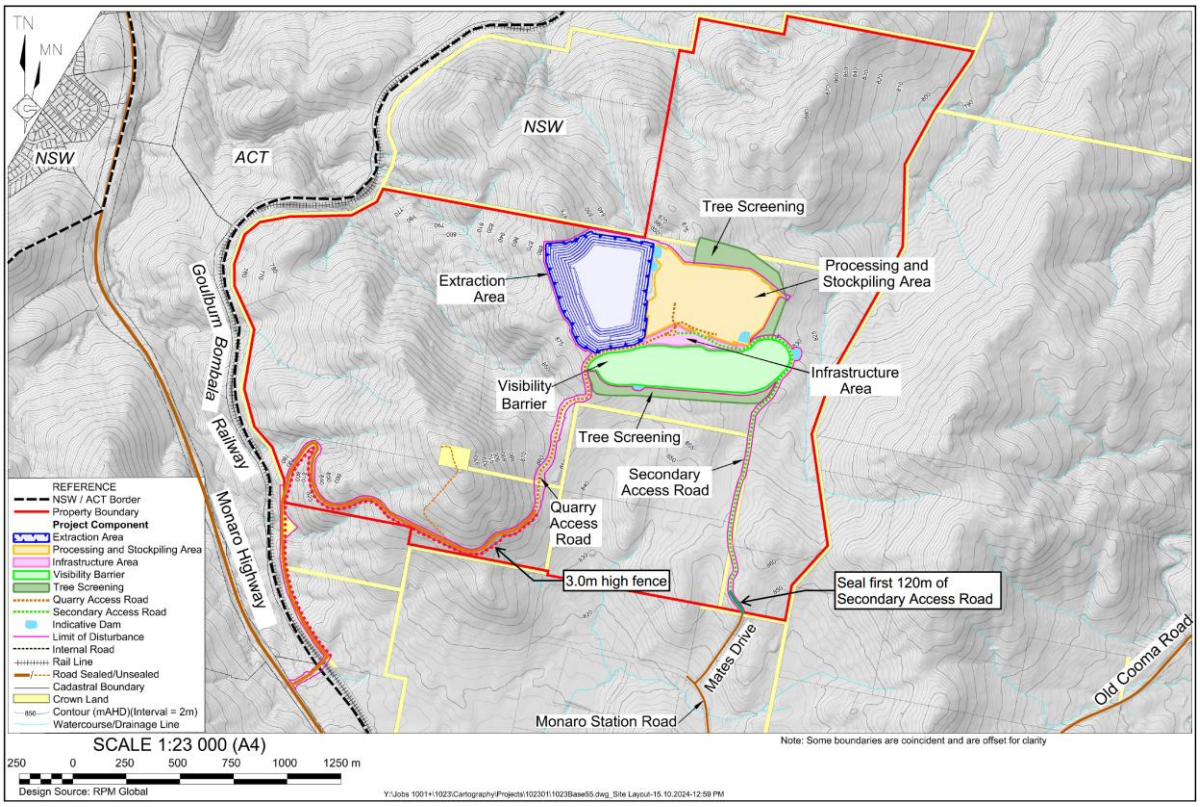


Figure 7 - Secondary Access Road Sealing

Appendix D: Sound Power Levels

Sound power levels and octave band spectra of noise sources were obtained from Table A1 of Australian Standard AS 2436 – 2010 *Guide to noise and vibration control on construction, demolition, and maintenance sites*, the UK Department for Environment Food and Rural Affairs *Update of noise database for prediction of noise on construction and open sites* 2005 & 2006, and the Octave Acoustics Noise Database.

The total sound power of a road truck on gravel was set in accordance with AS 2436 as 107 dB(A), with the contribution of the wheels, engine, and exhaust set with reference to *NCHRP Report 635: Acoustic Beamforming: Mapping Sources of Truck Noise* (National Academies of Sciences, Engineering, and Medicine 2009).

Table 51 - Sound Power Levels of Quarry Noise Sources, dB re 10^{-12} W

Noise Source	Source Height (m)	dB(A)	Octave Band Centre Frequency (Hz)							
			63	125	250	500	1000	2000	4000	8000
Road truck (wheels on asphalt)	0.5	102	100	98	97	97	98	96	91	85
Road truck (wheels on gravel)	0.5	105	103	101	100	100	101	99	94	88
Road truck (engine)	1.5	101	101	99	97	97	96	94	90	85
Road truck (exhaust)	3.6	96	114	103	93	92	88	86	81	76
Utility vehicle	0.5	106	102	99	100	101	104	98	86	78
Water truck	1.5	107	110	104	102	106	103	98	90	81
Concrete mixer truck	1.5	108	111	102	94	97	98	106	88	83
Grader	0.5	108	110	109	105	101	106	100	96	87
Percussion drill rig	1.5	116	112	118	111	114	110	109	104	103
Haul truck (loading / unloading)	1.5	113	117	112	108	110	108	106	100	92
Mobile crusher	2.0	112	114	112	112	109	106	103	99	94
Hydraulic excavator (50t)	1.5	115	119	120	111	112	108	106	105	98
Primary jaw crusher (mobile)	2.0	115	117	115	115	112	109	106	102	97
Secondary/tertiary cone crusher (mobile)	2.0	112	114	112	112	109	106	103	99	94
Quaternary vertical shaft impactor (mobile)	2.0	103	105	109	102	99	97	95	92	92
Screen (mobile)	2.0	109	121	114	107	106	103	99	97	90

Crane	1.0	103	101	99	94	95	102	94	86	77
Light tools	1.0	102	104	101	98	97	96	95	93	89
Scissor lift	1.0	106	108	105	102	102	102	99	93	91
Welder	1.0	101	95	96	97	96	97	94	89	84
Pugmill	2.0	113	120	112	112	108	107	106	103	100
Concrete crusher	2.0	112	114	112	112	109	106	103	99	94
Pre-coat plant	2.0	99	111	110	98	97	92	86	77	72
Front end loader (loading truck)	1.5	110	120	112	111	105	104	102	99	90
Front end loader (loading hopper)	1.5	103	111	105	98	98	98	96	92	86
Agitator	1.5	108	111	102	94	97	98	106	88	83
Asphalt plant	2.0	111	116	116	113	109	106	102	99	93
Concrete plant	2.0	104	100	101	107	100	97	95	91	88
Hydraulic excavator (26t)	1.5	108	110	115	110	105	100	98	94	87
Haul truck	1.5	113	117	112	108	110	108	106	100	92
Primary jaw crusher (fixed)	2.0	115	117	115	115	112	109	106	102	97
Secondary/tertiary cone crusher (fixed)	2.0	112	114	112	112	109	106	103	99	94
Quaternary vertical shaft impactor (fixed)	2.0	103	105	109	102	99	97	95	92	92
Screen (fixed)	2.0	109	121	114	107	106	103	99	97	90
Surge	2.0	110	115	112	110	105	104	102	98	93
Bobcat	1.5	103	111	105	98	98	98	96	92	86

