Appendix D

Noise and vibration impact assessment

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Holcim

Noise and Vibration Impact Assessment

Dubbo Quarry Continuation Project

Report Number

J180313 RP17

Client

Holcim (Australia) Pty Ltd

Date

14 January 2021

Version

Final

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14 January 2021

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1 Introduction

1.1 Overview

Holcim (Australia) Pty Ltd (Holcim) is the owner and operator of Dubbo Quarry (referred in this report as 'the quarry' or 'the site') which is located on Sheraton Road, Dubbo (refer Figure 1.1). The quarry has been in operation since 1980 under a development consent granted by Dubbo Regional Council (DRC). Accessible basalt resources within the existing quarry boundary (refer Figure 1.2) are close to exhaustion and planning approval is required to allow the quarry to continue operating. Holcim is, therefore, seeking approval for the Dubbo Quarry Continuation Project (henceforth referred to as 'the project') which involves the continued operation of the quarry through the development of two new resource areas to the south and west of the existing quarry boundary (refer Figure 1.2).

The project is classified as State significant development (SSD) under Part 4, Division 4.1 of the NSW *Environmental Planning Assessment Act 1979* (EP&A Act). This report will accompany the environmental impact statement (EIS) prepared for the project.

1.2 The site

The quarry is located within Dubbo Regional Local Government Area (LGA) approximately 1.9 km to the east of the city of Dubbo. The quarry is accessed via Sheraton Road which connects to the Mitchell Highway approximately 2 km north-west of the quarry.

The project area relates to the following land as shown on Figure 1.2:

- Lot 222 DP 1247780, owned by Holcim;
- Part Lot 221 DP 1247780, owned by an adjacent landowner on which the existing access road is located;
- Part Lot 100 DP 628628, for which Holcim propose to enter into an Access Licence with the landowners; and
- Crown Land where the project area crosses Eulomogo Creek.

Development consent for Dubbo Quarry was originally granted by Talbragar Shire Council on 18 March 1980 under SPR79/22 (the existing consent). This consent related to the establishment of a basalt quarry on former Portions 208 and 211, Parish Dubbo (the existing site) and contains eight conditions with no restrictions on production rates or operating hours. Holcim also holds Environment Protection Licence (EPL) No. 2212 for land-based extraction activities between 100,000 and 500,000 tonnes per annum (tpa).

The quarry produces high quality aggregates for use in the construction industry, such as concrete and asphalt production, and for use as road base. Precoated sealing aggregates from crushed basalt are produced at the quarry. The quarry produces many types of road base, both specification and non-specification, such as the premium road base product Heavy Duty DGB20 which is frequently used by local councils and Transport for NSW for the construction and upgrade of roads.

1.3 Project overview

The project involves continued operations within the existing site and into two new resource areas as described below (refer Figure 1.2):

- the existing approved disturbance boundary within Lot 222 DP 1247780;
- the Western Extension Area (WEA) which is west and north-west of the existing quarry boundary, located within Lot 222 DP 1247780 (north and south of Sheraton Road; and
- the Southern Extension Area (SEA) which is south of the existing quarry boundary on the southern side of Eulomogo Creek, located within part Lot 100 DP 628628.

A new haul road and crossing over Eulomogo Creek would also be constructed as part of the project to connect the existing site with the SEA. The quarry's access road, which connects to Sheraton Road, is to be relocated around the boundary of the WEA.

The existing consent for quarry operations places no restriction on production, with the existing infrastructure having the capacity to produce a maximum of 500,000 tpa. At a maximum production rate of 500,000 tpa, consistent with the existing operations, the two proposed extension areas provide sufficient resource for quarry operations to continue for approximately 20–25 years.

1.4 Report objectives

This noise and vibration impact assessment (NVIA) has been prepared by EMM to assess the potential operational noise, construction noise, blasting and road traffic noise impacts associated with the project.

This assessment addresses the relevant Secretary's Environmental Assessment Requirement (SEARs) (refer to Section 1.5) and has been prepared in accordance with all relevant NSW Environment Protection Authority (EPA) and Department of Planning, Industry and Environment (DPIE) policies and guidelines.

1.5 Secretary's Environmental Assessment Requirements

The SEARs for the project were issued on 3 April 2020. The SEARs related to noise and vibration and where they are addressed in this NVIA are provided in Table 1.2.

Table 1.1 Noise and vibration related SEARs

SEARs item – Noise and Blasting	Where addressed in NVIA
The EIS must address the following key issues: · Noise & Blasting – including:	
- a detailed assessment of the likely construction, operational and off- site 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;	Sections 3, 4 and 5
- proposed blasting hours, frequency and methods;	Section 4.2

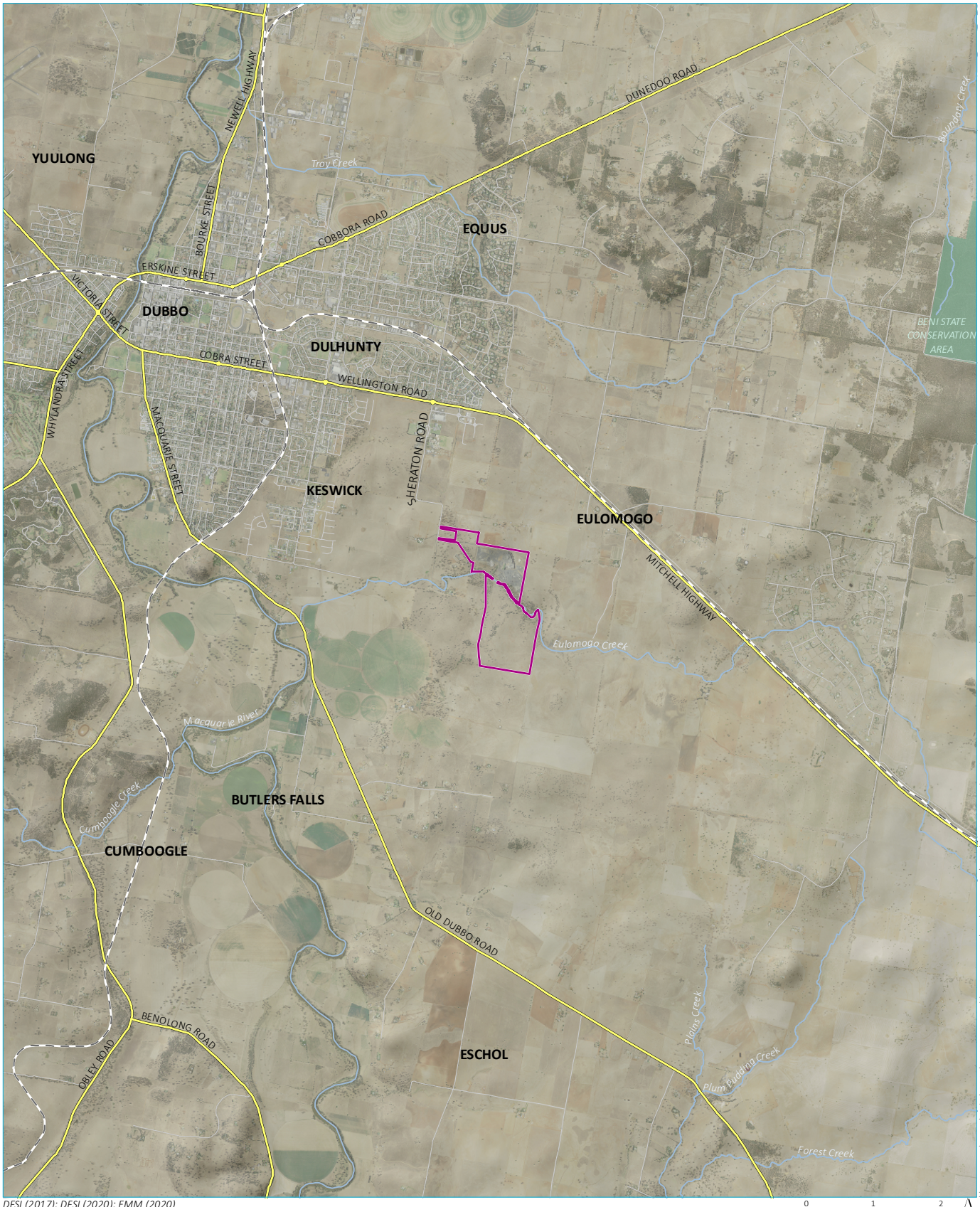
Table 1.1 Noise and vibration related SEARs

SEARs item – Noise and Blasting	Where addressed in NVIA
- 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 ANZEC guidelines; and	Section 5.4
- a detailed consideration of cumulative impacts of developments in the area, and having particular regard to potential impacts on sensitive receivers to the west;	Sections 3.1 and 5.1

In addition to the above SEARs, the EPA in its letter dated 29 January 2020 to DPIE have raised additional comments, as discussed in Table 1.2 below.

Table 1.2 EPA requirements – noise and vibration

Requirements		Report section
1.	Construction noise associated with the proposed development should be assessed using the Interim Construction Noise Guideline (DECC 2009).	Sections 3.5 and 5.2
2.	Vibration from all activities (including construction and operation) to be undertaken on the premises should be assessed using the guidelines contained in Assessing Vibration: a technical guideline (DEC 2006).	Section 3.6
3.	If blasting is required for any reasons during the construction or operational stage of the proposed development, 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).	Sections 3.6 and 5.4
4.	Operational noise from all industrial activities proposed (including private haul roads and private railway lines) to be undertaken on the premises should be assessed using the Noise Policy for Industry (EPA 2017).	Sections 3.1, 3.2 and 5.1
5.	Noise from increased road traffic on public roads should be assessed in accordance with the NSW Road Noise Policy (DECCW 2011) and associated application notes.	Sections 3.7 and 5.5



DFSI (2017); DFSI (2020); EMM (2020)

0 1 2 km

GDA 1994 MGA Zone 55

N

KEY

- Project area
- Rail line
- Major road
- Minor road
- Named watercourse
- NPWS reserve

Local context

Dubbo Quarry Continuation Project
Noise and Vibration Impact Assessment
Figure 1.1

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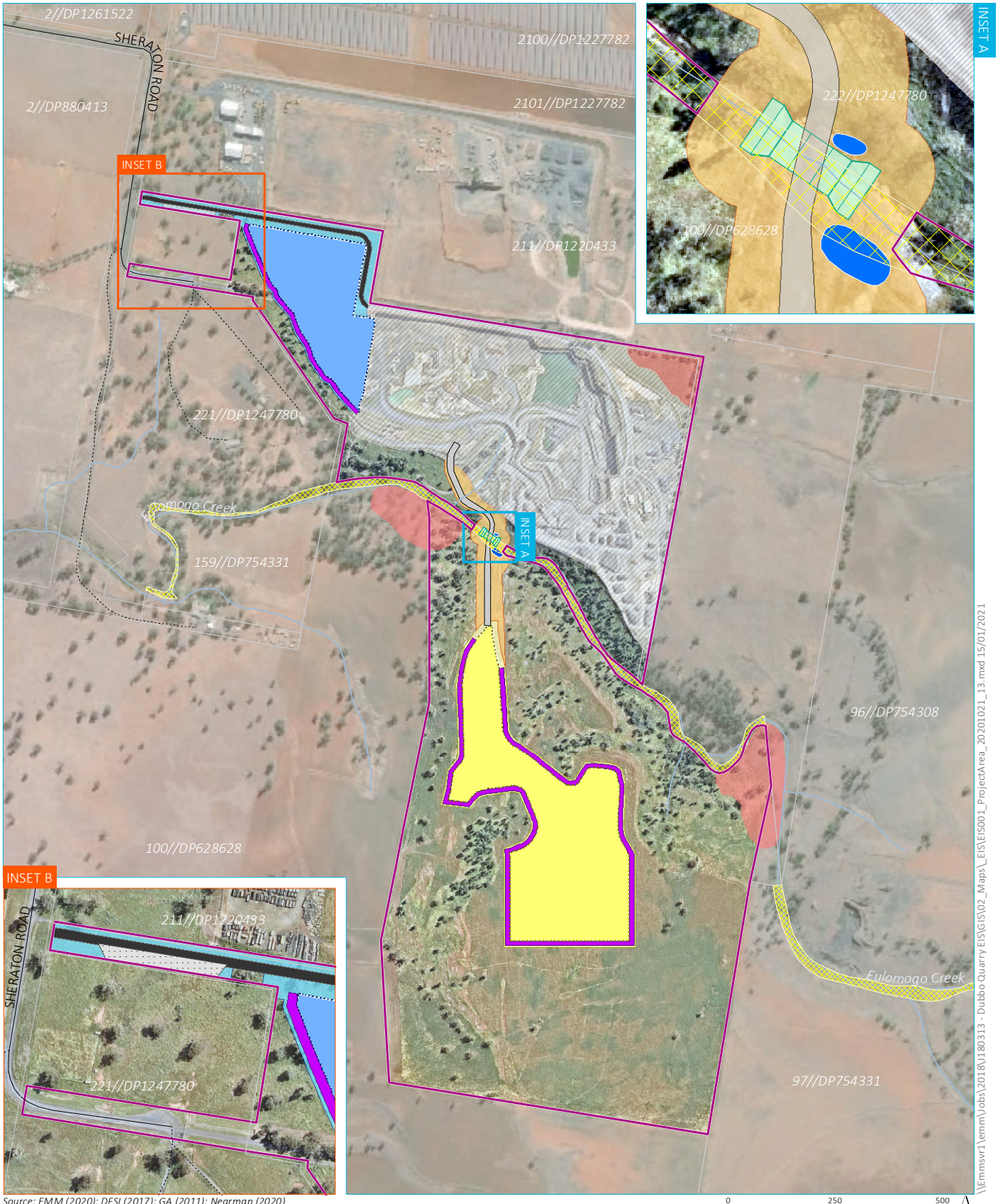

Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020)

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KEY

- Project area
- Sediment pond
- Aboriginal protection zone
- Indicative existing disturbance area
- Proposed haul road
- Indicative proposed water crossing
- Bund wall
- Proposed access road
- Truck tarping area
- Western extension area
- Western disturbance area
- Haul road disturbance area
- Southern extension area
- Southern disturbance area
- Minor road
- Vehicular track
- Watercourse/drainage line
- Waterbody
- Cadastral boundary (data does not align with surveyed site boundary)
- Crown land

Project site

Dubbo Quarry Continuation Project
Noise and Vibration Impact Assessment
Figure 1.2

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2 Existing environment

2.1 Noise and vibration assessment locations

The nearest representative noise sensitive locations to the quarry have been identified for the purpose of assessing potential noise and vibration impacts from the project. These locations were selected to represent the range and extent of noise impacts from the project and are referred to in this report as assessment locations. Details are provided in Table 2.1 and their locations are shown in Figure 2.1.

Table 2.1 Noise and vibration assessment locations

Assessment location ID	Receiver type	Easting	Northing
R1	Residential	655384	6427170
R2	Residential	655320	6426775
R3	Residential	654875	6427538
R4	Residential	655838	6428439
R5	Residential	657491	6427569
R6a	Residential	654596	6425165
R6b	Residential	654523	6425082
R7	Residential	655905	6424191
R8	Residential	655746	6424154
R9	Commercial	654823	6428948
R10	School	654942	6429244
R11	School	655013	6429009
R12	School	655075	6429237
R13	Residential	656466	6428804
R14	Residential	657233	6428009
R15	Residential	657502	6427973
R16	Residential	657768	6427678
R17	Industrial	656274	6427898
R18	Residential	653862	6427551
R19	Residential	654038	6427592
R20	Residential	656647	6424074
R21	Residential	656142	6423858
R22	Residential	657799	6427195
R23	Residential subdivision (approved)	655196	6428133

2.2 Background noise levels

Background noise levels were surveyed at the locations shown on Figure 2.1 for the adjacent (immediately north) South Keswich Quarry Project in 2016. The method and results from the ambient noise survey are documented in the noise and vibration impact assessment completed for the South Keswich Quarry Project (MAC Acoustics 2016). The results from the ambient noise survey are reproduced in Table 2.2.

Of relevance is that measured data shows rating background levels (RBLs) or background noise levels were lower than the *Noise Policy for Industry* (NPfI) (EPA 2017) minimum background noise level thresholds of 35 dB for the day period and 30 dB for the evening and night periods. Therefore, the NPfI minimum background noise level thresholds were adopted in this assessment in accordance with the NPfI. Furthermore, observations from the ambient noise survey also noted that noise from existing quarry operations were barely audible at the time of the attended noise monitoring and was considered to have negligible influence on measured background noise levels.

Table 2.2 Summary of measured existing background and ambient noise levels

Noise monitoring location	Period[1]	RBL, dB(A)	Measured $L_{Aeq,period}$ noise level[2], dB
L1	Day	30	47
	Evening	27	36
	Night	20	39
L2	Day	32	44
	Evening	30	40
	Night	21	41
L3	Day	34	45
	Evening	29	53
	Night	19	44

Source: MAC 2016.

Notes: 1. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; Evening: 6 pm to 10 pm; Night: 10 pm to 7 am, Sunday to Friday and 10 pm to 8 am Saturday and public holidays.
2. The energy averaged noise level over the measurement period and representative of general ambient noise.

The existing noise environment at residential assessment locations would be very similar to the areas where long-term background noise surveys were undertaken. Therefore, it is reasonable to conclude that the NPfI minimum background noise level thresholds would also apply to residential assessment locations surrounding the site.

2.3 Quarry noise

2.3.1 Existing plant and equipment

A site visit to measure sound power levels of plant and equipment currently in operation at the quarry was undertaken by EMM on 7 July 2020.

Sound power levels have been measured and derived in general accordance with ISO 6393:2019 'Earth-moving machinery – Determination of sound power level – Stationary test conditions' or ISO 6395:2008 'Earth-moving machinery – Determination of sound power level – Dynamic test conditions'.