Appendix E: Noise Logger Results

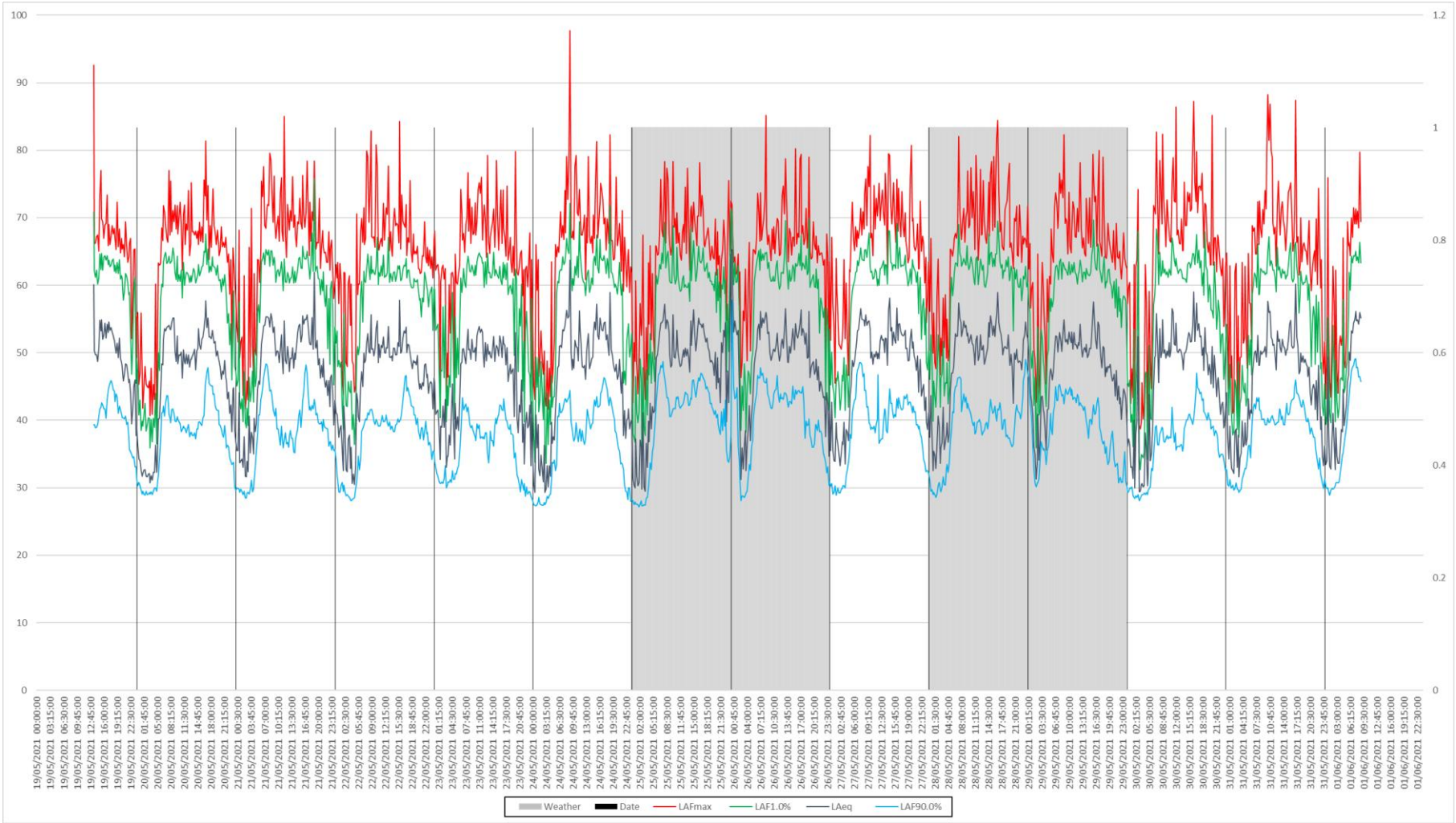


Figure 8 – Location 1 Noise Monitoring Results

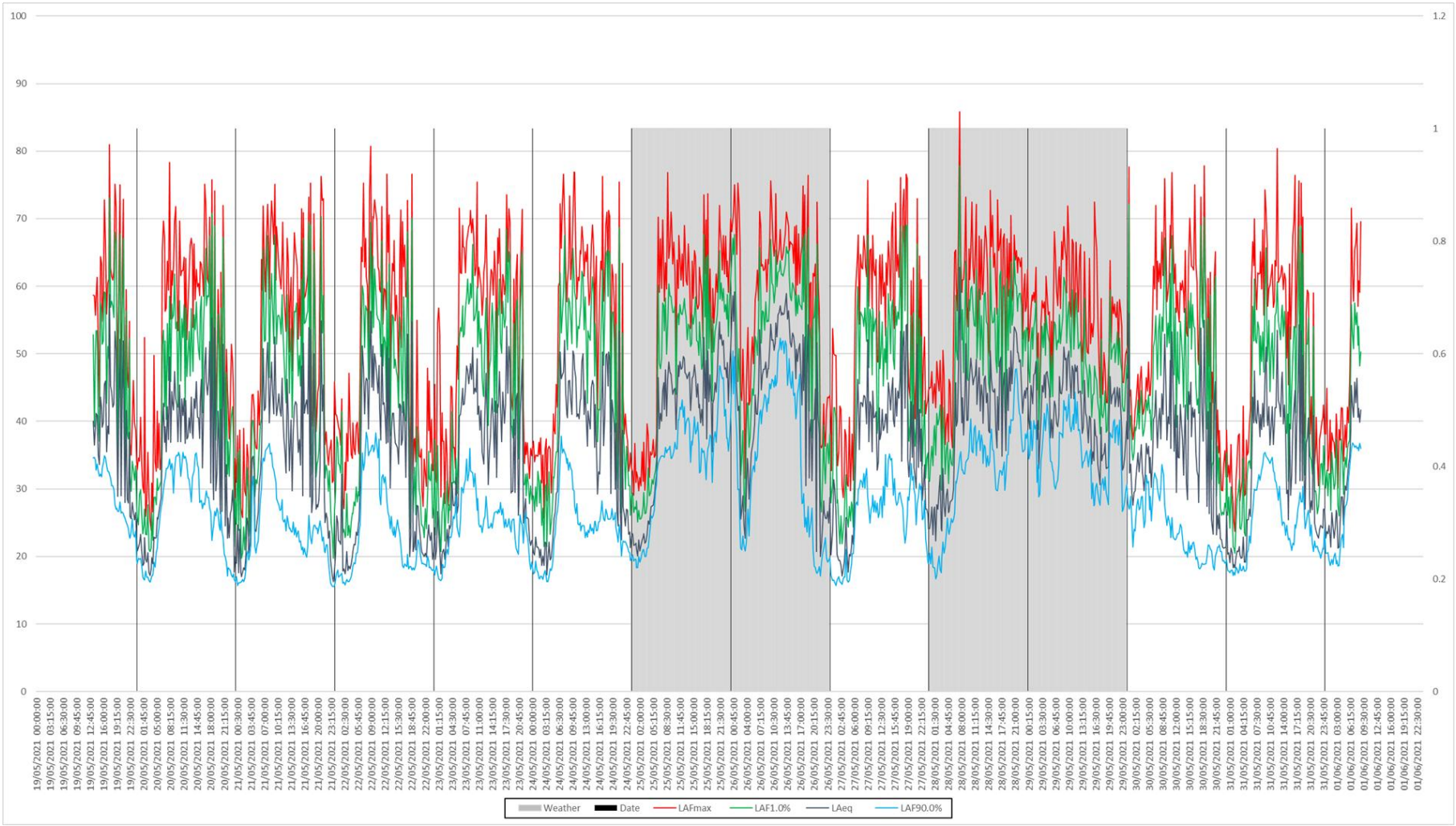


Figure 9 - Location 2 Noise Monitoring Results

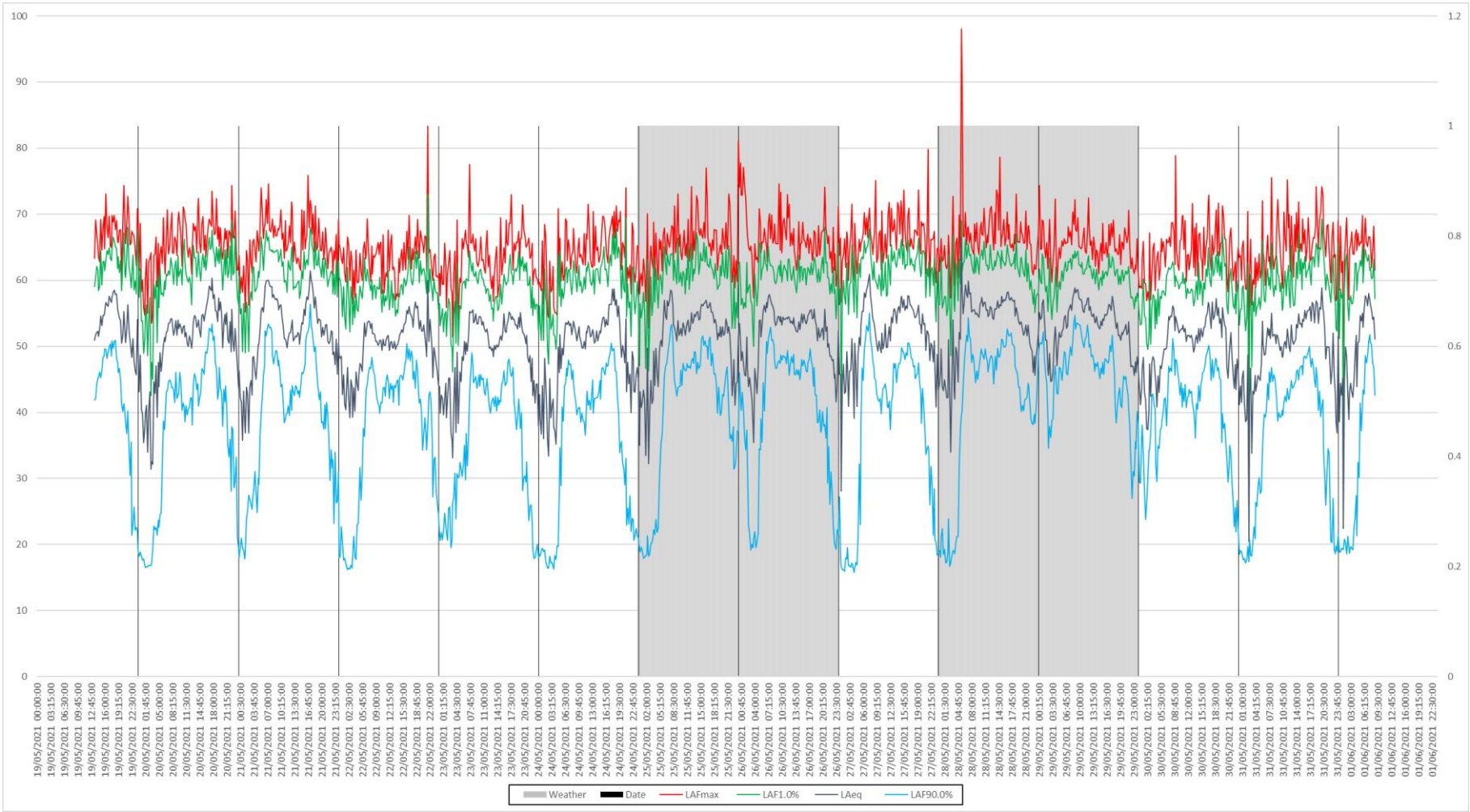


Figure 10 - Location 3 Noise Monitoring Results

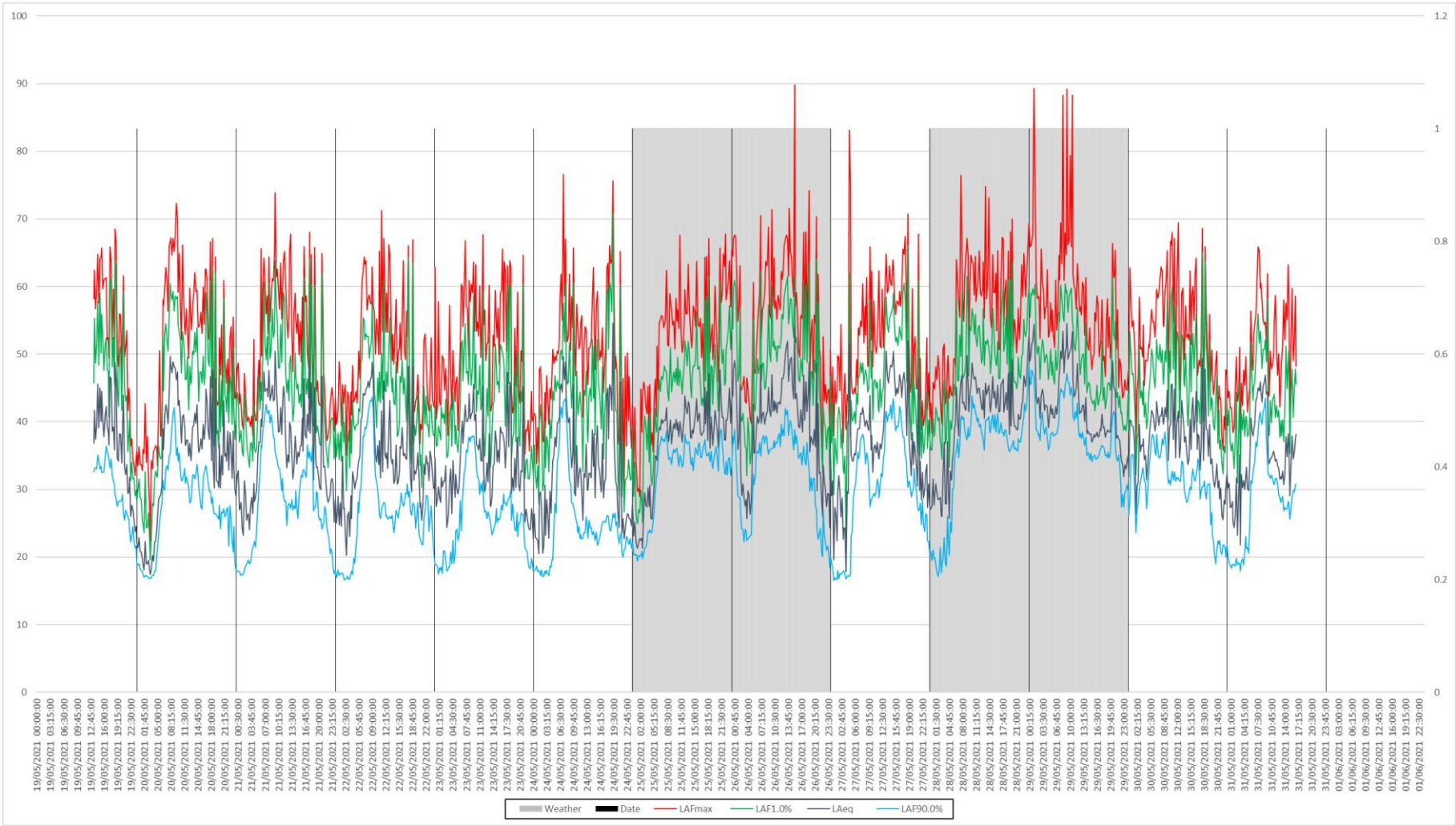


Figure 11 - Location 4 Noise Monitoring Results

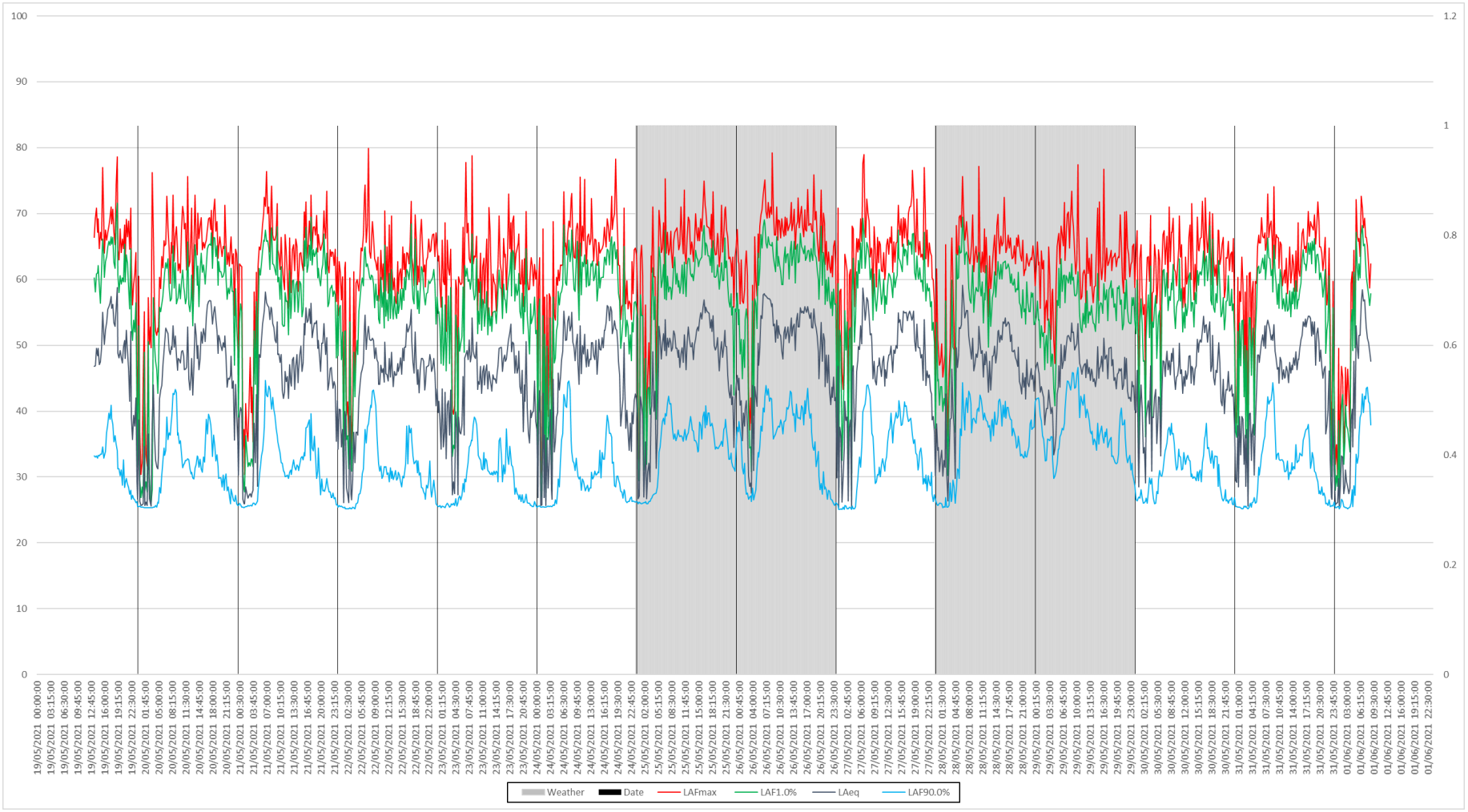


Figure 12 - Location 5 Noise Monitoring Results

Appendix F: Potentially Affected Receivers

ID	Address	State	NCA	Zoning	Approximate Distance from Quarry
R1	1995 Old Cooma Road, Royalla	NSW	4	RU2 - Rural Landscape	1300m
R2	37 Mates Drive, Royalla	NSW	4	C4 - Environmental Living	1600m
R3	20 Mates Drive, Royalla	NSW	4	C4 - Environmental Living	1700m
R4	220 Monaro Station Road, Royalla	NSW	4	C4 - Environmental Living	1500m
R5	212 Monaro Station Road, Royalla	NSW	4	C4 - Environmental Living	1500m
R6	188 Monaro Station Road, Royalla	NSW	4	C4 - Environmental Living	1600m
R7	8814 Monaro Highway, Royalla	NSW	4	C4 - Environmental Living	1900m
R8	8814 Monaro Highway, Royalla	NSW	4	C4 - Environmental Living	2100m
R9	80 Holland Drive, Royalla	NSW	4	C4 - Environmental Living	2100m
R10	65 Holland Drive, Royalla	NSW	4	C4 - Environmental Living	2000m
R11	93 Monaro Station Road, Royalla	NSW	4	C4 - Environmental Living	2100m
R12	8 Mates Drive, Royalla	NSW	4	C4 - Environmental Living	1900m
R13	8 Mates Drive, Royalla	NSW	4	C4 - Environmental Living	1900m
R14	47 Moringol Place, Royalla	NSW	5	C4 - Environmental Living	2100m
R15	49 Moringol Place, Royalla	NSW	5	C4 - Environmental Living	2200m
R16	48 Moringol Place, Royalla	NSW	5	C4 - Environmental Living	2300m
R17	1616 Old Cooma Road, Royalla	NSW	5	C4 - Environmental Living	2600m
R18	1550 Old Cooma Road, Royalla	NSW	5	C4 - Environmental Living	2800m
R19	1548 Old Cooma Road, Royalla	NSW	5	C4 - Environmental Living	2900m
R20	1484 Old Cooma Road, Googong	NSW	5	C4 - Environmental Living	2900m
R21	1482 Old Cooma Road, Googong	NSW	5	C4 - Environmental Living	2900m
R22	1466 Old Cooma Road, Googong	NSW	5	C4 - Environmental Living	2900m
R23	1384 Old Cooma Road, Googong	NSW	2	C4 - Environmental Living	3200m
R24	1330 Old Cooma Road, Googong	NSW	2	C4 - Environmental Living	3200m
R25	1312 Old Cooma Road, Googong	NSW	2	C4 - Environmental Living	3300m