The sound power level results for plant and equipment measured during the site visit are provided in Table 2.3.

Table 2.3 Measured plant and equipment sound power levels

Plant and equipment measured on-site	Sound power level ($L_{Aeq,15min}$) dB
Primary crusher and rock breaker – Lemco Jaw Crusher and AtlasCopco Rammer	114
Processing plant transfer point/conveyor drive	94
Secondary crusher/primary screen – Eljay Cone Crusher/Astec Flat 3 Deck[1]	117
Tertiary Crusher – Cedarapids Impactor	107
Secondary screen – Jacques Inclined 3 Deck	107
Tertiary screen – Cedarapids 3 Deck	107
Quaternary screen – 2 Deck	104
Precision screen – Pugmill Scorpion	107
Excavator (loading dump truck) – CAT 349ME (49t)	112
Front end loader (loading haul truck) – CAT 980 (30t)	108
Water pump (in pit)	102

Notes: 1. Secondary crusher and primary screen operate closely together, and hence separate measurements was not possible.

2.3.2 Boundary and offsite noise levels

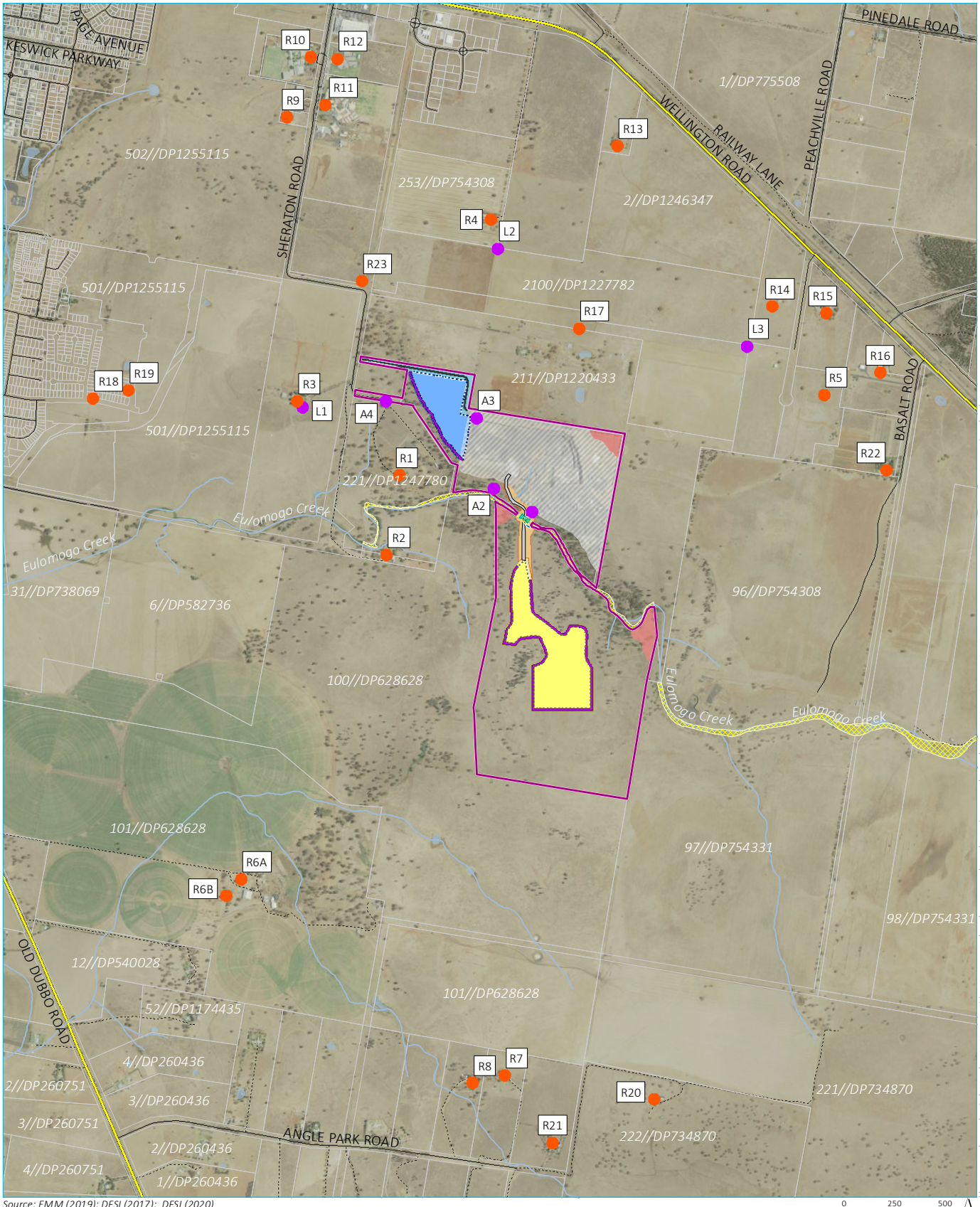
To gain an understanding of offsite noise emissions, a series of operator-attended noise measurements were undertaken at site boundaries and intermediate points between the quarry and assessment locations as shown on Figure 2.1. The measurements were undertaken in accordance with Australian Standard AS 1055-1997 *"Acoustics – Description and Measurement of Environmental Noise".*

The measured quarry noise contributions were used to calibrate the noise model developed for the project (Section 4.1.2). The results of the measurements are presented in Table 2.4.

Table 2.4 Summary of boundary and offsite quarry noise levels

Attended monitoring location	Site L_{Aeq} noise contribution[1], dB	Audible quarry source(s) and comments
A1 – Site boundary	56	Processing plant consistently audible and dominant. Shielded by intervening terrain.
A2 – Site boundary	59	Processing plant consistently audible and dominant.
A3 – Site Boundary	53	Processing plant consistently audible and dominant, dump truck at primary crusher, dump truck traversing, front-end loaders and excavator operating. Neighbouring quarry audible.
A4 – R2 driveway	43	Processing plant consistently audible and dominant, dump truck at primary crusher and road truck passbys. Neighbouring quarry occasionally audible.

Notes: 1. The duration of the measurements varied between 2 and 15 minutes and are considered relatively representative of a typical 15-minute operational period for the quarry source(s) measured.



Source: EMM (2019); DFSI (2017); DFSI (2020)

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GDA 1994 MGA Zone 55

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KEY

- Reciever location
- Noise monitoring location
- Project area
- Sediment pond
- Aboriginal protection zones
- Indicative existing disturbance area
- Proposed haul road
- Indicative proposed water crossing
- Bund wall
- Proposed access road
- Truck tarping area
- Western extension area
- Western disturbance area
- Haul road disturbance area
- Southern extension area
- Southern disturbance area
- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line
- Cadastral boundary (data does not align with surveyed site boundary)
- Crown land

Noise monitoring and assessment locations

Dubbo Quarry Continuation Project
Noise and Vibration Impact Assessment
Figure 2.1

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2.3.3 Noise complaint history

No complaints have been received to date from the surrounding community in relation to noise from quarry operations.

2.4 Meteorology

The NPfI requires assessment of noise under standard and noise-enhancing weather conditions. The NPfI defines these as follows.

- Standard meteorological conditions: defined by stability categories A through to D with wind speeds up to 0.5 metres per second (m/s) at 10 m above ground level (AGL) for day, evening and night periods.

- Noise-enhancing meteorological condition: defined by stability categories A through to D with light winds (up to 3 m/s at 10 m AGL) for the day and evening periods; and stability categories A through to 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.

The NPfI specifies the following two options to consider meteorological effects:

1. Adopt the noise-enhancing meteorological conditions for all assessment periods for noise impact assessment purposes without an assessment of how often these conditions occur – a conservative approach that considers source-to-receiver wind vectors for all assessment locations 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.

2.4.1 Winds

The NPfI recommends consideration of wind effects if they are “significant”. The NPfI defines “significant” as the presence of source-to-receiver wind speed (measured at 10 m above ground level) of 3 m/s or less, occurring for 30% of the time in any assessment period and season.

This is further clarified by defining source-to-receiver wind direction as being the directional component of wind. The NPfI states that where wind is identified to be a significant feature of the area then assessment of noise impacts should consider the highest wind speed below 3 m/s, which is considered to prevail for at least 30% of the time.

Conservatively, this assessment has adopted the NPfI’s first option above in assessing noise assuming prevalence of noise enhancing winds to all assessment locations, and hence an analysis to determine the significance of the noise-enhancing winds for the project was not undertaken.

2.4.2 Temperature inversions

The quarry will operate in limited capacity during the early morning hours (night period), including road trucks dispatching products, and hence temperature inversions were considered for this assessment.

Conservatively, this assessment has adopted the NPfI’s first option above in assessing noise assuming prevalence of noise enhancing temperature inversion conditions to all assessment locations for the night period.

3 Assessment criteria

3.1 Operational noise

Operational noise associated with quarrying activities at the site will be from plant and equipment, including road trucks travelling in and out of site.

Noise from development in NSW is regulated by the local council, DPIE and/or the EPA, and sites generally have a licence and/or development consent conditions stipulating noise limits. These limits are typically derived from project specific noise trigger or operational noise levels predicted at assessment locations. They are based on EPA guidelines (ie NPfI or previous Industrial Noise Policy) or noise levels that can be achieved by a specific site following the application of all feasible and reasonable noise mitigation.

The objectives of noise trigger levels established in accordance with the NPfI are to protect the community from excessive intrusive noise and preserve amenity for specific land uses. It should be noted that the audibility of a noise source does not necessarily equate to disturbance at an assessment location.

To ensure these objectives are met, the EPA provides project specific noise trigger levels, namely intrusiveness and amenity noise levels as described in the NPfI.

The quarry does not currently have noise limits stipulated in its development consent nor its Environment Protection Licence (EPL No. 2122).

3.1.1 Intrusiveness noise levels

The NPfI intrusiveness noise levels require that $L_{Aeq,15min}$ noise levels (energy average noise level over a 15-minute period) from the project do not exceed the RBL by more than 5 dB during the relevant operational periods. The intrusiveness noise levels are only applicable at residential assessment locations.

The project intrusiveness noise levels based on the adopted RBLs for the day and night periods (refer to Table 2.2) are presented in Table 3.1. Where assessment locations have been grouped together in the following tables, it is expected that the ambient noise environment at these assessment locations is similar. Intrusiveness noise levels are only applicable at residential assessment locations.

Table 3.1 Project intrusiveness noise levels

Residential assessment locations	Assessment period[1]	Adopted RBL, dB(A)	Project intrusiveness noise level (RBL + 5 dB), $L_{Aeq,15min}$, dB
R1-R8, R13-R16, R18, R20-R22	Day	35[2]	40
	Night	30[3]	35

Notes: 1. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; Night: 10 pm to 7 am Monday to Saturday; 10 pm to 8 am Sundays and public holidays.
2. The NPfI minimum RBL of 35 dB for the day period has been adopted.
3. The NPfI minimum RBL of 30 dB for the night period has been adopted.

3.1.2 Amenity noise levels

The assessment of amenity is based on noise levels specific to the land use. The noise levels relate only to industrial noise and exclude road or rail traffic noise. Where the measured existing industrial noise approaches the recommended amenity noise level (RANL), it needs to be demonstrated that noise levels from new developments will not contribute to existing industrial noise such that the RANLs are exceeded.

To ensure that industrial noise levels (existing plus new) remain within the RANLs for an area, the project amenity noise level for a new industrial development is the RANL (outlined in Table 2.2 of the NPfI) minus 5 dB. This approach has been adopted for this assessment and assumes that a receiver can be impacted by up to three or four individual industrial sites (or noise sources). It is noted that this is not true in all cases for the project as some assessment locations (eg R6a, R6b, R7, R20) may not be impacted by other industrial developments currently or in the future, and hence this is a conservative approach.

The project amenity noise levels are based on the NPfI 'rural' or 'suburban' noise amenity categories. The NPfI states the following definitions:

- Rural – an area with an acoustical environment that is dominated by natural sounds, having little to no road traffic noise and generally characterised by low background noise levels. Settlement patterns would be typically sparse.

- Suburban – an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry. This area often has the following characteristic: evening ambient noise levels defined by the natural environment and human activity.

The project amenity noise levels are presented in Table 3.2.

Table 3.2 Project amenity noise levels

Assessment locations	Indicative amenity area	Assessment period[1]	Project amenity $L_{Aeq,period}$ noise level[2] (RANL -5), dB
R1 to R8, R13-R16, R20-R22	Residential – Rural	Day	45
		Night	35
R18, R19	Residential – Suburban	Day	50
		Night	35
R23	Approved subdivision – Suburban	Day	50
		Night	35
R10-R12	School classroom – Internal	Noisiest 1-hour when in use	30 (40 external)[3]
R9	Commercial	When in use	60
R17	Industrial	When in use	65

Source: NPfI (EPA 2017)

Notes: 1. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; Night: 10 pm to 7 am Monday to Saturday; 10 pm to 8 am Sundays and public holidays. It is noted that the site does not operate during the evening period (ie 6 pm to 10 pm).
2. Project amenity noise level is the RANL (Table 2.2 of NPfI) minus 5 dB in accordance with Section 2.4 of the NPfI.
3. External level based on an external-to-internal noise reduction of 10 dB as per the NPfI.

3.1.3 Project noise trigger level

The project noise trigger level (PNTL) is the lower of the calculated intrusiveness or amenity noise levels. Taking account of the measured background noise levels, project intrusive noise levels and project amenity levels for residential assessment locations, a summary of the PNTLs for the assessment of noise from quarry operations is presented in Table 3.3 based on current zoning and land use.

Table 3.3 Project noise trigger levels

Assessment locations	Assessment period[1]	Intrusiveness noise level $L_{Aeq,15min}$, dB	Amenity noise level[2] $L_{Aeq,15min}$, dB	PNTL[3] $L_{Aeq,15min}$, dB
R1 to R8, R13-R16, R20-R22	Day	40	48	40
	Night	35	38	35
R18, R19	Day	40	53	40
	Night	35	38	35
R23[4]	Day	n/a	n/a	n/a
	Night	n/a	n/a	n/a
R10-R12	Noisiest 1-hour when in use	n/a	40[5]	40
R9	When in use	n/a	63	63
R17	When in use	n/a	68	68

Notes: 1. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; Night: 10 pm to 7 am Monday to Saturday; 10 pm to 8 am Sundays and public holidays.
2. The project amenity $L_{Aeq,15min}$ noise level is the RANL $L_{Aeq,period}$ +3 dB as per the NPfI, unless noted otherwise.
3. The PNTL is the lower of the calculated intrusiveness or amenity noise levels.
4. Residential vacant land approved for subdivision; hence amenity criteria apply as per the VLAMP as described later.
5. Noisiest 1-hour.

3.2 Sleep disturbance

The quarry will continue to operate during the early morning hours (night period) and therefore, in accordance with the NPfI, the potential for sleep disturbance has been assessed.

The NPfI suggests that a detailed maximum noise level event assessment should be undertaken where the development night-time noise levels at a residential location exceed the following screening criteria:

- $L_{Aeq,15min}$ 40 dB or the prevailing RBL plus 5 dB (whichever is the greater); and/or
- L_{Amax} 52 dB or the prevailing RBL plus 15 dB (whichever is the greater).

The sleep disturbance screening criteria adopted for all residential assessment locations are provided in Table 3.4.

Table 3.4 Project maximum noise level event screening criteria

Residential assessment locations	Adopted night RBL, dB(A)	Maximum noise level event screening criteria, dB	
		RBL +5 dB or standard[1]	RBL +15 dB or standard[1]
		$L_{Aeq,15min}$	L_{Amax}
R1-R8, R13-R16, R18-R22	30	40	52

Notes: 1. Whichever is greater.

3.3 Mitigating noise

Where noise levels from the project are predicted above the PNTLs, all feasible and reasonable mitigation measures are to be considered for the project to reduce noise levels towards the PNTL before any residual impacts are identified and addressed.

The significance of the residual noise impacts is generally based around the human perception to changes in noise levels in the environment as explained in the glossary of the acoustic terms (refer to Section 7). For example, a 1 to 2 dB change in noise level is typically indiscernible to the human ear. The characterisation of a residual noise impact of 1 to 2 dB above the PNTL is, therefore, considered negligible. The NPfI characterisation of residual noise impacts is outlined further in Table 3.5, reproduced from Table 4.1 of the NPfI.

Table 3.5 Significance of residual noise impacts

If the predicted noise level minus the project noise trigger level is:	And the total cumulative industrial noise level is:	Then the significance of the residual noise level is:
≤2 dB	Not applicable	Negligible
≥3 but ≤5 dB	< recommended amenity noise level or > recommended amenity noise level, but the increase in total cumulative industrial noise level resulting from the development is ≤1 dB	Marginal
≥3 but ≤5 dB	> recommended amenity noise level and the increase in total cumulative industrial noise level resulting from the development is >1 dB	Moderate
>5 dB	≤ recommended amenity noise level	Moderate
>5 dB	> recommended amenity noise level	Significant

Source: NPfI (EPA 2017).

3.4 Voluntary Land Acquisition and Mitigation Policy

The *Voluntary Land Acquisition and Mitigation Policy For State Significant Mining, Petroleum and Extractive Industry Developments* (VLAMP) (DPIE 2018) outlines how acquisition and mitigation rights are assigned to landholders to address noise and air quality impacts from state significant mining, petroleum and extractive industry developments.

The three outcomes of the VLAMP are:

- negotiated agreements;
- voluntary mitigation; and
- voluntary acquisition.

There are a number of policies and guidelines developed by the NSW Government to guide the assessment of potential impacts of development for mining, petroleum and extractive industries in NSW. The policies and guidelines include criteria for assessment of amenity, health and safety of people. Feasible and reasonable mitigation measures are considered in the application of the criteria. However, in some circumstances compliance with criteria is not possible even with all feasible and reasonable mitigation measures incorporated.