ID	Address	State	NCA	Zoning	Approximate Distance from Quarry
R26	1 Shillington Avenue, Googong	NSW	2	C4 - Environmental Living	3400m
R27	327 Fernleigh Drive, Googong	NSW	2	C4 - Environmental Living	2900m
R28	327 Fernleigh Drive, Googong	NSW	2	C4 - Environmental Living	2900m
R29	359 Fernleigh Drive, Googong	NSW	2	C4 - Environmental Living	2800m
R30	359 Fernleigh Drive, Googong	NSW	2	C4 - Environmental Living	2800m
R31	361 Fernleigh Drive, Googong	NSW	2	C4 - Environmental Living	2500m
R32	360 Fernleigh Drive, Googong	NSW	2	C4 - Environmental Living	2400m
R33	358 Fernleigh Drive, Googong	NSW	2	C4 - Environmental Living	2400m
R34	358 Fernleigh Drive, Googong	NSW	2	C4 - Environmental Living	2400m
R35	174 Old Tuggeranong Road, Tuggeranong	ACT	2	NUZ2 - Rural	2100m
R36	174 Old Tuggeranong Road, Tuggeranong	ACT	2	NUZ2 - Rural	2400m
R37	18 Christmas Street, Tuggeranong	ACT	1	RZ1 - Suburban	2900m
R38	14 Mighell Place, Tuggeranong	ACT	1	RZ1 - Suburban	2900m
R39	35 Freda Gibson Circuit, Tuggeranong	ACT	1	RZ1 - Suburban	2700m
R40	16 Eltham Place, Tuggeranong	ACT	1	RZ1 - Suburban	2700m
R41	17 Bridgen Crescent, Tuggeranong	ACT	1	RZ2 - Suburban Core	3000m
R42	35 Goldfinch Circuit, Tuggeranong	ACT	1	RZ1 - Suburban	3100m
R43	7 Callister Crescent, Tuggeranong	ACT	1	RZ1 - Suburban	3400m
R44	36 Eaglemount Retreat, Tuggeranong	ACT	1	RZ1 - Suburban	3900m
R45	14 Banyule Grove, Tuggeranong	ACT	1	RZ1 - Suburban	4100m
R46	26 Aldor Green, Tuggeranong	ACT	1	RZ1 - Suburban	4100m
R47	9 Langker Place, Tuggeranong	ACT	1	RZ1 - Suburban	4400m

Appendix G: Operational Noise at All Receivers

Table 52 – Scenario 1 Operational Noise at All Receivers, dB $L_{Aeq,15min}$

NCA	ID	Day		Night		
		Standard Conditions	Criteria	Standard Conditions	Noise Enhancing Conditions	Criteria
NCA 5	R1	39	-	35	37	-
NCA 5	R2	36	40	29	33	35
NCA 5	R3	32	40	25	32	35
NCA 5	R4	36	40	32	34	35
NCA 5	R5	35	40	30	33	35
NCA 5	R6	36	40	29	32	35
NCA 4	R7	33	40	32	33	35
NCA 4	R8	27	40	25	30	35
NCA 5	R9	32	40	24	31	35
NCA 5	R10	33	40	26	31	35
NCA 5	R11	34	40	25	30	35
NCA 5	R12	35	40	26	32	35
NCA 5	R13	33	40	25	30	35
NCA 6	R14	32	40	22	30	35
NCA 6	R15	32	40	23	30	35
NCA 6	R16	34	40	23	29	35
NCA 6	R17	16	40	9	25	35
NCA 6	R18	12	40	4	25	35
NCA 6	R19	11	40	3	24	35
NCA 6	R20	11	40	3	22	35
NCA 6	R21	11	40	4	24	35
NCA 6	R22	11	40	3	26	35
NCA 2	R23	13	40	5	25	35
NCA 2	R24	14	40	6	25	35

NCA	ID	Day		Night		
		Standard Conditions	Criteria	Standard Conditions	Noise Enhancing Conditions	Criteria
NCA 2	R25	14	40	6	24	35
NCA 2	R26	16	40	8	24	35
NCA 2	R27	17	40	9	19	35
NCA 2	R28	17	40	10	24	35
NCA 2	R29	19	40	11	24	35
NCA 2	R30	18	40	10	24	35
NCA 2	R31	17	40	9	22	35
NCA 2	R32	23	40	15	23	35
NCA 2	R33	28	40	18	28	35
NCA 2	R34	26	40	17	28	35
NCA 1	R35	26	45	13	26	35
NCA 1	R36	24	45	16	26	35
NCA 1	R37	15	45	9	23	35
NCA 1	R38	14	45	6	16	35
NCA 1	R39	16	45	11	18	35
NCA 1	R40	18	45	13	20	35
NCA 1	R41	13	45	4	15	35
NCA 1	R42	11	45	2	14	35
NCA 1	R43	5	45	-	11	35
NCA 1	R44	11	45	1	19	35
NCA 1	R45	3	45	-	13	35
NCA 1	R46	5	45	-	16	35
NCA 1	R47	5	45	-	17	35

Table 53 - Scenario 2 Operational Noise at All Receivers, dB $L_{Aeq,15min}$

NCA	ID	Day		Night		
		Standard Conditions	Criteria	Standard Conditions	Noise Enhancing Conditions	Criteria
NCA 5	R1	36	-	35	36	-
NCA 5	R2	30	40	28	31	35
NCA 5	R3	28	40	25	30	35
NCA 5	R4	33	40	31	32	35
NCA 5	R5	31	40	29	31	35
NCA 5	R6	30	40	28	31	35
NCA 4	R7	33	40	32	33	35
NCA 4	R8	26	40	25	29	35
NCA 5	R9	26	40	23	30	35
NCA 5	R10	27	40	25	30	35
NCA 5	R11	27	40	24	29	35
NCA 5	R12	27	40	24	30	35
NCA 5	R13	27	40	23	29	35
NCA 6	R14	26	40	21	30	35
NCA 6	R15	27	40	22	29	35
NCA 6	R16	27	40	21	29	35
NCA 6	R17	16	40	8	22	35
NCA 6	R18	12	40	4	24	35
NCA 6	R19	11	40	3	24	35
NCA 6	R20	11	40	3	21	35
NCA 6	R21	12	40	3	24	35
NCA 6	R22	12	40	3	25	35
NCA 2	R23	14	40	5	24	35
NCA 2	R24	15	40	6	24	35
NCA 2	R25	15	40	6	24	35

NCA	ID	Day		Night		
		Standard Conditions	Criteria	Standard Conditions	Noise Enhancing Conditions	Criteria
NCA 2	R26	17	40	8	23	35
NCA 2	R27	17	40	9	19	35
NCA 2	R28	17	40	9	24	35
NCA 2	R29	18	40	11	24	35
NCA 2	R30	18	40	10	24	35
NCA 2	R31	17	40	9	22	35
NCA 2	R32	22	40	15	23	35
NCA 2	R33	25	40	19	28	35
NCA 2	R34	24	40	18	28	35
NCA 1	R35	28	45	13	25	35
NCA 1	R36	27	45	14	25	35
NCA 1	R37	14	45	9	23	35
NCA 1	R38	13	45	6	16	35
NCA 1	R39	16	45	11	18	35
NCA 1	R40	17	45	13	21	35
NCA 1	R41	13	45	4	16	35
NCA 1	R42	11	45	2	14	35
NCA 1	R43	6	45	-	11	35
NCA 1	R44	10	45	1	19	35
NCA 1	R45	4	45	-	12	35
NCA 1	R46	5	45	-	16	35
NCA 1	R47	5	45	-	18	35

Appendix H: Openings in Noise Barrier

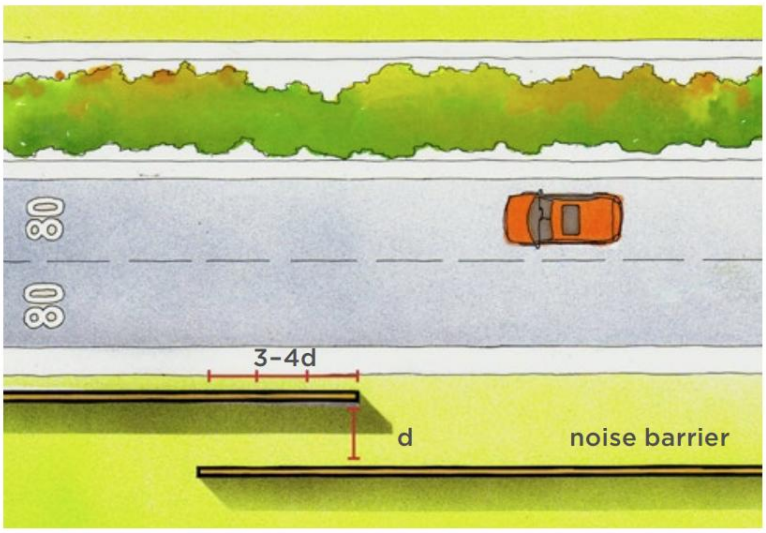


Figure 13 - Overlapping Opening in Noise Barrier (Source: TfNSW Noise Wall Design Guideline, June 2023)

Appendix I: Construction Noise & Vibration Management

Management and mitigation strategies to minimise construction noise and vibration impacts are detailed below.

Physical Noise Controls

Machinery Noise Attenuation Treatments

Australian Standard AS2436 sets out some example applications of noise attenuation treatments which have been adapted based on equipment which is expected may operate at the Subject Site during building works phase. To ensure a best practice approach to the minimisation of noise from construction machinery it is recommended that these noise attenuation treatments as shown below in Table 54 are adopted where possible.

Table 54 – Typical Noise Sources and Mitigation Advice Adapted from AS2436

Machine	Source of Noise	Possible Mitigation	Alternative Mitigation
Dump truck Excavator	Engine	Fit more efficient silencer or exhaust silencer. Enclosure panels, when fitted should be kept closed.	-
Compressor Generator	Engine	Fit more efficient exhaust silencer	Screen the compressor or generator. Use electric motor in preference to diesel or petrol engine for compressors. If there is no mains supply, a sound reduced compressor or generator can be used to supply several pieces of plant. Use centralized generator system.
	Compressor or generator	Acoustically dampen metal casing Enclosure panels should be kept closed.	
Pneumatic rock breaker and tools	Tool	Fit a muffler or silencer that reduce the noise without impairing efficiency.	Use rotary drill and burster. Hydraulic and electric tools are also available. A thermic lance can be used to burn holes in rock and to cut through large sections of rock.
	Bit	Use dampened bit to eliminate 'ringing'. Little noise once surface is broken.	
	Air-line	Leaks in air line should be sealed	-
	Motor	Fit muffler to pneumatic saws.	-
Concrete mixer	Filling	Do not let aggregates fall from an excessive height.	-
	Cleaning	Do not hammer the drum.	
Materials handling	Impact of material	Do not drop materials from a height. Screen dropping zones especially on conveyor systems.	Cover surface with resilient material or unload elsewhere.

Noise Control Effectiveness

The relative effectiveness of different forms of noise control as listed in AS2436, is presented in Table 55 below.

Table 55 – Relative Effectiveness of Various Forms of Noise Control

Control by	Nominal noise reduction possible, in total A-weighted sound pressure level L_{pA} dB
Distance	Approximately 6dB for each doubling of distance
Screening	Normally 5 – 10, maximum 15
Enclosure	Normally 15 – 25, maximum 50
Silencing	Normally 5 – 10, maximum 20

General Work Practices

Some general construction activities can be carried out in the following ways:

Work practices at any time of day

- Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise.
- Ensure site managers periodically check the site and nearby residences and other sensitive land uses for noise problems so that solutions can be quickly applied.
- Include in tenders, employment contracts, subcontractor agreements and work method statements clauses that require minimisation of noise and compliance with directions from management to minimise noise.
- Avoid the use of radios or stereos outdoors where neighbours can be affected.
- Avoid the overuse of public address systems.
- Avoid shouting, and minimise talking loudly and slamming vehicle doors.
- Keep truck drivers informed of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices (for example, minimising the use of engine brakes, and no extended periods of engine idling).
- Develop a one-page summary of approval or consent conditions that relate to relevant work practices, and pin it to a noticeboard so that all site operators can quickly reference noise information.
- Workers may at times need to discuss or negotiate practices with their managers.

Additional work practices at night

- Avoid the use of equipment which generates impulsive noise.
- Minimise the need for reversing or movement alarms.
- Avoid dropping materials from a height.
- Avoid metal-to-metal contact on equipment.
- Schedule truck movements to avoid residential streets if possible.
- Avoid mobile plant clustering near residences and other sensitive land uses.
- Ensure periods of respite are provided in the case of unavoidable maximum noise level events.

Plant & Equipment

In terms of both cost and results, controlling noise at the source is one of the most effective methods of minimising the noise impacts from any construction activities.

Use quieter methods

- Examine and implement, where feasible and reasonable, alternatives to rock-breaking work methods, such as hydraulic splitters for rock and concrete, hydraulic jaw crushers, chemical rock and concrete splitting, and controlled blasting such as penetrating cone fracture. The suitability of alternative methods should be considered on a case-by-case basis.
- Use alternatives to diesel and petrol engines and pneumatic units, such as hydraulic or electric-controlled units where feasible and reasonable. Where there is no electricity supply, use an electrical generator located away from residences.

Use quieter equipment

- Examine different types of machines that perform the same function and compare the noise level data to select the least noisy machine. For example, rubber wheeled tractors can be less noisy than steel tracked tractors.
- Noise labels are required by NSW legislation for pavement breakers, mobile compressors, chainsaws and mobile garbage compactors. These noise labels can be used to assist in selecting less noisy plant.
- Pneumatic equipment is traditionally a problem – select silenced compressors, silenced jackhammers and damped bits where possible.
- When renting, select quieter items of plant and equipment where feasible and reasonable.
- When purchasing, select, where feasible and reasonable, the most effective mufflers, enclosures and low-noise tool bits and blades. Always seek the manufacturer's advice before making modifications to plant to reduce noise.

Operate plant in a quiet and efficient manner

- Reduce throttle setting and turn off equipment when not being used.
- Examine and implement, where feasible and reasonable, the option of reducing noise from metal chutes and bins by placing damping material in the bin.