However, it is important to recognise that:

- not all exceedances of the relevant assessment criteria equate to unacceptable impacts;
- consent authorities may decide that it is in the public interest to allow the development to proceed, even though there would be exceedances of the relevant assessment criteria, because of the broader social and economic benefits of the development; and
- some landowners may be prepared to accept higher impacts on their land, subject to entering into suitable negotiated agreements with applicants, which may include the payment of compensation.

Consequently, the VLAMP assessment process can lead to a range of possible outcomes.

Under the VLAMP, if a development cannot comply with the relevant impact assessment criteria, or if the mitigation or acquisition criteria are likely to be exceeded, the applicant should consider a negotiated agreement with the affected landowner or acquisition of the land. In doing so, the land is then no longer subject to the impact assessment, mitigation or acquisition criteria, with the exception of the provisions that apply under the "Use of acquired land", which is primarily related to informing and protecting existing or prospective tenants.

In relation to noise, the VLAMP states the following regarding the application of voluntary mitigation and voluntary land acquisition:

> A consent authority can apply voluntary mitigation and voluntary land acquisition rights to reduce:
>
> - operational noise impacts of a development on privately owned land; and
> - rail noise impacts of a development on privately owned land near a non-network rail line (private rail line), that is on, or exclusively servicing and industrial site (see Appendix 3 of the Rail Infrastructure Noise Guideline (RING) (EPA 2013));
>
> But not:
>
> - construction noise impacts, as these impacts are shorter term and can be controlled;
> - noise impacts on the public road or rail network; or
> - modifications of existing developments with legacy noise issues, where the modification would have beneficial or negligible noise impacts[13].
>
> [13] Noise issues for existing premises may be addressed through site-specific pollution reduction programs under the *Protection of the Environment Operations Act 1997*.

Of the most relevance to the project, is the last point above relating to the relative noise impact of the proposed operation compared to the existing development. This assessment demonstrates that the noise emissions from the project are predicted to be relatively the same as existing operational noise emissions at all assessment locations.

The key steps in the application of the VLAMP process are summarised in Figure 3.1.

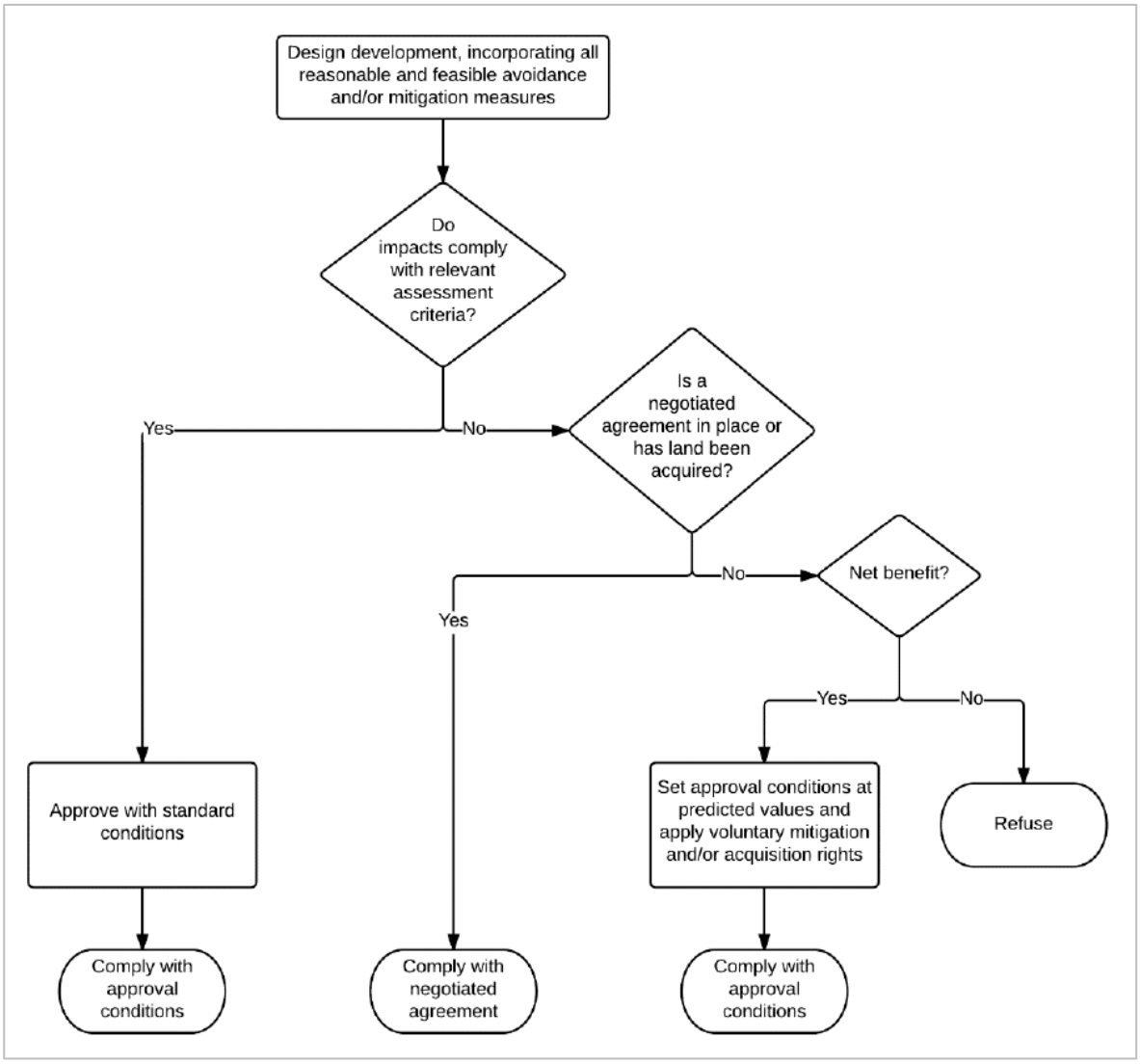


Figure 3.1 VLAMP process

The characterisation of the noise impacts (as outlined in the VLAMP) are generally based on human perception to changes in noise levels as explained in the glossary of the acoustic terms in this report. For example, a change in noise level of 1 to 2 dB is typically indiscernible to the human ear. The characterisation of a residual noise impact of 0 to 2 dB above the PNTL is therefore considered negligible.

Voluntary mitigation or voluntary acquisition rights apply when a development contributes to exceedances of the criteria set out in Table 1 of the VLAMP.

Voluntary mitigation rights apply to any residence on privately-owned land if, even with the implementation of best practice management at the site, in the opinion of the consent authority:

- the noise generated by the development would meet the requirements in Table 3.6, 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 and noise levels at the residence are already above the recommended amenity noise levels in Table 2.2 of the NPfI; or

- the development includes a private rail line and the use of that private rail line would cause exceedances of the recommended acceptable levels in Table 6 of Appendix 3 of the RING (EPA 2013) by greater than or equal to 3 dB at any residence on privately-owned land.

Voluntary acquisition rights apply to any residence on privately-owned land if, even with the implementation of best practice management at the site, in the opinion of the consent authority:

- the noise generated by the development would be characterised as significant, according to Table 3.6, at any residence on privately-owned land; or
- the noise generated by the development would contribute to exceedances of the acceptable noise levels plus 5 dB in Table 2.2 of the NPfI 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; or
- the development includes a private rail line and the use of that private rail line would cause exceedances of the recommended maximum criteria in Table 6 of Appendix 3 of the RING (EPA 2013) at any residence on privately-owned land.

The VLAMP characterisation of residual noise impacts is outlined further in Table 3.6 and is generally consistent with that in the NPfI described in the previous section.

Table 3.6 VLAMP characterisation of noise impacts and potential treatments

If the predicted noise level minus the project noise trigger level is:	And the total cumulative industrial noise level is:	Characterisation of impacts	Potential treatment
All time periods 0–2 dB	Not applicable	Impacts are considered to be **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	Less than recommended amenity noise level Greater than recommended amenity noise level but the increase in total cumulative industrial noise level resulting from development is <1 dB	Impacts are considered to be **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	Greater than recommended amenity noise level and the increase in total cumulative industrial noise level resulting from the development is >1 dB	Impacts are considered to be **moderate**	As for marginal impacts but also upgraded façade elements like windows, doors or roof insulation, to further increase the ability of the building façade to reduce noise levels.
Day and evening >5 dB	Less than recommended amenity noise level	Impacts are considered to be **moderate**	As for marginal impacts but also upgraded façade elements like windows, doors or roof insulation, to further increase the ability of the building façade to reduce noise levels.

Table 3.6 VLAMP characterisation of noise impacts and potential treatments

If the predicted noise level minus the project noise trigger level is:	And the total cumulative industrial noise level is:	Characterisation of impacts	Potential treatment
Day and evening >5 dB	Greater than recommended amenity noise level	Impacts are considered to be **significant**	Provide mitigation as for moderate impacts and refer to voluntary land acquisition provisions.
Night >5 dB	Not applicable	Impacts are considered to be **significant**	Provide mitigation as for moderate impacts and refer to voluntary land acquisition provisions.

Source: VLAMP (DPIE 2018).

3.5 Construction noise

The NSW Department of Environment and Climate Change (DECC) *Interim Construction Noise Guideline* (ICNG) (2009) has been jointly developed by NSW Government agencies, including the EPA and DPIE. The objectives of the guideline relevant to the planning process are to promote a clear understanding of ways to identify and minimise noise from construction and to identify feasible and reasonable work practices. The guideline recommends standard construction hours where noise from construction activities is audible at residential premises (ie assessment locations), as follows:

- Monday to Friday 7 am to 6 pm;
- Saturday 8 am to 1 pm; and
- no construction work on Sundays or public holidays.

The ICNG acknowledges that works outside standard hours may be necessary; however, justification should be provided to the relevant authorities.

The ICNG provides two methodologies to assess construction noise emissions. The first is a quantitative approach, which is suited to major construction projects with typical durations of more than three weeks. This method requires noise emission predictions from construction activities at the nearest assessment locations and assessment against ICNG recommended noise management levels.

The second is a qualitative approach, which is a simplified assessment process that relies more on noise management strategies. This method is suited to short-term infrastructure and maintenance projects of less than three weeks in duration.

This assessment has adopted a quantitative approach. The qualitative aspects of the assessment include identification of assessment locations, description of works involved and proposed noise management measures (eg a complaint handling procedure).

3.5.1 Construction noise management levels for residential assessment locations

The ICNG noise management levels (NMLs) which apply to residential assessment locations are provided in Table 3.7.

Table 3.7 Construction NMLs for residential assessment locations

Time of day	NML $L_{Aeq,15min}$	Application
Recommended standard hours: Monday to Friday 7 am to 6 pm, Saturday 8 am to 1 pm, no work on Sundays or public holidays	Noise-affected RBL + 10 dB	The noise-affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq,15min}$ is greater than the noise-affected 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 residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB	The highly noise-affected level represents 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 + 5 dB	• 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 5 dB above the noise-affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see Section 7.2.2 of the ICNG.

Source: ICNG (DECC 2009).

3.5.2 Construction NMLs for other land uses

The ICNG recommended NMLs for other land uses are provided in Table 3.8.

Table 3.8 ICNG construction NMLs for other land uses

Land use	NML, $L_{Aeq,15mi}$
Industrial premises	External noise level 75 dB (when in use)
Offices, retail outlets	External noise level 70 dB (when in use)
Classrooms at schools and other educational institutions	Internal noise level 45 dB (when in use)

Source: ICNG (DECC 2009).

3.5.3 Project construction NMLs

The project construction NMLs for the recommended standard hours are presented in Table 3.9 for all assessment locations.

Table 3.9 Project construction NMLs

Assessment locations	Receiver type	Assessment period	Adopted RBL[1]	NML $L_{Aeq,15min}$, dB
R1-R8, R13-R16, R18-R22	Residential	Day (ICNG standard hours[1])	35[2]	45
R10-R12	School	When in use	n/a	45 (55 external[3])
R9	Commercial	When in use	n/a	70
R17	Industrial	When in use	n/a	75

Notes: 1. Monday to Friday 7 am to 6 pm; Saturday 8 am to 1 pm; and no construction work on Sundays or public holidays.
2. The NPfI minimum RBL of 35 dB for the day period has been adopted in accordance with the ICNG.
3. External level based on an external-to-internal noise reduction of 10 dB in accordance with the ICNG.

3.6 Construction vibration

Vibration criteria for the project has been adopted from the following guidelines and standards:

(a) human comfort limits provided in the NSW *Assessing Vibration: a technical guideline* (DEC 2006);

(b) Australian Standard AS 2187.2 - 2006 "Explosives - Storage and Use - Use of Explosives"; and

(c) BS 7385 Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2" as they are "applicable to Australian conditions".

3.6.1 Human comfort – Assessing vibration: a technical guideline (DEC)

The human comfort assessment criteria provided in the *Assessing Vibration: a technical guideline* (DEC 2006) is based on the limits contained in BS 6472 – 2008 'Evaluation of human exposure to vibration in buildings (1-80Hz)'.

The guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. At vibration values below the preferred values, there is a low probability of adverse comment or disturbance to building occupants. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, it is recommended the operator negotiate directly with the affected community.

The guideline defines three vibration types and provides direction for assessing and evaluating the applicable criteria. Table 2.1 of the guideline provides examples of the three vibration types and has been reproduced in Table 3.10.

Table 3.10 Examples of types of vibration (from Table 2.1 of the guideline)

Continuous Vibration	Impulsive Vibration	Intermittent Vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZECC (1990).	Trains, intermittent nearby construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer these would be assessed against impulsive vibration criteria.

Intermittent vibration is representative of activities such as impact hammering, vibratory rolling or general excavation work (such as an excavator tracking) and, as such, is most relevant to this assessment.

Intermittent vibration (as defined in Section 2.1 of the guideline) is assessed using the vibration dose concept which relates to vibration magnitude and exposure time.

Section 2.4 of the Guideline provides acceptable values for intermittent vibration in terms of vibration dose values (VDV) which requires the measurement of the overall weighted RMS (root mean square) acceleration levels over the frequency range 1 Hz to 80 Hz. To calculate VDV the following formula (refer *section 2.4.1* of the guideline) was used:

$$VDV = \left[\int_0^T a^4(t)dt\right]^{0.25}$$

Where VDV is the vibration dose value in $m/s^{1.75}$, *a (t)* is the frequency-weighted rms of acceleration in m/s^2 and *T* is the total period of the day (in seconds) during which vibration may occur.

The Acceptable Vibration Dose Values (VDV) for intermittent vibration are reproduced in Table 3.11.

Table 3.11 Acceptable vibration dose values (VDV) for intermittent vibration (m/s $^{1.75}$)

Location	Daytime		Night-time	
	Preferred value, m/s$^{1.75}$	Maximum value, m/s$^{1.75}$	Preferred value, m/s$^{1.75}$	Maximum value, m/s$^{1.75}$
Critical Areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes: 1. Daytime is 7 am to 10 pm and night-time is 10 pm to 7 am.
2. These criteria are indicative only, and there may be a need to assess intermittent values against continuous or impulsive criteria for critical areas.

There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values. The Guideline states that activities should be designed to meet the preferred values where an area is not already exposed to vibration.

Given the separation distances, vibration related to proposed construction works is unlikely to impact offsite occupants and hence has not been considered further.

3.7 Blasting

3.7.1 Human perception

The criteria adopted by the EPA for the assessment of blasting impacts for human perception are provided in the Australian and New Zealand Environment Conservation Council (ANZECC) guidelines *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* (the ANZECC guideline) (1990).

The blasting criteria address two main effects of blasting for human perception:

- airblast overpressure; and
- ground vibration.

Airblast overpressure and ground vibration limits exist for the quarry as specified in the EPL. The EPL includes limits for both airblast overpressure and ground vibration. Ground vibration limits provided in the EPL are consistent with the criteria recommended in the ANZECC guideline, as shown in the following sections.

The airblast overpressure level of 115 dB linear peak may be exceeded on up to 5% of the total number of blasts over 12 months. However, the level should not exceed 120 dB linear peak at any time.

The peak particle velocity (PPV) level from ground vibration should not exceed 5 mm/s for more than 5% of the total number of blasts over 12 months. However, the PPV level should not exceed 10 mm/s at any time.

A summary of the blasting criteria for human perception adopted for the project are provided in Table 3.12.

Table 3.12 Project airblast overpressure and ground vibration criteria

Blasting emission	Criteria	Allowable exceedance
Airblast overpressure	115 dB ($L_{linear\ peak}$)	5% of the total number of blasts over 12 months
	120 dB ($L_{linear\ peak}$)	Nil
Ground vibration	5 mm/s (PPV)	5% of the total number of blasts over 12 months
	10 mm/s (PPV)	Nil

3.7.2 Structural vibration

In terms of vibration criteria for structural damage, the Australian Standard AS 2187.2-2006 *Explosives - Storage and Use - Use of Explosives* (AS 2187) recommends that the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2* be used as they are "applicable to Australian conditions" (BS 7385).

AS 2187 sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration that are considered in AS 2187 include demolition, blasting (carried out during resource extraction or construction excavation), piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The recommended limits (guide values) for transient vibration to manage minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 3.13 and graphically in Figure 3.2.

Table 3.13 Transient vibration guide values - minimal risk of cosmetic damage

Line[1]	Type of building	PPV in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s	50 mm/s
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Notes: 1. Refers to the "Line" illustrated in Figure 3.2

AS 2187 notes that the guide values in Table 3.13 relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings.

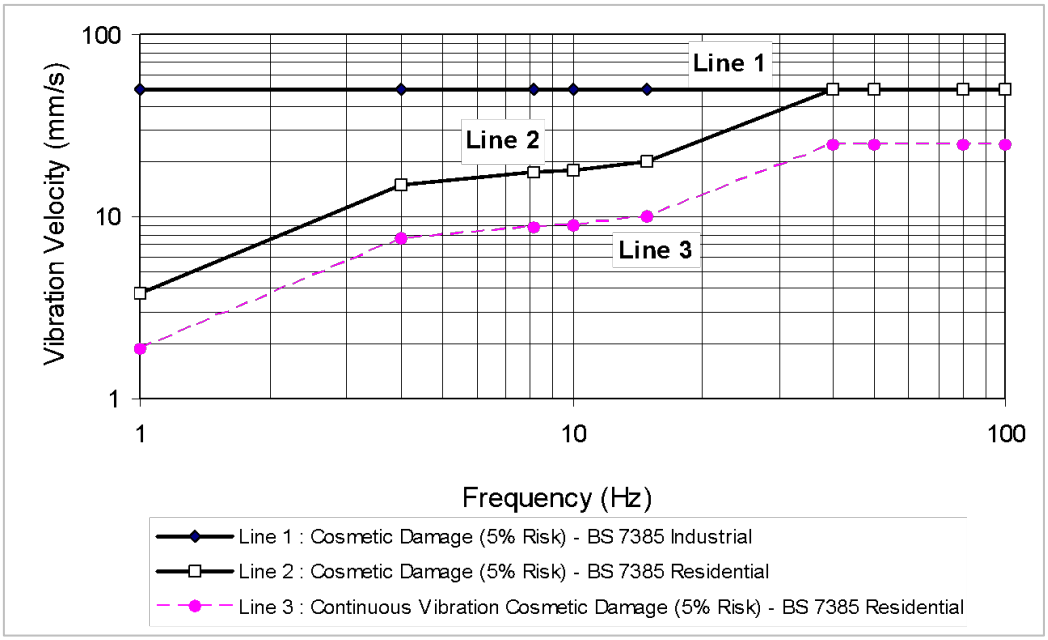


Figure 3.2 Graph of transient vibration guide values for cosmetic damage

In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for building types corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low PPV value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz (as shown in Figure 3.2).

Fatigue considerations are also addressed in AS 2187, which concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in Table 3.13 should not be reduced for fatigue considerations.

In order to assess the likelihood of cosmetic damage due to vibration, AS 2187 specifies that vibration measurements should be undertaken at the base of the building and the highest of the orthogonal vibration components (transverse, longitudinal and vertical directions) should be compared with the criteria curves presented in Table 3.13.

It is important to note that addition to the guide values nominated in Table 3.13 the standard states the following:

> Some data suggests that the probability of damage tends towards zero at 12.5 mm/s PPV. This is not inconsistent with an extensive review of the case history information available in the UK.

The blasting criteria above have been adopted for the assessment of structural vibration impacts for the project.

3.8 Road traffic noise

Construction and operational traffic require assessment for potential noise impacts. The principle guidance to assess the impact of the road traffic noise at assessment locations is provided by the NSW Department of Environment, Climate Change and Water's (DECCW) *Road Noise Policy* (RNP) (2011).

All quarry related traffic will access or depart the site via Sheraton Road and the Mitchell Highway. Sheraton Road has been classified conservatively as a local road under the definitions of the RNP. However, it is noted that the southern section of Sheraton Road immediately north of the existing and proposed quarry access roads is also used by the South Keswick Quarry and South Keswick Solar Farm.

Further, the northern section of Sheraton Road which is immediately to the south of the Mitchell Highway is also used to access the Dubbo Christian School, St Johns Primary School and St Johns College.

The road traffic noise assessment criteria for residential land use are presented in Table 3.14, reproduced from Table 3 of the RNP for road categories relevant to the project.

Table 3.14 Road traffic noise assessment criteria for residential land use

Road category	Type of project/development	Assessment criteria, $L_{Aeq,period}$, dB	
		Day (7 am to 10 pm)	Night (10 pm to 7 am)
Freeway/arterial/sub-arterial roads	Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use developments.	$L_{Aeq,15hr}$ 60 (external)	$L_{Aeq,9hr}$ 55 (external)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments.	$L_{Aeq,1hr}$ 55 (external)	$L_{Aeq,1hr}$ 50 (external)

The road traffic noise assessment criteria for non-residential land uses relevant to the project (ie schools) are presented in Table 3.13, reproduced from Table 4 of the RNP.

Table 3.15 Road traffic noise assessment criteria for non-residential land uses

Existing sensitive land use	Assessment criteria, $L_{Aeq,period}$, dB
School classrooms	$L_{Aeq,1hr}$ 40 (internal) – when in use

Additionally, the RNP states that where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to an increase of up to 2 dB.

Furthermore, Appendix B of the RNP states that noise levels shall be rounded to the nearest integer, whilst the difference between two noise levels is to be rounded to one decimal place.

4 Noise and vibration assessment method

4.1 Noise modelling

4.1.1 Software and general methodology

This section presents the methods and base parameters used to model operational and construction noise and calculate ground vibration emissions from the project.

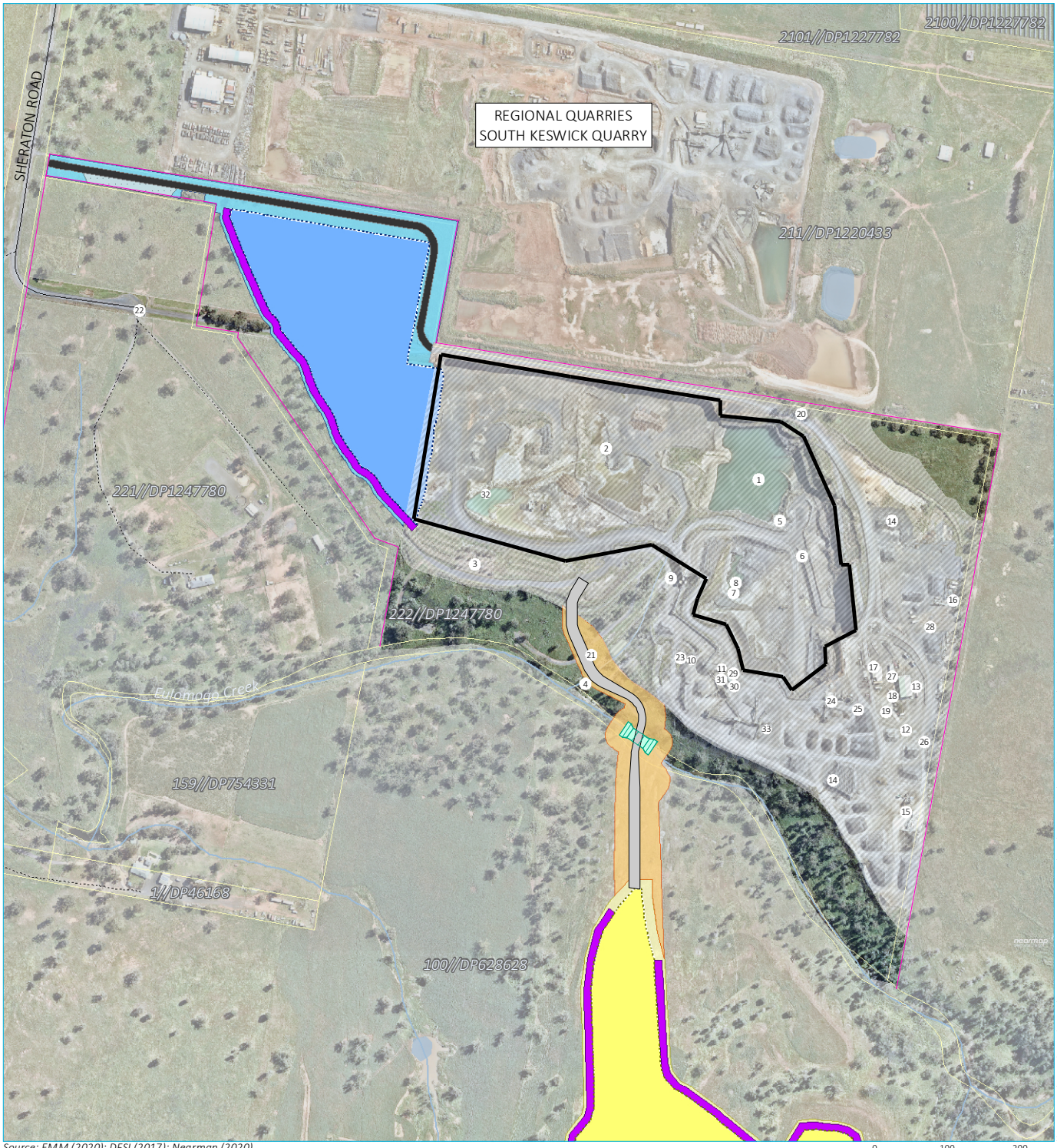
Operational and construction noise levels were predicted using DGMR Software proprietary modelling software, iNoise. The model allows prediction under the ISO9613-2 *"Acoustics – Attenuation of Sound during Propagation Outdoors – general method"* algorithm. Features which affect the predicted noise levels that are considered in the noise modelling include:

- plant and equipment sound power levels and locations;
- screening from structures;
- receiver locations;
- ground topography;
- noise attenuation due to geometric spreading;
- ground absorption; and
- atmospheric absorption.

The model was populated with 3-D topography of the project and surrounding area, extending out to include all assessment locations. Plant and equipment representing the range of proposed operation and construction scenarios were modelled at locations representing the worst-case operational and construction scenarios.

4.1.2 Operational noise modelling

The noise assessment is based on information provided by Holcim, including a description of existing and future quarry activities, site layout and plant and equipment locations. The site layout is shown Figure 4.1.



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

0 100 200 m

GDA 1994 MGA Zone 55

N

\\Emmsvr1\emm\Jobs\2018\J180313 - Dubbo Quarry EIS\GIS\02_Maps_EIS_TechReports\NVIA\NVIA004_ExistingSite_20201126_01.mxd 15/01/2021

KEY

- Pit boundary
- Surveyed site boundary

Existing site feature

1. In pit dam
2. West pit
3. Rehabilitation area
4. V-notch weir
5. Pump 1
6. East pit
7. Pump 2
8. Pump 2 storage pond (holding)
9. Primary crusher
10. Tertiary crusher
11. Secondary crusher
12. Diesel store
13. Workshop
14. Stockpile area
15. Pug mill
16. Laydown area
17. Site office
18. Toilets
19. Truck parking
20. Culvert
21. Settling pond
22. Current site access
23. Transformer station
24. Jet patcher/ paveline loading facility
25. Bitumen emulsion plant
26. Spare part storage
27. Employees car park
28. Pre coat plant
29. Pump house
30. Pit water storage
31. Main control centre
32. West pit pond
33. Tertiary Screen

- Proposed access road
- Proposed haul road
- Indicative proposed water crossing
- Truck tarping area
- Bund wall
- Indicative existing disturbance area
- Western extension area
- Western disturbance area
- Haul road disturbance area
- Southern extension area
- Southern disturbance area
- Proposed water crossing
- Minor road
- Vehicular track
- Watercourse/drainage line
- Waterbody
- Cadastral boundary (data does not align with surveyed site boundary)

Site layout

Dubbo Quarry Continuation Project
Noise and Vibration Impact Assessment
Figure 4.1

EMM
creating opportunities

i Plant and equipment

Modelled operational plant and equipment and associated sound power levels are presented in Table 4.1. The sound power levels of plant and equipment adopted for the noise modelling have been determined from on-site measurements or otherwise have been supplemented using EMM's database of plant and equipment used for similar projects. Single or one-third octave sound power level data is provided in Appendix A.

Noise from approved existing quarry operations was modelled and validated based on site noise contributions determined during operator-attended noise measurements completed on-site and at site boundary locations (refer to Section 2.3).

Preliminary noise modelling of quarry operations identified the 'primary screen/secondary (cone) crusher' as a dominant noise source on-site and hence mitigation of this source would reduce potential impacts at most affected residential receivers. Therefore, a 5 dB reduction in sound power level that could be achieved by a partial enclosure or screening of the 'primary screen/secondary (cone) crusher' was adopted as a mitigation measure in the future noise models. The construction of a 4 m high bund on the western boundary of the WEA and boundaries of the SEA was also adopted to mitigate noise from the project. Furthermore, to reduce potential noise impacts during the night period, Holcim is committed to limit existing night-time operations (4 am to 7 am) by reducing these to product dispatch related activities only, which would include road trucks, front-end loaders (sales) and water pumps (where required). An analysis of feasible and reasonable noise mitigation measures undertaken for the project is summarised in Section 6.

Approved existing plant and equipment used at the quarry on a day-to-day basis are not proposed to change as a result of the project. When required, however, additional equipment will be hired to undertake short-term quarrying activities such as topsoil and overburden stripping (ie dozer, excavator and dump truck) and blast hole drilling (ie drill).

Table 4.1 Modelled operational noise sources

Noise source	Associated activities	Quantity	Sound power level[1] L_{Aeq}, dB
Primary (jaw) crusher with rock breaker	Crushing	1	114
Processing plant transfer point/conveyor drive	Conveyor belt operation	1	94
Primary screen/secondary (cone) crusher	Screening and crushing	1	117/112[2]
Tertiary (impactor) crusher	Crushing	1	107
Screen 2	Screening	1	107
Screen 3	Screening	1	108
Screen 4	Screening	1	104
Pugmill/generator	Blending aggregates and roadbases	1	107
Excavator (CAT 349)	Dig/load material at the pit face, overburden stripping, rehabilitation works, general earthmoving.	1	108-112[3]
Dump Truck (CAT 769)	Transport of material from pit areas to processing plant	2	111[4]
Front-end loader (WA500)	Plant, stockpiling and blending.	1	107[4]
Front-end loader (WA470)	Plant, stockpiling and blending, general yard and site work.	1	107[4]
Front-end loader (CAT 980)	Sales, plant, stockpiling and blending.	2	106

Table 4.1 Modelled operational noise sources

Noise source	Associated activities	Quantity	Sound power level[1] L_{Aeq}, dB
Road truck	Transport of product	3-5[5]	105[4]
Water pump	Pump water in pit	2	102
Water Cart	Spray water on internal roads	1	105[4]
Dozer (CAT D11 or equivalent)	Stripping/pushing topsoil and overburden	1	116[4]
Excavator (CAT 349 or equivalent)	Stripping topsoil and overburden	1	108-112[3]
Dump truck (CAT 769 or equivalent)	Transport stripped topsoil and overburden	1	111
Drill	Blast hole drilling	1	105-116[4,6]

Notes:
1. Determined from on-site measurements unless noted otherwise.
2. Mitigated using screening or partial enclosure providing a 5 dB attenuation to the original sound power level.
3. When loading dump trucks.
4. From EMM database.
5. An increase in existing road truck numbers from 3 to a maximum of 5 (in/out) per 15 minutes has been modelled as a worst-case scenario.
6. Range between engine noise and impact noise.

ii Modelled operational scenarios

To assess the potential noise impacts from the project at assessment locations, four key operational scenarios were modelled as follows:

1. Existing (approved) quarry operations:
    a) Blast hole drilling of existing pit (up to 10 days). Loading of material by an excavator into dump trucks for transport to the processing plant, processing of material, handling/stockpiling of products and loading of road trucks for transport to customers offsite.
    b) Loading of material in the existing pit by an excavator into dump trucks for transport to the processing plant, processing of material, handling/stockpiling of products and loading of road trucks for transport to customers offsite.
2. Future Year 1 (Y1) quarry operations:
    a) Construction of a 4 m high bund (for noise and visual mitigation purposes) from stripped topsoil and overburden in the southern section of the WEA using a dozer (approximately four weeks per year). Loading of material in the existing pit by an excavator into dump trucks for transport to the processing plant, processing of material, handling/stockpiling of products and loading road of trucks for transport to customers offsite.
    b) Blast hole drilling in the southern section of the WEA (up to 10 days per year). Loading of material in the existing pit by an excavator into dump trucks for transport to the processing plant, processing of material, handling/stockpiling of products and loading of road trucks for transport to customers offsite.
    c) Loading of material in the southern section of the WEA by an excavator into dump trucks for transport to the processing plant, processing of material, handling/stockpiling of products and loading of road trucks for transport to customers offsite.

3. Future Year 3 (Y3) quarry operations:

    a) Construction of a 4 m high bund (for noise and visual mitigation purposes) from stripped topsoil and overburden in the northern section of the SEA using a combination of a dozer, excavator and dump truck (approximately four weeks per year). Loading of material in the southern section of the WEA by an excavator into dump trucks for transport to the processing plant, processing of material, handling/stockpiling of products and loading of road trucks for transport to customers offsite.

    b) Blast hole drilling in the northern section of the SEA (up to 10 days per year). Loading of material in the southern section of the WEA by an excavator into dump trucks for transport to the processing plant, processing of material, handling/stockpiling of products and loading of road trucks for transport to customers offsite.

    c) Loading of material in the northern section of the SEA by an excavator into dump trucks for transport to the processing plant, processing of material, handling/stockpiling of products and loading of road trucks for transport to customers offsite.

4. Future Year 21 (Y21) quarry operations:

    a) Construction of a 4 m high bund (for noise and visual mitigation purposes) from stripped topsoil and overburden in the southern section of the SEA using a combination of a dozer, excavator and dump truck (approximately four weeks per year). Loading of material in the SEA by an excavator into dump trucks for transport to the processing plant, processing of material, handling/stockpiling of products and loading of road trucks for transport to customers offsite.

    b) Blast hole drilling in the southern section of the SEA (up to 10 days per year). Loading of material in the SEA by an excavator into dump trucks for transport to the processing plant, processing of material, handling/stockpiling of products and loading of road trucks for transport to customers offsite.

    c) Loading of material in the southern section of the SEA by an excavator into dump trucks for transport to the processing plant, processing of material, handling/stockpiling of products and loading of road trucks for transport to customers offsite.

Noise levels were predicted to assessment locations identified in Table 2.1 using the noise sources outlined in Table 4.1. The overall $L_{Aeq,15min}$ noise levels were predicted for direct assessment against the PNTLs.