Maintain equipment

- Regularly inspect and maintain equipment to ensure it is in good working order. Also check the condition of mufflers.
- Equipment must not be operated until it is maintained or repaired, where maintenance or repair would address the annoying character of noise identified.
- For machines with enclosures, check that doors and door seals are in good working order and that the doors close properly against the seals.
- Return any hired equipment that is causing noise that is not typical for the equipment – the increased noise may indicate the need for repair.
- Ensure air lines on pneumatic equipment do not leak.

Location of plant

- Place as much distance as possible between the plant or equipment and residences and other sensitive land uses.
- Restrict areas in which mobile plant can operate so that it is away from residences and other sensitive land uses at particular times.
- Locate site vehicle entrances away from residences and other sensitive land uses.
- Carry out noisy fabrication work at another site (for example, within enclosed factory premises) and then transport to site.

Alternatives to reversing alarms

- Avoid use of reversing alarms by designing site layout to avoid reversing, such as by including drive-through for parking and deliveries.
- Install where feasible and reasonable less annoying alternatives to the typical 'beeper' alarms taking into account the requirements of the Occupational Health and Safety legislation; examples are smart alarms

that adjust their volume depending on the ambient level of noise and multifrequency alarms that emit noise over a wide range of frequencies.

- In all circumstances, the requirements of the relevant Occupational Health and Safety legislation must be complied with.

Maximise shielding

- Reuse existing structures rather than demolish and reconstruct.
- Use full enclosures, such as large sheds, with good seals fitted to doors to control noise from night-time work.
- Use temporary site buildings and materials stockpiles as noise barriers.
- Schedule construction of permanent walls so that they can be used as early as possible as noise barriers.
- Use natural landform as a noise barrier – place fixed equipment in cuttings, or behind earth berms.
- Note large reflecting surfaces on and off site that might increase noise levels, and avoid placing noise-producing equipment in locations where reflected noise will increase noise exposure or reduce the effectiveness of mitigation measures.

Administrative Controls

Time Management

Scheduling noisy work during periods when people are least affected is an important way of reducing noise impact.

Provide respite periods

- Where night work near residences cannot be feasibly or reasonably avoided, restrict the number of nights per week and/or the number of nights per calendar month that the works are undertaken, in consultation with residents who will be most affected.

Schedule activities to minimise noise impacts

- Organise work to be undertaken during the recommended standard hours where possible.
- Schedule work to avoid times when there are special events, such as international sporting competitions, if the construction site is in the vicinity of the venue. When works outside the recommended standard hours are planned, avoid scheduling on Sundays or public holidays.
- Schedule work when neighbours are not present (for example, commercial neighbours, colleges and schools may not be present outside business hours or on weekends).
- Schedule noisy activities around times of higher background noise (local road traffic or when other local noise sources are active) where possible to provide masking or to reduce the amount that the construction noise intrudes above the background.
- Consult with affected neighbours about scheduling activities to minimise noise impacts.

Organise deliveries and access

- Amalgamated loads can lead to less noise and congestion in nearby streets.
- Optimise the number of vehicle trips to and from the site – movements can be organised to amalgamate loads rather than using a number of vehicles with smaller loads.
- Schedule deliveries to nominated hours only.

Site Management

All personnel working on site should be appropriately inducted. The site induction should address the requirements of the NVMP and their responsibilities with regard to noise and vibration management.

Contractors will need to ensure equipment is operated in the correct manner including replacement of engine covers, repair of defective silencing equipment, tightening of rattling components, repair of leakages in compressed air lines and shutting down equipment not in use.

Regular reinforcement of noise and vibration sensitivity should be raised at toolbox meetings.

Community Consultation

The community is more likely to be understanding and accepting of noise if the information provided is frank, does not attempt to understate the likely noise level, and if commitments are firmly adhered to.

Notification Before & During Construction

- Provide, reasonably ahead of time, information such as total building time, what works are expected to be noisy, their duration, what is being done to minimise noise and when respite periods will occur. For works outside standard hours, inform affected residents and other sensitive land use occupants between five and 14 days before commencement.
- Provide information to neighbours before and during construction through media such as letterbox drops, meetings or individual contact. In some areas, the proponent will need to provide notification in languages other than English. A website could also be established for the project to provide information.
- Use a site information board at the front of the site with the name of the organisation responsible for the site and their contact details, hours of operation and regular information updates. This signage should be clearly visible from the outside and include after hours emergency contact details.
- Maintain good communication between the community and project staff.
- Appoint a community liaison officer where required.
- For larger projects consider a regular newsletter with site news, significant project events and timing of different activities.
- Provide a dedicated contact phone number for enquiries during the works.
- Facilitate contact with people to ensure that everyone can see that the site manager understands potential issues, that a planned approach is in place and that there is an ongoing commitment to minimise noise.

Complaints Handling

- Provide a readily accessible contact point, for example, through a dedicated information and complaints line.
- Give complaints a fair hearing.
- Have a documented complaints process, including an escalation procedure so that if a complainant is not satisfied there is a clear path to follow.
- Call back as soon as possible to keep people informed of action to be taken to address noise problems. Call back at night-time only if requested by the complainant to avoid further disturbance.
- Provide a quick response to complaints, with complaint handling staff having both a good knowledge of the project and ready access to information.
- Implement all feasible and reasonable measures to address the source of complaint.
- Keep a register of any complaints, including details of the complaint such as date, time, person receiving complaint, complainant's contact number, person referred to, description of the complaint, work area (for larger projects), time of verbal response and timeframe for written response where appropriate.

Complaint Resolution

If there are complaints concerning noise once the project has started, the steps below can be followed to address the noise. A copy of the complaints register should be kept on site.

Step 1: Noise sources that may have caused the complaint should be identified.

Step 2: Answer the following questions regarding each noise source:

- Is the noise from the source loud either in an absolute sense or relative to other noise sources in the area?
- Does the noise include any tones or impulses?
- Does the noise occur at times when interference with sleep or comfort is likely – for example, at night?

Step 3: Implement feasible and reasonable work practices to minimise or avoid noise.

Compliance Monitoring

Noise monitoring may be required at locations which approximate the nearest noise sensitive receiver where loud and high impact activities are expected to be conducted. The equipment should be set so that email or text alerts are sent to relevant staff if the nominated trigger levels are exceeded. Upon receiving the alert, the relevant staff member should investigate the nature or cause of the event and, if required, implement appropriate action in accordance with the processes outlined above.

The details of the monitoring program including the locations and duration of monitoring will be determined in consultation with the Contractor, Acoustic Engineer engaged on the project, and appropriate authority (where applicable).