Further, the following assumptions have been adopted for the operational noise modelling:

- Night-time operations (4 am to 7 am) consist only of product dispatch activities, which include road trucks, front-end loaders (sales) and water pumps (where required).

- A 4 m high bund will be constructed during stripping activities on the western boundary of the WEA (from Y1), along the western and eastern boundaries of the SEA (from Y3) and eventually the southern boundary of the SEA (from Y21). The 4 m high bunds have been included in the noise model established for all future scenarios after stripping is completed in the relevant pit areas;

- the excavator is operating in the pit extraction areas, including loading material into dump trucks for transport to the processing area;

- the two dump trucks are operating between pit extraction areas and the processing area (primary crusher);

- the processing area comprises crushing and screening plant, including a rock breaker at the primary crusher;

- processed material in the processing, stockpile and sale areas is handled and loaded into road trucks by front-end loaders; and
- 20 road trucks per hour (equivalent to 5 trucks per 15 minute period) travel on the site access road (existing or new) and through the quarry stockpile and sale areas.

4.1.3 Construction noise

Construction activities associated with the project would be limited to the ICNG standard hours (daytime hours only). Construction works will include the following activities:

- new access road construction; and
- creek crossing construction (Eulomogo Creek).

The construction of the new access road and Eulomogo Creek crossing are expected to occur within the first two years of the project and will take 3-4 weeks and 4-8 weeks, respectively, to be completed. Noise generated by other activities associated with the construction of the internal southern haul road to access the SEA will be assessed under the NPfI.

Construction equipment sound power levels have been taken from the UK Department for Environment, Food and Rural Affairs (DEFRA) *Update of noise database for prediction of noise on construction and open sites* (2005 and 2006), where available. Otherwise data was sourced from an EMM database which is based on measurements conducted at other sites.

Construction equipment items were modelled as operating continuously and at full power. A summary of the construction activities, duration, equipment quantity and sound power levels (Lw) are presented in Table 4.2.

Table 4.2 Construction activities and equipment sound power levels

Construction activities	Equipment	Quantity[1]	Lw[2], L_{Aeq}, dB
New access road construction Duration = 3-4 weeks	Grader	1	104[3]
	Roller	1	104
	Asphalt truck and tipper	1	105
Bridge construction Duration = 4-8 weeks	Concrete agitator truck	1	108
	Crane	1	94-104

Notes: 1. In a typical 15-minute period.
2. From DEFRA database (2005) unless noted otherwise.
3. From EMM' database.

Construction activities are not proposed to be undertaken outside of the ICNG standard hours and, therefore, assessment of the sleep disturbance at residential assessment locations has not been considered further for construction.

To assess a potential worst-case construction scenario, this assessment has assumed the equipment listed for each construction activity in Table 4.2 are operating continuously over a 15 minute period. Construction noise levels were predicted at the assessment locations identified in Table 2.1.

4.1.4 Sleep disturbance

Maximum noise levels from future night-time operations (limited to product dispatch activities) with the potential to cause sleep disturbance at nearby residences have been assessed in accordance with the NPfI.

Operational $L_{Aeq,15min}$ noise levels were predicted for the night period and assessed against the relevant sleep disturbance trigger levels. These represent worst-case maximum $L_{Aeq,15min}$ noise levels predicted for the night period based on existing and future general quarry operations.

Representative maximum L_{Amax} noise events considered from proposed future night-time operations (limited to product dispatch activities) included front-end loaders loading processed material into road trucks in the sales area – L_w 122 dB L_{Amax}

This L_{Amax} sound power level (L_w) has been determined from on-site measurements and was adopted in the prediction of sleep disturbance impacts at residential assessment locations.

4.1.5 Noise enhancing meteorology

The noise model utilised international standard ISO 9613-2:1996 'Acoustics – Attenuation of sound during propagation outdoors'. Section 1 of ISO 9613-2:1996 states the following:

> The method predicts the equivalent continuous A-weighted sound pressure level (as described in parts 1 to 3 of ISO 1996) under meteorological conditions favourable to propagation from sources of known sound emission.
>
> These conditions are for downwind propagation, as specified in 5.4.3.3 of ISO 1996-2:1987 or, equivalently, propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs at night.

A summary of modelling meteorological conditions for which noise predictions have been provided are shown in Table 4.3.

Table 4.3 Meteorological conditions adopted for noise modelling

Modelling algorithm	Assessment period	Air temperature	Wind speed[1]	Relative humidity	Stability class
ISO_9613	Day	20°C	2 m/s	70%	n/a
	Night	10°C	2 m/s	90%	n/a

Notes: Downwind conditions in accordance with Section 5 and Section 8 of ISO 9613.

4.2 Blasting

4.2.1 Overview

Operational blast activities at the quarry currently occur approximately 7 to 10 times per year. Blast emission monitoring is undertaken during all blasts at a location to the west of the quarry between R1 and R3. The airblast overpressure and ground vibration monitoring data relevant to the quarry was supplied to EMM by Holcim. This data included blast ID information, maximum instantaneous charge (MIC), measured airblast overpressure (dB, Linear Peak) and ground vibration (PPV, mm/s) levels at the monitoring location.

Data from blast monitoring undertaken for blasts between 2018 and 2020 were used to develop prediction laws for airblast overpressure and ground vibration for this assessment. A total of 16 samples were provided for analysis and include measurements at distances of 596 m to 1,216 m.

Relationships between the level of blast emissions and scaled distances have been developed based on the measured data as discussed in the following sections. This approach is considered more representative than using empirical formulae such as that found in the Imperial Chemical Industries (ICI) Explosives Blasting Guide (ICI Technical Services 1995).

4.2.2 Airblast overpressure site law

For airblast overpressure, the scaled distance (SD) was determined from the following equation:

$$SD = \frac{D}{\sqrt[2]{MIC}}$$

Where *D* is the distance between the monitoring location and the blast site and *MIC* is the maximum explosive charge mass (kg) detonated in an eight-millisecond interval.

The relationship between measured airblast overpressure levels and scaled distances is shown graphically in Figure 4.2.

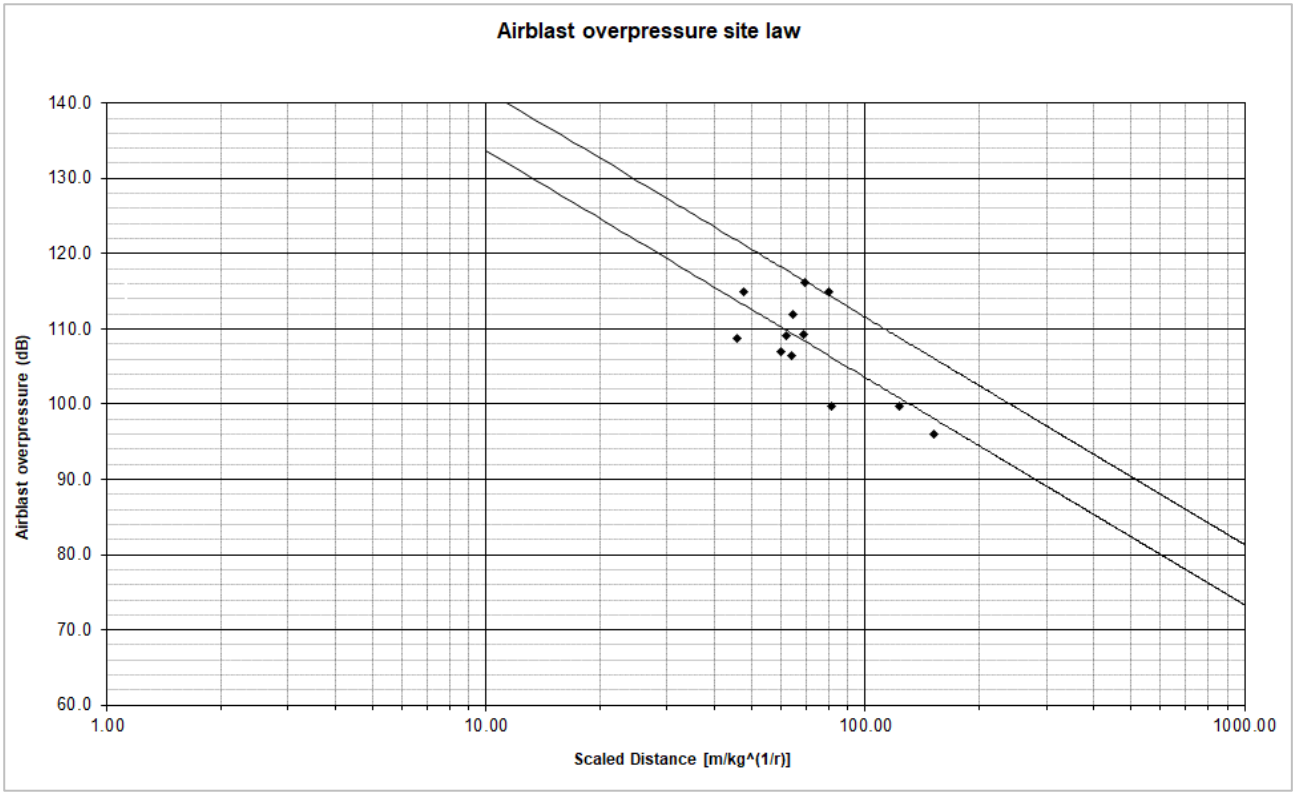


Figure 4.2 Airblast overpressure monitoring data and site law

The site law for airblast overpressure emissions has been calculated to be:

$$\text{Airblast overpressure}(95\%) = 172.0 - 30.2 \log SD$$

Where *Airblast overpressure (95%)* are the levels of airblast overpressure (Linear peak, dB) below which 95% of the total population of data points reside, assuming that the population has the same statistical distribution as the underlying measured sample.

4.2.3 Ground vibration site law

For ground vibration, the scaled distance (SD) was determined from the following equation:

$$SD = \frac{D}{\sqrt[3]{MIC}}$$

Where *D* is the distance between the monitoring location and the blast site and *MIC* is the maximum explosive charge mass (kg) detonated in an eight-millisecond interval.

The relationship between measured ground vibration levels and scaled distances is shown graphically in Figure 4.3.

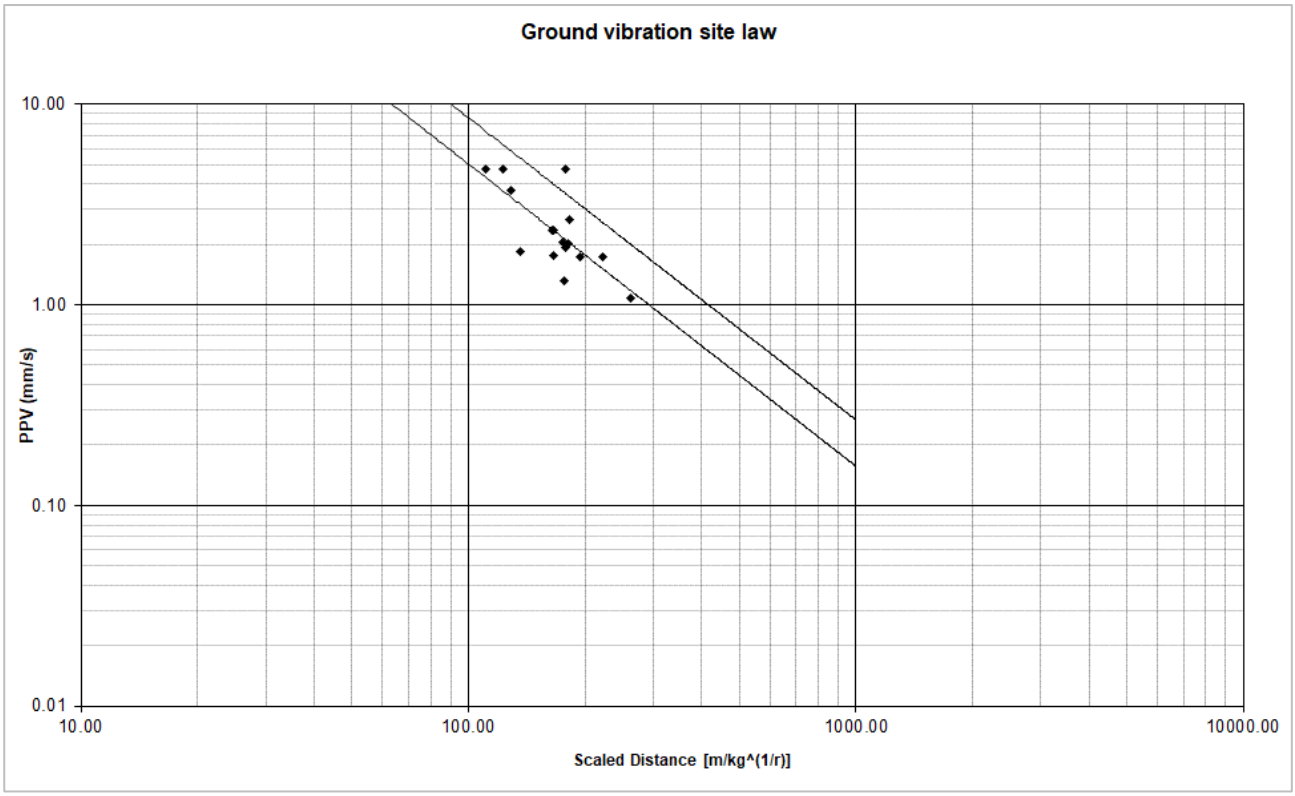


Figure 4.3 Ground vibration monitoring data and site law

The site law for ground vibration emissions has been calculated to be:

$$\text{PPV}(95\%) = 8819\, SD^{-1.51}$$

Where *PPV(95%)* are the levels of ground vibration (peak particle velocity, mm/s) below which 95% of the total population of data points reside, assuming that the population has the same statistical distribution as the underlying measured sample.

4.3 Road traffic noise

4.3.1 Overview

Vehicular access to the quarry will be via Sheraton Road. Project related road traffic movements has the potential to impact on residential properties and other land uses on Sheraton Road. The assessment has considered existing road traffic volumes and projected vehicle movements associated with the project. Road traffic movements from construction would be significantly lower than operational movements. It is of note that noise from vehicles travelling on the access road is assessed as operational noise in accordance with the NPfI.

4.3.2 Existing traffic volumes

Existing average hourly traffic movements for Sheraton Road (south of the Mitchell Highway) were established from classified traffic counts conducted at the roundabout intersection between Sheraton Road and the Mitchell Highway on 4 June 2019. It is noted that site related traffic on this day was relatively low compared to normal operations. These traffic numbers have been adopted for the assessment of road traffic noise at three assessment locations on Sheraton Road, including R3, R10-R12 (schools) and R23 on Sheraton Road.

It is noted that R11 (ie St Johns College) is the school with the shortest distance (ie 35 m) between Sheraton Road and potentially most affected classroom and hence has been adopted as a worst-case 'school' assessment location for the purpose of the road traffic noise assessment. The existing traffic movements assumed for assessment of road traffic noise is considered to be conservative, as it is representative of a relatively quiet day for general traffic, thus resulting in a greater increase in road traffic noise levels due to the project.

Once the site's new access road is built, quarry generated traffic on Sheraton Road will be further (~130 m) from R1 and R3.

A summary of existing hourly traffic volumes adopted are presented in Table 4.4.

Table 4.4 Summary of existing hourly traffic volume assumptions

Assessment location - road section	Morning (night) peak hour movements 6 am to 7 am				Day peak hour movements 8 am to 9 am			
	LV	HV	Total	HV%	LV	HV	Total	HV%
R3 – Sheraton Road south of the quarry new access road	4	8	12	67	4	20	24	83
R11 – Sheraton Road south of the Mitchell Highway	11	8	19	0	335	35	373	9

Notes: 1. Location R1 has not been included given the agreement in place between this owner and the proponent.

The existing daily traffic volumes (annual production volumes of approximately 350,000 tpa) for the quarry is 132 HV movements and 84 LV movements on a busy/peak day.

Peak traffic movements currently generated from the quarry are between 7:30 am and 9 am in the morning, and between 4 pm to 5 pm in the afternoon. Existing traffic movements during these peak quarry traffic periods consist of 20 HV movements and 4 LV movements per hour. All other quarry related HV movements are assumed to occur evenly throughout the quarry's 'transport' operating hours, which equates to 8 HV movements per hour.

4.3.3 Projected traffic volumes

Inclusive of existing quarry traffic volumes provided in Section 4.3.2, the peak daily traffic volumes (assuming a future maximum production of 500,000 tpa) for the project are predicted to be 242 HV movements and 84 LV movements. This equates to 110 additional peak daily HV movements and no additional LV movements.

The additional traffic movements during the peak quarry traffic morning and afternoon periods for a future maximum scenario are predicted to be 20 HV movements per hour. All other additional quarry HV movements are assumed to occur evenly throughout the quarry's 'transport' operating hours, which equate to 14 HV movements per hour.

4.3.4 Assessment methodology

The US Environmental Protection Agency Federal Highway Administration (FHWA) traffic noise model (TNM) for road traffic noise calculations was used for the assessment of road traffic noise for the project. The FHWA TNM calculation method is more sensitive to low traffic volumes (ie <200 vehicles per hour) compared to other calculation methods and hence was adopted for the assessment of road traffic noise for the project.

Road traffic noise levels from the project have been assessed by calculating existing and future (at a worst case maximum production scenario) at potentially the most affected assessment locations. The following assumptions have been adopted for the road traffic noise assessment:

- a vehicle speed of 40 km/h for the first 800 m of Sheraton Road south of the Mitchell Highway intersection. This is due to the morning peak quarry traffic period coinciding with the morning school zone period;
- a vehicle speed of 35 km/h around the corner of Sheraton Road (near R3) immediately west of the quarry entrance gate, consistent with road signage for safe speeds around the corner;
- a vehicle speed of 60-80 km/h for the section of Sheraton Road (near R3) to the north of the proposed new quarry entrance gate and to the south of the South Keswick Quarry entrance gate;
- no buildings or other intervening structures (eg noise barrier) between Sheraton Road and the assessment locations have been identified; and
- calculated noise levels include a facade reflection correction in accordance with the RNP.