Appendix J: Minimum Assumed Construction Distances

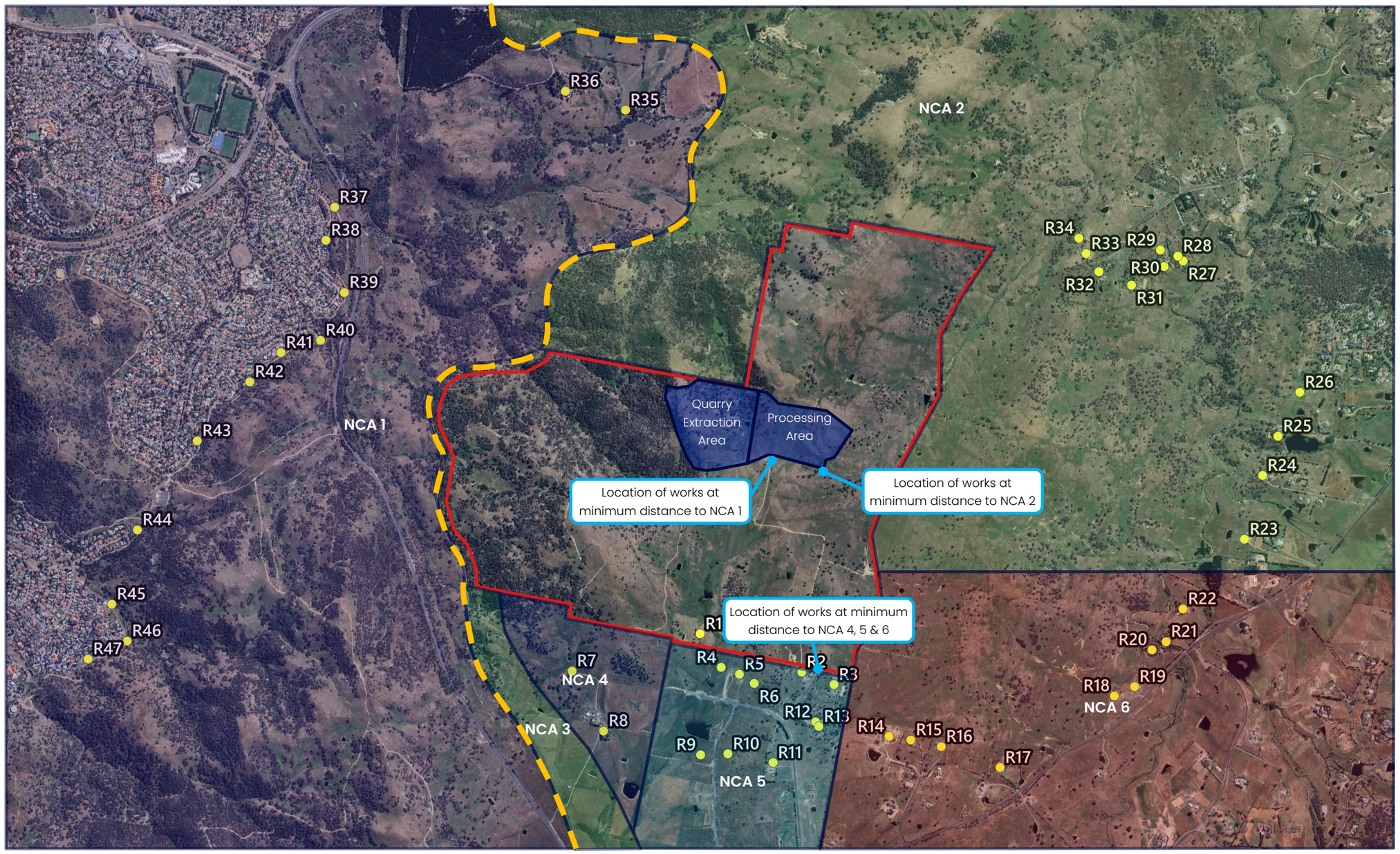


Figure 14 – Minimum Assumed Construction Working Distances for Secondary Access Road

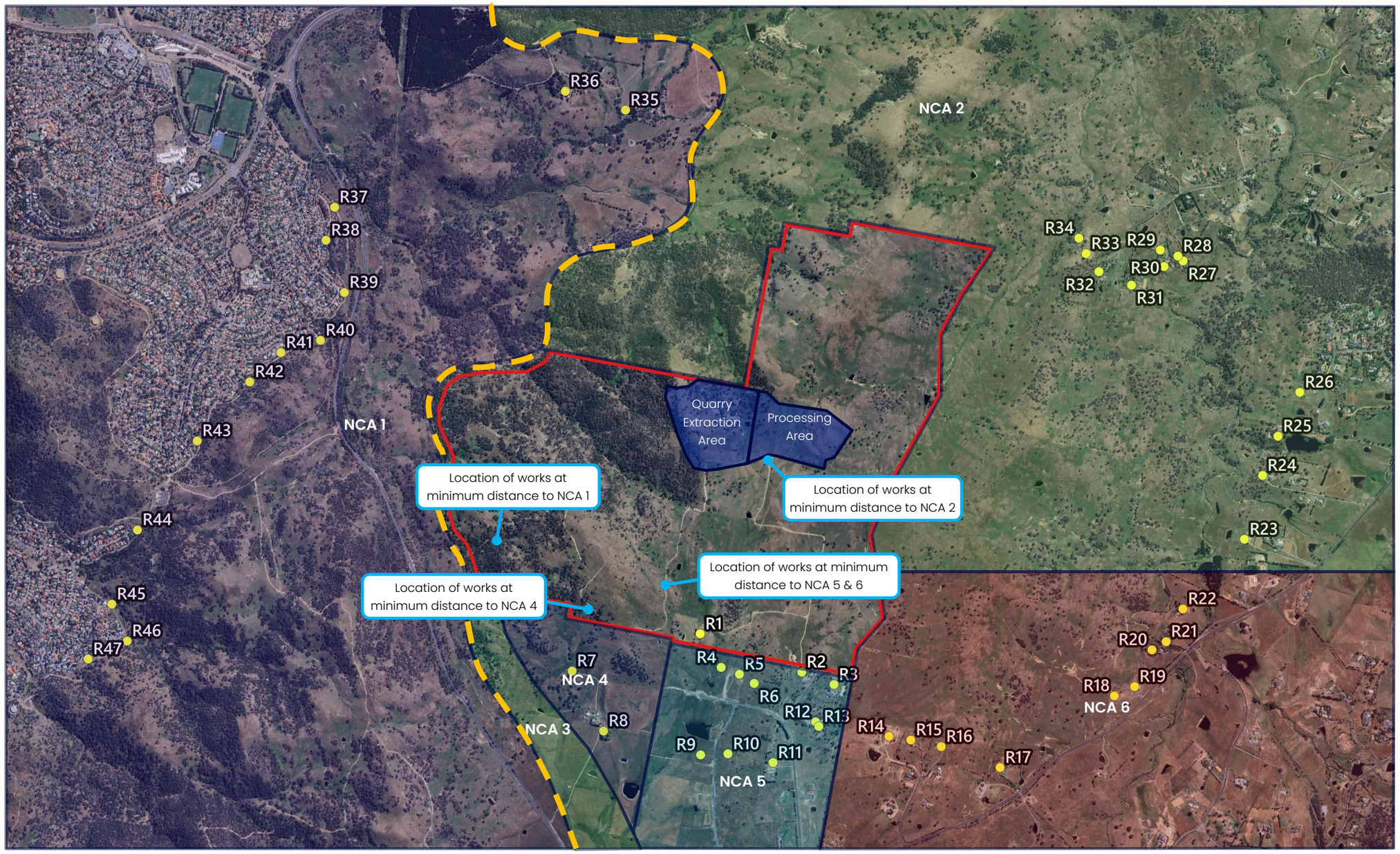


Figure 15 – Minimum Assumed Construction Working Distances for Main Access Road