5 Impact assessment

5.1 Operational noise

Operational noise levels predicted at assessment locations for the day and night (4 am-7 am) periods are provided in the following sections. The levels presented for each assessment location represent the energy-average noise levels over a 15 minute period and assume all plant and equipment are operating concurrently in accordance with the scenarios outlined in Section 4.1.2 under ISO 9613 noise-enhancing meteorological conditions (Section 4.1.5). In addition, existing noise levels for existing quarry operations are provided for comparison for the relevant future operational scenarios. It is noted that no existing noise predictions are provided for stripping operations given no stripping has been recently undertaken on-site. However, historic stripping related noise can be assumed similar at most locations to future stripping related noise levels as predicted herein.

5.1.1 Stripping operations

Site noise levels predicted at assessment locations during stripping operations (approximately four weeks in duration per year) for the day period are provided in Table 5.1. A 'marginal', 'moderate' or 'significant' exceedance of the PNTL as per the NPfI is shown as underlined, shaded or bold shaded, respectively.

Table 5.1 Predicted operational noise levels during stripping operations

Assessment location	Receiver type	Predicted site $L_{Aeq,15min}$ noise level, dB			Day PNTL, dB	Exceedance, dB		
		Y1	Y3	Y21		Y1	Y3	Y21
R1	Residential[1]	61	50	48	n/a	n/a	n/a	n/a
R2	Residential	58	50	48	40	**18**	10	8
R3	Residential	56	44	42	40	**16**	4	2
R4	Residential	56	<40	<40	40	**16**	Nil	Nil
R5	Residential	53	<40	<40	40	13	Nil	Nil
R6a	Residential	47	<40	<40	40	7	Nil	Nil
R6b	Residential	46	<40	<40	40	6	Nil	Nil
R7	Residential	43	<40	<40	40	3	Nil	Nil
R8	Residential	45	<40	<40	40	5	Nil	Nil
R9	Commercial	<63	<63	<63	63	Nil	Nil	Nil
R10	School	49	<40	<40	40	**9**	Nil	Nil
R11	School	50	<40	<40	40	**10**	Nil	Nil
R12	School	49	<40	<40	40	**9**	Nil	Nil
R13	Residential	52	<40	<40	40	12	Nil	Nil
R14	Residential	54	<40	<40	40	**14**	Nil	Nil
R15	Residential	52	<40	<40	40	12	Nil	Nil
R16	Residential	51	<40	<40	40	11	Nil	Nil
R17	Industrial	<68	<68	<68	68	Nil	Nil	Nil
R18	Residential	49	<40	<40	40	9	Nil	Nil
R19	Residential	50	<40	<40	40	10	Nil	Nil
R20	Residential	45	<40	<40	40	5	Nil	Nil

Table 5.1 Predicted operational noise levels during stripping operations

Assessment location	Receiver type	Predicted site $L_{Aeq,15min}$ noise level, dB			Day PNTL, dB	Exceedance, dB		
		Y1	Y3	Y21		Y1	Y3	Y21
R21	Residential	42	<40	<40	40	2	Nil	Nil
R22	Residential	51	<40	<40	40	11	Nil	Nil
R23	Subdivision[2]	55	<53	<53	53	2	Nil	Nil

Notes: 1. Holcim currently has a negotiated agreement in place with the landowner of this residential property and hence PNTLs do not apply at this location.
2. Approved residential subdivision, however there are no proposed residential development.

The significance of residual noise impacts for stripping operations (day only) is summarised below:

- Y1 (WEA):
  - PNTL is significantly exceeded (by >5 dB and >RANL) at R2-R4, R10-R12 and R14
  - PNTL is moderately exceeded (by >5 dB and <RANL) at R5-R6b, R13, R15, R16, R18, R19 and R22
  - PNTL is marginally exceeded (by 3-5 dB and <RANL) at R7, R8 and R20
  - PNTL is negligibly exceeded (by 2 dB) at R21 and R23
- Y3 (northern section of SEA):
  - PNTL is moderately exceeded (by >5 dB and <RANL) at R2
  - PNTL is marginally exceeded (by 4 dB and <RANL) at R3
- Y21 (southern section of SEA)
  - PNTL is moderately exceeded (by >5 dB and <RANL) at R2
  - PNTL is negligibly exceeded (by 2 dB) at R3

Following stripping operations in the WEA in Y1, site $L_{Aeq,15min}$ noise levels are predicted to decrease by at least 8 dB at the most affected assessment locations, as shown for Y3 and Y21. Furthermore, site $L_{Aeq,15min}$ noise levels are predicted to be much lower during general quarry operations once stripping is completed (approximately four weeks in each relevant area), as discussed in the following sections.

5.1.2 Drilling operations

Site noise levels predicted at assessment locations during drilling operations (up to 10 days in duration) for the day period are provided in Table 5.2. A 'marginal' or 'moderate' exceedance of the PNTL as per the NPfI is shown as underlined or shaded, respectively.

Table 5.2 Predicted operational noise levels during drilling operations

Assessment location	Receiver type	Predicted site $L_{Aeq,15min}$ noise level, dB				Day PNTL, dB	Exceedance, dB			
		Exist.	Y1	Y3	Y21		Exist.	Y1	Y3	Y21
R1	Residential[1]	50	48	48	48	n/a	n/a	n/a	n/a	n/a
R2	Residential	48	47	47	47	40	8	7	7	7
R3	Residential	42	43	42	42	40	2	3	2	2
R4	Residential	40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R5	Residential	40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R6a	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R6b	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R7	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R8	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R9	Commercial	<63	<63	<63	<63	63	Nil	Nil	Nil	Nil
R10	School	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R11	School	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R12	School	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R13	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R14	Residential	40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R15	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R16	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R17	Industrial	<68	<68	<68	<68	68	Nil	Nil	Nil	Nil
R18	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R19	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R20	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R21	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R22	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R23	Subdivision[2]	<53	<53	<53	<53	53	Nil	Nil	Nil	Nil

Notes: 1. Holcim currently has a negotiated agreement in place with the landowner of this residential property and hence PNTLs do not apply at this location.
2. Approved residential subdivision, however there are no proposed residential development.

The significance of residual noise impacts for drilling operations (day only) is summarised below:

- Existing (existing pit):
  - PNTL is moderately exceeded (by >5 dB and <RANL) at R2
  - PNTL is negligibly exceeded (by 2 dB) at R3
- Y1 (WEA):
  - PNTL is moderately exceeded (by >5 dB and <RANL) at R2
  - PNTL is marginally exceeded (by 3 dB and <RANL) at R3

- Y3 (northern section of SEA):
  - PNTL is moderately exceeded (by >5 dB and <RANL) at R2
  - PNTL is negligibly exceeded (by 2 dB) at R3
- Y21 (southern section of SEA)
  - PNTL is moderately exceeded (by >5 dB and <RANL) at R2
  - PNTL is negligibly exceeded (by 2 dB) at R3

During drilling operations in the WEA and SEA, site $L_{Aeq,15min}$ noise levels are predicted to be moderately and marginally above the relevant PNTLs at R2 and R3, respectively. However, when comparing existing and future (Y1, Y3 and Y21), no material change (>±1 dB) in site $L_{Aeq,15min}$ noise levels is predicted at any of the assessment locations. Therefore, no additional noise impacts are predicted from the project during drilling operations at any of the assessment locations.

5.1.3 General quarry operations

i Daytime operations

Site noise levels predicted at assessment locations during general operations (no stripping or drilling) for the day period are provided in Table 5.3. A 'moderate' exceedance of the PNTL as per the NPfI is shown as shaded.

Table 5.3 Predicted operational noise levels during general daytime operations

Assessment location	Receiver type	Predicted site $L_{Aeq,15min}$ noise level, dB				Day PNTL, dB	Exceedance, dB			
		Exist.	Y1	Y3	Y21		Exist.	Y1	Y3	Y21
R1	Residential[1]	49	48	49	48	n/a	n/a	n/a	n/a	n/a
R2	Residential	48	47	48	47	40	8	7	8	7
R3	Residential	41	42	42	42	40	1	2	2	2
R4	Residential	40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R5	Residential	40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R6a	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R6b	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R7	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R8	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R9	Commercial	<63	<63	<63	<63	63	Nil	Nil	Nil	Nil
R10	School	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R11	School	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R12	School	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R13	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R14	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R15	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R16	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R17	Industrial	<68	<68	<68	<68	68	Nil	Nil	Nil	Nil

Table 5.3 Predicted operational noise levels during general daytime operations

Assessment location	Receiver type	Predicted site $L_{Aeq,15min}$ noise level, dB				Day PNTL, dB	Exceedance, dB			
		Exist.	Y1	Y3	Y21		Exist.	Y1	Y3	Y21
R18	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R19	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R20	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R21	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R22	Residential	<40	<40	<40	<40	40	Nil	Nil	Nil	Nil
R23	Subdivision[2]	<53	<53	<53	<53	53	Nil	Nil	Nil	Nil

Notes: 1. Holcim currently has a negotiated agreement in place with the landowner of this residential property and hence PNTLs do not apply at this location.
2. Approved residential subdivision, however there are no proposed residential development.

The significance of residual noise impacts for general daytime operations is summarised below:

- Existing (existing pit):
  - PNTL is moderately exceeded (by >5 dB and <RANL) at R2
  - PNTL is negligibly exceeded (by 1 dB) at R3
- Y1 (WEA):
  - PNTL is moderately exceeded (by >5 dB and <RANL) at R2
  - PNTL is negligibly exceeded (by 2 dB) at R3
- Y3 (northern section of SEA):
  - PNTL is moderately exceeded (by >5 dB and <RANL) at R2
  - PNTL is negligibly exceeded (by 2 dB) at R3
- Y21 (southern section of SEA)
  - PNTL is moderately exceeded (by >5 dB and <RANL) at R2
  - PNTL is negligibly exceeded (by 2 dB) at R3

During future general daytime operations, site $L_{Aeq,15min}$ noise levels are predicted to moderately exceed the PNTL at R2. However, when compared to existing noise levels, no material change (>±1 dB) in site $L_{Aeq,15min}$ noise levels is predicted at any of the assessment locations. Therefore, no additional noise impacts are predicted from the project during general daytime operations at any of the assessment locations.

The application of modifying factors to predicted operational noise was considered in this assessment in accordance with the guideline provided in Fact sheet C of the NPfI. Based on the type of existing plant and equipment used at the quarry and that no additional plant or equipment are proposed for the project, it is unlikely that operational noise sources (existing and proposed) would contain annoying characteristics such as tonal noise or intermittent noise.

Low frequency noise (or LFN) was assessed based on post-analysis of data from attended noise measurements and predicted one-third octave centre frequency noise levels at assessment locations. It was identified that site noise could contain low frequency noise components at R2 during general daytime operations. Hence, this could result in a +2 dB modifying factor adjustment to the noise levels shown in Table 5.3 for R2. This positive adjustment could apply to both existing and future operational scenarios and, therefore, no additional changes in noise impacts are predicted from the project during general daytime operations. It is noted that LFN is not typical to quarry operations, in particular when at significant distances from site or source.

Based on 'moderate' residual noise impacts predicted at R2 and consistent with the NPfI, recommended receiver-based mitigation measures are as follows:

- provide mechanical ventilation/comfort condition systems to enable windows to be closed without compromising internal air quality/amenity; and
- upgraded façade elements such as windows, doors or roof insulation, to further increase the ability of the building façade to reduce noise levels.

Discussion with regard to negotiated noise agreements between Holcim and the land owner(s) is provided in Section 6.

To illustrate the difference in predicted noise levels during general daytime operations versus stripping or drilling activities over a typical year, an example chart was produced for R4 as shown in Figure 5.1.

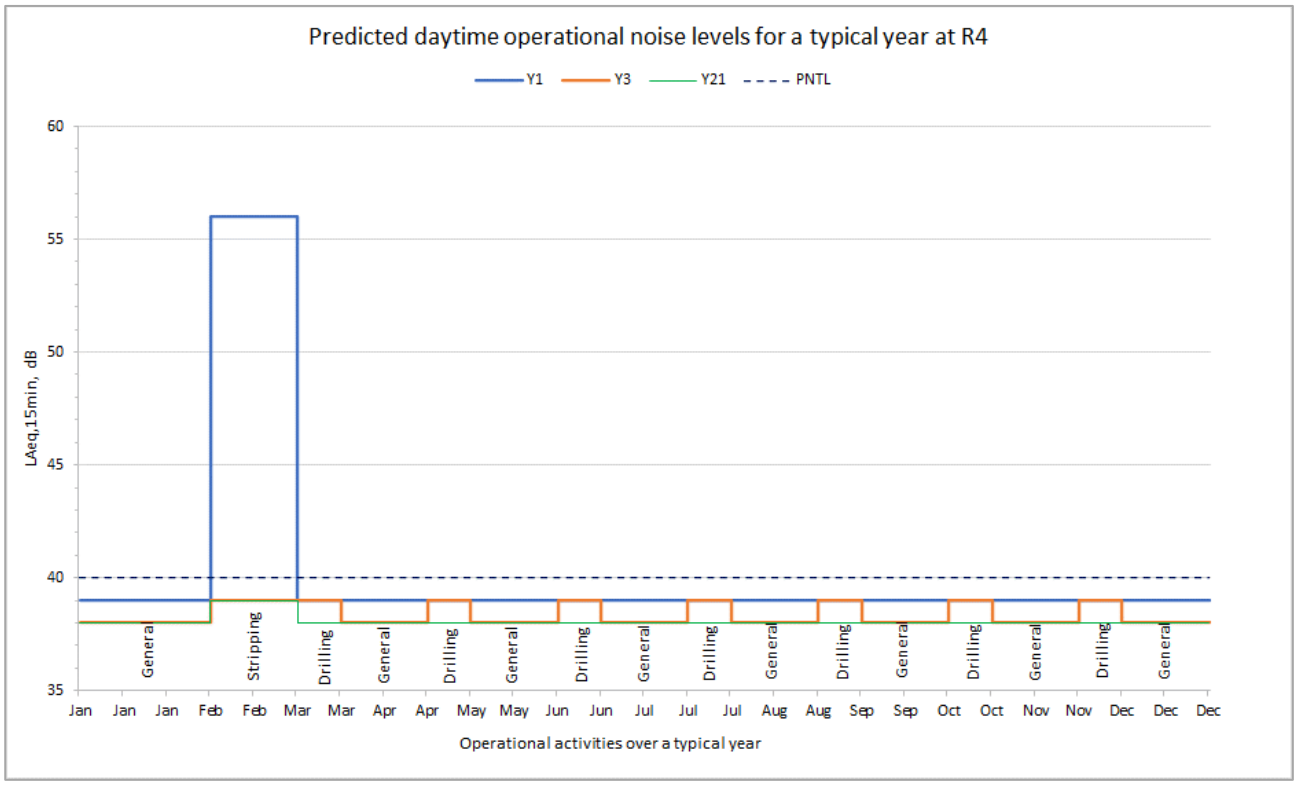


Figure 5.1 Difference in predicted noise levels during general daytime operations versus stripping or drilling activities for R4

ii Night-time operations

Site noise levels predicted at assessment locations during night-time (4 am-7 am) operations (limited to product dispatch activities) are provided in Table 5.4. A 'marginal', 'moderate' or 'significant' exceedance of the PNTL as per the NPfI is shown as underlined, shaded or bold shaded, respectively.

Table 5.4 Predicted operational noise levels during night-time operations

Assessment location	Receiver type	Predicted site $L_{Aeq,15min}$ noise level, dB				Night PNTL, dB	Exceedance, dB			
		Exist.	Y1	Y3	Y21		Exist. (all operations)	Future operations (dispatch only)		
								Y1	Y3	Y21
R1	Residential[1]	50	39	39	39	n/a	n/a	n/a	n/a	n/a
R2	Residential	49	36	36	35	35	**14**	1	1	Nil
R3	Residential	43	39	39	38	35	8	4	4	3
R4	Residential	41	35	35	35	35	6	Nil	Nil	Nil
R5	Residential	41	<35	<35	<35	35	6	Nil	Nil	Nil
R6a	Residential	<35	<35	<35	<35	35	Nil	Nil	Nil	Nil
R6b	Residential	<35	<35	<35	<35	35	Nil	Nil	Nil	Nil
R7	Residential	<35	<35	<35	<35	35	Nil	Nil	Nil	Nil
R8	Residential	<35	<35	<35	<35	35	Nil	Nil	Nil	Nil
R9	Commercial	<63	<63	<63	<63	63	Nil	Nil	Nil	Nil
R10	School	<35	<35	<35	<35	n/a	n/a	n/a	n/a	n/a
R11	School	<35	<35	<35	<35	n/a	n/a	n/a	n/a	n/a
R12	School	<35	<35	<35	<35	n/a	n/a	n/a	n/a	n/a
R13	Residential	38	<35	<35	<35	35	3	Nil	Nil	Nil
R14	Residential	41	<35	<35	<35	35	6	Nil	Nil	Nil
R15	Residential	39	<35	<35	<35	35	4	Nil	Nil	Nil
R16	Residential	39	<35	<35	<35	35	4	Nil	Nil	Nil
R17	Industrial	<68	<68	<68	<68	68	Nil	Nil	Nil	Nil
R18	Residential	35	<35	<35	<35	35	Nil	Nil	Nil	Nil
R19	Residential	36	<35	<35	<35	35	1	Nil	Nil	Nil
R20	Residential	<35	<35	<35	<35	35	Nil	Nil	Nil	Nil
R21	Residential	<35	<35	<35	<35	35	Nil	Nil	Nil	Nil
R22	Residential	39	<35	<35	<35	35	4	Nil	Nil	Nil
R23	Subdivision[2]	38	39	39	39	38	Nil	1	1	1

Notes: 1. Holcim currently has a negotiated agreement in place with the landowner of this residential property and hence PNTLs do not apply at this location.
2. Approved residential subdivision, however there are no proposed residential development.

The significance of residual noise impacts for night-time operations is summarised below:

- Existing (existing pit):
  - PNTL is significantly exceeded (by >5 dB and >RANL) at R2.
  - PNTL is moderately exceeded (by >5 dB and ≤RANL) at R3-R5 and R14.
  - PNTL is marginally exceeded (by 3-4 dB and ≤RANL) at R13, R15, R16 and R22.
  - PNTL is negligibly exceeded (by 1 dB) at R19.
- Y1 (WEA):
  - PNTL is marginally exceeded (by 4 dB and ≤RANL) at R3. Site noise contributions are improved on existing levels.
  - PNTL is negligibly exceeded (by 1 dB) at R2 and R23. Site noise contributions at R2 are improved on existing levels.
- Y3 (northern section of SEA):
  - PNTL is marginally exceeded (by 4 dB and ≤RANL) at R3. Site noise contributions are improved on existing levels.
  - PNTL is negligibly exceeded (by 1 dB) at R2 and R23. Site noise contributions at R2 are improved on existing levels.
- Y21 (southern section of SEA)
  - PNTL is marginally exceeded (by 3 dB and ≤RANL) at R3. Site noise contributions are improved on existing levels.
  - PNTL is negligibly exceeded (by 1 dB) at R23.

During future night-time operations (limited to product dispatch activities), site $L_{Aeq,15min}$ noise levels are predicted to marginally exceed the PNTL at R3. However, when compared to existing noise levels, site $L_{Aeq,15min}$ noise levels are predicted to decrease at most assessment locations. Therefore, no additional noise impacts are predicted from the project during night-time operations at most assessment locations.

The exception is at assessment location R23, where future site $L_{Aeq,15min}$ noise levels are predicted to increase negligibly (by 1 dB) from existing and negligibly (by 1 dB) exceed the PNTL. However, R23 is representative of vacant land with no approved dwelling or residential development. To deal with this, the VLAMP provides a noise trigger level that consist of the NPfI RANL ($L_{Aeq,period}$) + 5 dB, that should not be exceeded on more than 25% of the land. Assessment location R23 is representative of the most affected point within the vacant land and hence where the NPfI suburban RANL ($L_{Aeq,period}$) + 5 dB (ie 48 dB $L_{Aeq,15min}$) would begin to apply from. Based on the future noise levels shown in Table 5.4 for R23, site $L_{Aeq,15min}$ noise levels are predicted to satisfy the VLAMP noise trigger level for vacant land at R23.

The application of modifying factors to predicted operational noise was considered in this assessment in accordance with the guideline provided in Fact sheet C of the NPfI. Based on the type of existing plant and equipment used at the quarry and that no additional plant or equipment are proposed for the project, it is unlikely that operational noise sources (existing and proposed) would contain annoying characteristics such as tonal noise or intermittent noise.

Low frequency noise was assessed based on post-analysis of data from attended noise measurements and predicted one-third octave centre frequency noise levels at assessment locations. It was identified that existing site noise could contain low frequency noise components at R2, R5, R16, R19 and R22 during night-time operations. A +2 dB modifying factor adjustment to the relevant existing operational noise levels shown in Table 5.4 could apply for R5, R16 R19 and R22. A +5 dB modifying factor adjustment to the existing operational noise levels shown in Table 5.4 could apply for R2. For future operations however, it was identified that site noise levels are predicted to satisfy the relevant low frequency noise threshold levels as per the NPfI during night-time operations. Therefore, modifying factor adjustment would not apply at any of the assessment locations during night-time operations. Positive adjustments have only been identified for existing night-time operations and, therefore, this is a beneficial noise outcome for the project. Notwithstanding, it is noted that LFN is not typical to quarry operations, in particular when at significant distances from site or source.

Based on 'marginal' residual noise impacts predicted at R3 and consistent with the NPfI, receiver-based mitigation measures including mechanical ventilation/comfort condition systems to enable windows to be closed without compromising internal air quality/amenity are recommended.

5.2 Construction noise

Construction noise levels predicted at assessment locations for the ICNG standard hours (day period equivalent) are provided in the following sections. The level presented for each assessment location represents the energy-average noise level over a 15-minute period and assumes all equipment operating concurrently in accordance with the scenarios outlined in Section 4.1.3 under ISO 9613 noise-enhancing meteorological conditions (Section 4.1.5). To determine the worst-case noise from the proposed construction activities, construction noise levels predicted for each activity were added to noise levels from existing general daytime operations. Furthermore, it is important to note that the modelled construction works represent worst-case scenarios. Therefore, noise levels from the proposed construction works would be for most of the times lower than the predicted levels.

Holcim will manage construction noise levels during the construction works as discussed further in Section 6.

5.2.1 New access road construction

Site noise levels predicted at assessment locations during the new access road construction (3-4 weeks in duration) during standard hours are provided in Table 5.5.

During the new access road construction, it is predicted that the NMLs will be marginally (by 3 dB) and negligibly (by 1 dB) exceeded at R2 and R3, respectively. Noise levels are not predicted to exceed the 75 dB highly noise affected NML at any residence.

Table 5.5 Predicted site noise levels during the new access road construction

Assessment location	Receiver type	Predicted site $L_{Aeq,15min}$ noise level, dB	NML, dB	Exceedance, dB
R1	Residential[1]	50	n/a	n/a
R2	Residential	48	45	3
R3	Residential	46	45	1
R4	Residential	<45	45	Nil
R5	Residential	<45	45	Nil
R6a	Residential	<45	45	Nil
R6b	Residential	<45	45	Nil
R7	Residential	<45	45	Nil
R8	Residential	<45	45	Nil
R9	Commercial	<70	70	Nil
R10	School	<55	55	Nil
R11	School	<55	55	Nil
R12	School	<55	55	Nil
R13	Residential	<45	45	Nil
R14	Residential	<45	45	Nil
R15	Residential	<45	45	Nil
R16	Residential	<45	45	Nil
R17	Industrial	<75	75	Nil
R18	Residential	<45	45	Nil
R19	Residential	<45	45	Nil
R20	Residential	<45	45	Nil
R21	Residential	<45	45	Nil
R22	Residential	<45	45	Nil
R23	Subdivision[2]	45	45	Nil

Notes: 1. Holcim currently has a negotiated agreement in place with the landowner of this residential property and hence PNTLs do not apply at this location.
2. Approved residential subdivision, however there are no proposed residential development.

5.2.2 Eulomogo Creek crossing construction

Site noise levels predicted at assessment locations during the Eulomogo Creek crossing construction (4-8 weeks in duration) during standard hours are provided in Table 5.6.

During the Eulomogo Creek crossing construction, it is predicted that the NMLs will be negligibly (by 2 dB) exceeded at R2. Noise levels are not predicted to exceed the highly noise affected NML (75 dB) at any residence.

Table 5.6 Predicted site noise levels during the Eulomogo Creek bridge construction

Assessment location	Receiver type	Predicted site $L_{Aeq,15min}$ noise level, dB	NML, dB	Exceedance, dB
R1	Residential[1]	49	n/a	n/a
R2	Residential	47	45	2
R3	Residential	<45	45	Nil
R4	Residential	<45	45	Nil
R5	Residential	<45	45	Nil
R6a	Residential	<45	45	Nil
R6b	Residential	<45	45	Nil
R7	Residential	<45	45	Nil
R8	Residential	<45	45	Nil
R9	Commercial	<70	70	Nil
R10	School	<55	55	Nil
R11	School	<55	55	Nil
R12	School	<55	55	Nil
R13	Residential	<45	45	Nil
R14	Residential	<45	45	Nil
R15	Residential	<45	45	Nil
R16	Residential	<45	45	Nil
R17	Industrial	<75	75	Nil
R18	Residential	<45	45	Nil
R19	Residential	<45	45	Nil
R20	Residential	<45	45	Nil
R21	Residential	<45	45	Nil
R22	Residential	<45	45	Nil
R23	Subdivision[2]	<45	45	Nil

Notes: 1. Holcim currently has a negotiated agreement in place with the landowner of this residential property and hence PNTLs do not apply at this location.
2. Approved residential subdivision, however there are no proposed residential development.

5.3 Sleep disturbance

Maximum predicted $L_{Aeq,15min}$ noise levels during night-time operations (limited to product dispatch activities) for Y1, Y3 and Y21 as shown in Table 5.4 were assessed against the relevant sleep disturbance screening criteria. Maximum L_{Aeq} noise levels are predicted to satisfy the NPfI screening criteria for sleep disturbance at all residential assessment locations.

Maximum predicted L_{Amax} noise levels during night-time operations for Y1, Y3 and Y21 are provided in Table 5.7. The levels presented for each assessment location represent the maximum noise event scenarios outlined in Section 4.1.4 under ISO 9613 noise-enhancing meteorological conditions (Section 4.1.5).

Maximum L_{Amax} noise levels are predicted to satisfy the NPfI screening criteria for sleep disturbance at all residential assessment locations during noise-enhancing meteorological conditions. Therefore, it is unlikely that the project will cause sleep disturbance at any residential receivers.

Table 5.7 Predicted L_{Amax} noise levels during night-time operations

Residential assessment location	Predicted site L_{Amax} noise level, dB				Night L_{Amax} screening criterion, dB	Exceedance, dB			
	Exist.	Y1	Y3	Y21		Exist.	Y1	Y3	Y21
R1[1]	<52	<52	<52	<52	n/a	n/a	n/a	n/a	n/a
R2	<52	<52	<52	<52	52	Nil	Nil	Nil	Nil
R3	<52	<52	<52	<52	52	Nil	Nil	Nil	Nil
R4	<52	<52	<52	<52	52	Nil	Nil	Nil	Nil
R5	<52	<52	<52	<52	52	Nil	Nil	Nil	Nil
R6a	<52	<52	<52	<52	52	Nil	Nil	Nil	Nil
R6b	<52	<52	<52	<52	52	Nil	Nil	Nil	Nil
R7	<52	<52	<52	<52	52	Nil	Nil	Nil	Nil
R8	<52	<52	<52	<52	52	Nil	Nil	Nil	Nil
R13	<52	<52	<52	<52	52	Nil	Nil	Nil	Nil
R14	<52	<52	<52	<52	52	Nil	Nil	Nil	Nil
R15	<52	<52	<52	<52	52	Nil	Nil	Nil	Nil
R16	<52	<52	<52	<52	52	Nil	Nil	Nil	Nil
R18	<52	<52	<52	<52	52	Nil	Nil	Nil	Nil
R19	<52	<52	<52	<52	52	Nil	Nil	Nil	Nil
R20	<52	<52	<52	<52	52	Nil	Nil	Nil	Nil
R21	<52	<52	<52	<52	52	Nil	Nil	Nil	Nil
R22	<52	<52	<52	<52	52	Nil	Nil	Nil	Nil

Notes: 1. Holcim currently has a negotiated agreement in place with the landowner of this residential property and hence PNTLs do not apply at this location.
2. Approved residential subdivision, however there are no proposed residential development.

5.4 Blasting

To determine the allowable MICs for the project and the potential impacts at surrounding sensitive receivers, calculations were conducted using the site laws developed for airblast overpressure and ground vibration emissions based on measured data (refer to Section 4.2).

The results of the allowable MIC calculations are summarised in Table 5.8 for the nearest residential assessment locations to the project.

Table 5.8 Allowable MICs for blasting

Proposed pit	Nearest residential assessment locations[1]	Distance to blast[2]	Allowable MIC based on predictions	Airblast overpressure level (Linear peak)	Ground vibration level (PPV)
WEA	R3	580 m	56 kg	115 dB	<5 mm/s
	R2	610 m	62 kg	115 dB	<5 mm/s
	R4	810 m	110 kg	115 dB	<5 mm/s
	R14	1605 m	433 kg	115 dB	<5 mm/s
SEA	R2	635 m	68 kg	115 dB	<5 mm/s
	R3	1370 m	315 kg	115 dB	<5 mm/s
	R5	1670 m	468 kg	115 dB	<5 mm/s

Notes: 1. Other residential assessment locations are situated at a greater distance from proposed blast locations.
2. Based on the worst-case approximate geographical distance to the nearest proposed blast location.

The results demonstrate that strict control of MIC values will be required to achieve the 95% 115 dB (Linear peak) criterion at the nearest residential receivers. The 5 mm/s PPV criterion will be satisfied if the airblast overpressure target is met.

The MIC values in Table 5.9 should be used as a guide for proposed blasts.

Table 5.9 Recommended blast MIC for the project based on distance to receiver

Blast distance to receiver	MIC to satisfy the 95% airblast overpressure and ground vibration criteria
580 m	56 kg
600 m	60 kg
700 m	82 kg
800 m	107 kg
900 m	136 kg
1.0 km	168 kg
1.1 km	203 kg
1.2 km	242 kg
1.3 km	284 kg
1.4 km	329 kg
1.5 km	378 kg

Ground vibration from blasting also has the potential to impact on non-residential receivers (eg industrial buildings) surrounding the project. The blasting criterion used in this assessment for residential receivers is lower than the criteria for structural damage to buildings (refer to Section 3.7.2). Therefore, no impacts from blasting on non-residential receivers (ie structural damage to buildings) is anticipated from the project if the limiting MICs provided for the nearest residential receivers are followed.

Potential impacts from blast ground vibration at off-site receivers is currently managed by Holcim in accordance with the limits provided in the EPL, including through blast monitoring. Holcim will continue to implement mitigation measures currently in place at the quarry and will implement additional measures to reduce the potential impact of blast ground vibration at nearby receivers as discussed further in Section 6.3.

It is noted that a new shed (non-residential) building is proposed immediately to the north of the WEA at the South Keswick Quarry and hence impacts from vibration to this building should be managed in accordance with applicable commercial building criteria in the future once constructed.

5.5 Road traffic noise

In accordance with the RNP, Sheraton Road is classified as a local road for road traffic noise assessment purposes. Based on existing traffic volumes (Section 4.3.2) and projected site generation (Section 4.3.3), calculated existing and future road traffic noise levels at most affected receivers on Sheraton Road are presented in Table 5.10.

Table 5.10 Road traffic noise results

Assessment location	Speed (km/h)		Distance[1] (m)		Existing road traffic noise levels, $L_{Aeq,1hr}$, dB		Future (maximum production scenario) Road traffic noise levels, $L_{Aeq,1hr}$, dB		RNP local road criteria, $L_{Aeq,1hr}$, dB		Relative increase, dB	
	Existing	Future[2]	Existing	Future[2]	Day	Night	Day	Night	Day	Night	Day	Night
R3	35	35	250	350	50	46	51	47	55	50	1.5	1.0
	80	60	400	450	53	49	54	49	55	50	0.7	0.1
R11 (internal)	40		39		50[3]/40[4]	n/a	52[3]/42[4]	n/a	40	n/a	1.2	n/a

Notes:
1. Approximate distance from most affected façade to nearest carriageway on Sheraton Road.
2. After the construction of the new access road, located approximately 160 m to the north of the existing access road.
3. A 10 dB external to internal reduction has been applied for internal classroom noise levels, assuming a standard construction building with windows open.
4. A 20 dB external to internal reduction has been applied for internal classroom noise levels, assuming a standard construction building with windows closed.

Predicted noise levels for the nearest residence on Sheraton Road (R3) confirm that future (existing + maximum production scenario) road traffic noise levels will be compliant with the RNP local road criteria. Road traffic noise levels from both the nearest corner and further north along the road (where trucks would be travelling fastest) have been assessed for completeness.

Road traffic noise levels have been predicted for the internal classroom areas (R11) according to the worst-case (busiest) traffic period while the school is in use. A nominal external-to-internal noise reduction for both windows open and windows closed scenarios has been assumed (ie 10 dB and 20 dB respectively). Given that the windows open scenario shows existing road traffic noise exceeding the relevant RNP criterion by 10 dB, it has been assumed that classrooms would be fitted with mechanical ventilation and operate with windows closed. Future (existing + maximum production scenario) road traffic noise levels are predicted to exceed the internal criteria by up to 2 dB, representing an increase of 1.2 dB in noise level from the existing scenario. A 1 to 2 dB increase in noise level is generally considered to be negligible by the EPA, as per the NPfI, as this level of change in noise is largely imperceptible to the human ear in an environmental context. Additionally, the RNP states that where existing road traffic noise criteria are already exceeded, any increase in total traffic noise level should be limited to 2 dB.

Further, this peak site traffic period occurs during the morning or afternoon school zone timing, so it is likely that only limited (if any) classes would be in session at these times.

In accordance with the RNP and based on predicted road traffic noise levels discussed above, the project is not expected to cause any additional road traffic noise impacts.

6 Mitigation and management

6.1 Operational noise

6.1.1 Feasible and reasonable mitigation measures

An analysis of feasible and reasonable noise mitigation measures was undertaken for the project. As noted in Section 4.1.2, a preliminary noise modelling exercise identified mitigation measures that would reduce site noise levels at offsite receivers. 'At source' mitigation measures adopted in the noise modelling included mitigation of the 'primary screen/secondary (cone) crusher' and limiting night-time quarry operations. Further, the construction of a 4 m high bund along boundaries in the WEA and SEA was adopted in the noise modelling as 'at path' mitigation. Several other management and mitigation measures were considered in this assessment, with some deemed not to be feasible and/or reasonable. A summary of management and mitigation measures considered for the project is provided in Table 6.1.

Table 6.1 Consideration of possible feasible and reasonable management and mitigation measures

Type of noise measure	Measure	Feasible	Reasonable	Justification
At source	Full enclosure of the 'primary screen/secondary (cone) crusher'	No	Yes	The 'primary screen/secondary (cone) crusher' was identified as a high ranked contributor to offsite noise but a 'full' enclosure was not feasible because of physical design and operational constraints.
	Partial enclosure or screening of the 'primary screen/secondary (cone) crusher'	Yes	Yes	The 'primary screen/secondary (cone) crusher' was identified as a high ranked contributor to offsite noise. This measure has the potential to significantly reduce offsite noise levels (compared to existing levels) and has been adopted in the model and will be implemented by Holcim.
	Limit night-time quarry operations (4 am to 7 am) to product dispatch activities (ie no processing or extracting activities)	Yes	Yes	This measure will reduce potential noise impacts during the most sensitive night period and has been adopted in the model and will be implemented by Holcim.
	Use of a smaller dozer model (eg CAT D9) for stripping	Yes	No	This measure will increase the duration of stripping activities and will only negligibly (≤2 dB) decrease total quarry noise levels.
	Attenuation to other plant and equipment	Yes	No	Several noise sources were considered for attenuation (eg excavator and dump trucks); however, such measures would not decrease total quarry noise levels.
At path	Construct a noise attenuation bund between receivers and the quarry	Yes	Yes	A 4 m high bund on the western boundary of the WEA and boundaries of the SEA has been adopted in the model and will be implemented by Holcim.

Table 6.1 Consideration of possible feasible and reasonable management and mitigation measures

Type of noise measure	Measure	Feasible	Reasonable	Justification
At receivers	Architectural treatment of affected dwellings (eg improved glazing, acoustic insulation and mechanical ventilation/ air-conditioning)	Yes	Yes	This measure will be negotiated between Holcim and the landholders of affected residential properties.

To address the predicted residual noise impacts outlined in Section 5.1.3, in particular at the most affected residential property, ie R2, an agreement will be negotiated between Holcim and the relevant land owner(s).

6.1.2 Noise management

A noise management plan and monitoring program will be developed to include verification of noise monitoring completed for representative stages of proposed operations to confirm actual noise levels from the site at most affected residences.

6.2 Construction noise

6.2.1 General

The ICNG requires that construction noise levels be assessed against NMLs. Construction noise levels have been predicted marginally above NMLs at assessment locations R2 and R3. It is not uncommon for construction projects to exceed NMLs. For this reason, they are not considered as noise criteria, but as a trigger for all feasible and reasonable noise mitigation and management to be considered, if exceeded.

There is limited opportunity due to proximity of residential assessment locations, site location and local topography to provide significant noise mitigation. Duration of the construction works are relatively short (up to eight weeks) and during standard hours (day) only. Noise management measures that could be implemented on site are provided in the following sections.

6.2.2 Work practices

Work practice methods include:

- regular reinforcement (such as at toolbox talks) of the need to minimise noise;
- review and implementation of feasible and reasonable mitigation measures to reduce noise;
- avoiding the use of portable radios, public address systems or other methods of site communication that may unnecessarily impact upon nearby residents;
- develop routes for the delivery of materials and parking of vehicles to minimise noise;
- where possible, avoid the use of equipment that generates impulsive noise; and
- notify potentially affected residents prior to the commencement of works.

6.2.3 Plant and equipment

Additional measures for plant and equipment include:

- where possible, choose quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks;
- operate plant and equipment in the quietest and most efficient manner; and
- regularly inspect and maintain plant and equipment to minimise noise level increases, to ensure that all noise attenuation devices are operating effectively.

6.3 Blasting

6.3.1 Overview

The site will adopt good industry practice blast management including real time monitoring of all blasts. It is noted that blasting is generally undertaken once per month and that blast criteria adopted herein are applied to all development, including relatively larger scale mining operations where blasting occurs daily throughout the year.

6.3.2 Blast Management Plan

A blast management plan will be prepared to include proposed blast design, locations, size and monitoring. This will include management of any aboriginal items known or found in the area.

7 Conclusion

Holcim, the owner and operator or Dubbo Quarry, is seeking approval for the Dubbo Quarry Continuation Project which involves the continued operation of the quarry through the development of two new resource areas to the south and west of the existing quarry boundary. This NVIA has been prepared to support the application and assess potential noise impacts associated with construction, operation and road traffic.

Predicted noise levels from quarry operations have been provided for each operational scenario. Exceedances of NPfI PNTLs from operations are predicted for several residential assessment locations across each operational scenario. Exceedances range from negligible (1-2 dB) to significant (>5 dB and >RANL). However, future noise levels are generally predicted to be relatively unchanged compared to existing operational noise levels and are predicted to decrease for the night period. Further, no noise complaints have been received to date from the surrounding community in relation to existing quarry operations.

Feasible and reasonable noise mitigation measures have been adopted for proposed operations as detailed herein. To address the predicted residual noise impacts, negotiated agreements as per the VLAMP, may need to be considered. The application of negotiated agreements will be subject to Conditions of Approval and imposed noise limits. Additionally, at-receiver mitigation has been recommended for residences where site noise levels are predicted to moderately exceed the PNTLs.

Construction noise levels from the project are predicted to exceed NMLs at the closest assessment locations by up to 3 dB at R2, and by up to 1 dB at R3. There is limited opportunity due to proximity of residential assessment locations, site location and local topography to provide significant noise mitigation during construction. Further, duration of the construction works are relatively short (up to eight weeks) and during standard hours (day) only. Noise management measures that could be implemented on site have been recommended.

The potential for sleep disturbance has been assessed as per NPfI requirements. No exceedance of the relevant sleep disturbance screening criteria is predicted due to site operations.

Potential impacts of blasting have been assessed, with maximum permissible MICs recommended for each project area to ensure compliance with the relevant airblast overpressure and ground vibration criteria.

Road traffic noise levels under a worst-case maximum production scenario are predicted to satisfy RNP assessment requirements.

References

Australian and New Zealand Environment Conservation Council (ANZECC) 1990, *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration*

Australian Standard AS 1055-1997 "Acoustics - Description and Measurement of Environmental Noise"

Australian Standard AS 2187.2-2006 "Explosives - Storage and Use - Use of Explosives"

British Standard BS 7385 Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2"

British Standard BS 6472-2008 "Evaluation of human exposure to vibration in buildings (1-80Hz)"

Department of Environment, Food and Rural Affairs (DEFRA) 2005, *Update of Noise Database for Prediction of Noise on Construction and Open Sites*

EMM (2020) *Luddenham Quarry Modification 5 - Modification Report*

German Standard DIN 4150 Part 2-1975 "Structural vibration - Part 2 Human exposure to vibration in Buildings"

Golder Associates (2009) *Noise Management Plan, Clay/Shale Quarry, Adams Road, Luddenham*

International Standard Organisation ISO 9613-2 "*Acoustics – Attenuation of Sound during Propagation Outdoors – general method"*

NSW Environment Protection Authority (EPA) 2000, *NSW Industrial Noise Policy*

NSW Environment Protection Authority (EPA) 2017, *Noise Policy for Industry*

NSW Government 2018, *Voluntary Land Acquisition and Mitigation Policy - For State Significant Mining, Petroleum and Extractive Industry Developments*

NSW Department of Environment Climate Change and Water (DECCW) 2011, *Road Noise Policy*

NSW Department of Environment and Conservation (DEC) 2006, *Assessing Vibration: a technical guideline*

NSW Department of Environment and Climate Change (DECC) 2009, *The Interim Construction Noise Guideline*

Abbreviations

Abbreviation	Term
AGL	above ground level
ANZECC	Australian and New Zealand Environment Conservation Council
BMP	Blast Management Plan
DEC	Department of Environment and Conservation
DECC	Department of Environment and Climate Change
DECCW	Department of Environment, Climate Change and Water
DEFRA	Department of Environment, Food and Rural Affairs (United Kingdom)
DPIE	Department of Planning, Industry and Environment
EPA	Environment Protection Authority
EIS	environmental impact statement
EMM	EMM Consulting Pty Limited
FHWA	US EPA Federal Highways
HV	heavy vehicle
ICNG	Interim Construction Noise Guideline
LGA	local government area
LV	light vehicle
NATA	National Association of Testing Authorities
NPfI	Noise Policy for Industry
NML	noise management level
NVIA	Noise and vibration impact assessment
PPV	peak particle velocity
POEO Act	Protection of the Environment Operations Act 1997 (NSW)
PNTL	project noise trigger level
RBL	rating background level
RNP	Road Noise Policy
RMS	root mean square
SEARs	Secretary's environmental assessment requirements
SSD	State significant development
VDV	vibration dose value

Glossary

Technical terms used in this report for the discussion of acoustics (noise and vibration) are defined in Table 7.1.

Table 7.1 Glossary of acoustic terms

Term	Definition
Amenity noise level	The amenity noise levels relate to the overall level of industrial noise subject to land zoning or use.
A-weighting	There are several different weightings utilised for describing noise, the most common being the 'A-weighting'. This attempts to closely approximate the frequency response of the human ear.
Day period	Monday to Saturday: 7 am to 6 pm, on Sundays and public holidays: 8 am to 6 pm.
dB	Noise is measured in the unit called the decibel (dB).
DPIE	NSW Department of Planning, Industry and Environment
EIS	Environmental Impact Statement
EMM	EMM Consulting Pty Limited
EP&A Act	NSW *Environmental and Planning Assessment Act 1979* (NSW)
EPA	NSW Environment Protection Authority (formerly the Department of Environment, Climate Change and Water).
Evening period	Everyday: 6 pm to 10 pm.
ICNG	Interim Construction Noise Guideline
Intrusive noise level	The intrusive noise level refers to noise that intrudes above the background level by more than 5 dB.
L_{A1}	The A-weighted noise level exceeded for 1% of the time.
L_{A10}	The A-weighted noise level which is exceeded 10% of the time. It is roughly equivalent to the average of maximum noise level.
L_{A90}	The A-weighted noise level that is exceeded 90% of the time. Commonly referred to as the background noise level.
L_{Aeq}	The A-weighted energy average noise level. This is the equivalent continuous sound pressure level over a given period. The $L_{Aeq,15min}$ descriptor refers to an L_{Aeq} noise level measured over a 15 minute period.
L_{Amax}	The maximum A-weighted sound pressure level received during a measurement interval or predicted at a receiver.
Night period	Monday to Saturday: 10 pm to 7 am; Sundays and public holidays: 10 pm to 8 am.
PNTL	The project noise trigger levels (PNTLs) are targets for a particular industrial noise source or industry. The PNTL is the lower of either the project intrusive noise level or project amenity noise level.
POEO Act	NSW *Protection of the Environment Operations Act 1997* (NSW)
RBL	The rating background level (RBL) is an overall single value background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the average background levels.
RNP	Road Noise Policy
Sound power level (L_w)	A measure of the total power radiated by a source. The sound power of a source is a fundamental property of the source and is independent of the surrounding environment.
Temperature inversion	A meteorological condition where the atmospheric temperature increases with altitude.

It is useful to have an appreciation of the decibel (dB), the unit of noise measurement. Table 7.2 gives an indication as to what an average person perceives about changes in noise levels in the environment. Examples of common noise levels are provided in Figure 7.1.

Table 7.2 Perceived change in noise in the environment

Change in sound pressure level (dB)	Perceived change in noise
1-2	not perceptible
3	just perceptible
5	noticeable difference
10	twice (or half) as loud
15	large change
20	four times (or quarter) as loud

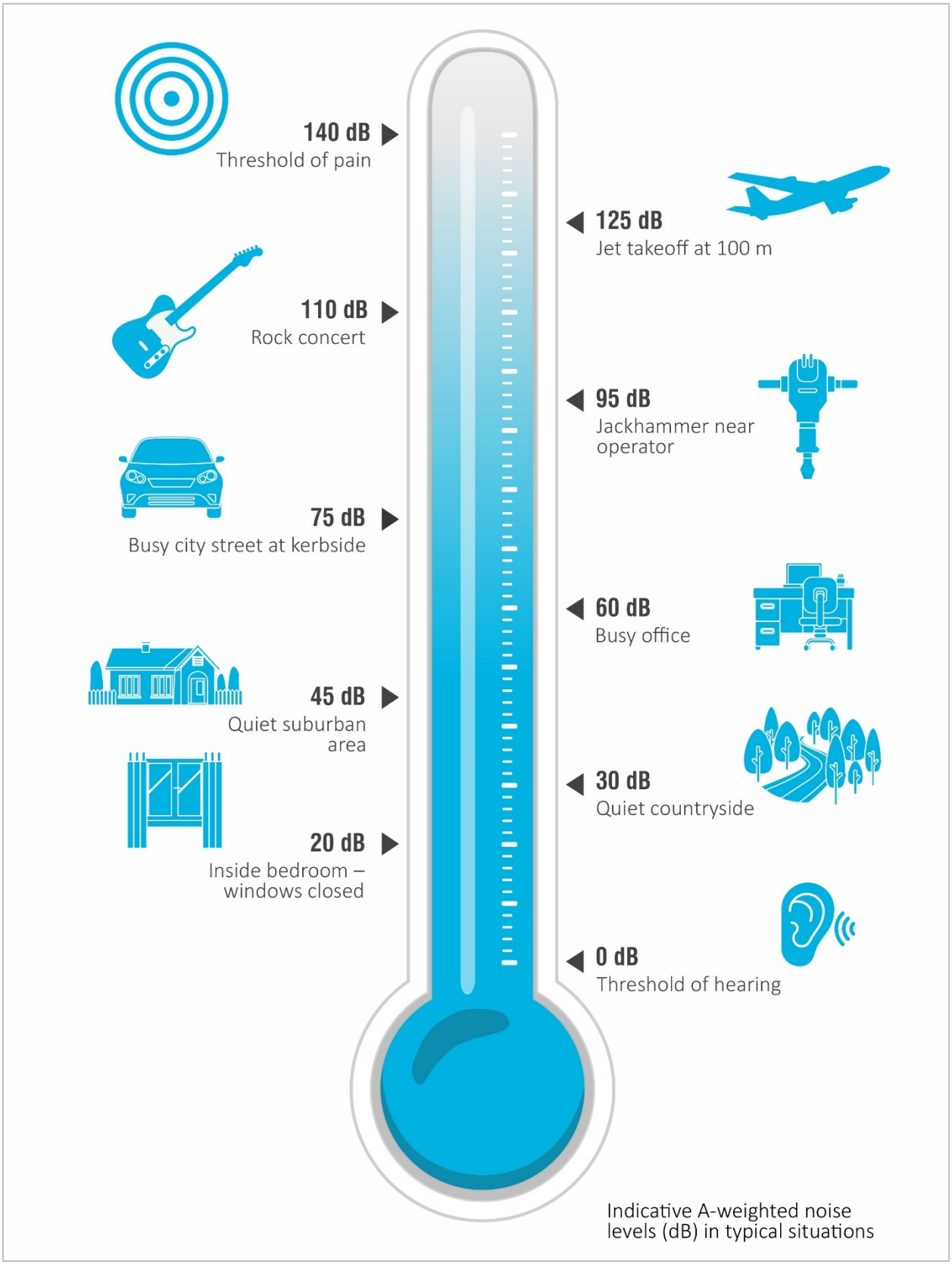


Figure 7.1 **Common noise levels**

Appendix A

Noise modelling – Single octave or 1/3 octave sound power level data

Table A.1 Single octave or 1/3 octave sound power level data

Modelled noise sources	1/1 or 1/3 octave (Hz) sound power levels, dB																											Total, dB(A)
	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k	
Primary crusher	105	109	114	112	110	110	113	113	110	108	110	109	107	107	105	104	103	103	103	102	100	97	96	94	91	88	84	114
Screen 1/crusher 2 (existing)	96	99	107	107	108	108	107	107	107	101	103	108	107	108	107	110	106	105	106	105	105	104	102	101	98	95	91	117
Processing plant transfer point/conveyor drive	80	83	87	92	87	85	85	86	84	87	83	86	86	84	86	85	84	84	83	82	80	78	76	74	72	71	73	94
Tertiary crusher	97	101	103	102	108	104	102	102	102	99	98	99	98	97	100	99	97	97	96	96	97	93	92	91	90	87	86	107
Screen 2	100	105	110	104	105	102	105	103	105	105	99	98	97	98	98	98	96	96	95	95	94	92	91	89	87	86	89	107
Screen 3	102	103	104	106	104	104	102	101	100	97	97	102	101	102	100	98	97	97	96	96	96	95	94	93	92	91	90	108
Screen 4	94	99	100	99	102	102	99	105	107	99	93	94	95	95	93	93	93	92	92	92	91	91	91	90	88	86	84	104
Pugmill/generator	92	101	102	103	109	110	106	101	101	100	101	103	100	99	99	96	97	96	95	92	92	89	86	84	83	80	76	107
FEL WA 500	72	72	72	92	92	92	95	95	95	91	91	91	91	91	91	94	94	94	95	95	95	92	92	92	84	84	84	107
FEL 980 loading RT	92	101	110	113	115	117	113	99	99	101	101	97	95	97	94	96	97	95	97	93	90	89	86	82	80	78	76	106
FEL WA 470	65	65	65	83	83	83	89	89	89	89	89	89	94	94	94	97	97	97	97	97	97	92	92	92	85	85	85	107
Water pump	81	82	88	108	95	93	92	93	90	90	93	93	91	95	92	91	90	92	94	92	91	89	88	86	83	82	79	102
Excavator	101	104	102	104	106	108	113	104	101	104	98	95	92	100	100	98	97	96	97	97	95	95	92	90	88	85	83	108
Excavator (loading dump trucks)	97	101	104	106	105	107	111	110	107	107	103	101	100	103	103	102	101	101	102	103	100	99	96	93	91	88	85	112
Dump truck	-	66	-	-	85	-	-	99	-	-	106	-	-	104	-	-	105	-	-	105	-	-	97	-	-	86	-	111
Watercart	-	60	-	-	75	-	-	88	-	-	99	-	-	99	-	-	98	-	-	97	-	-	92	-	-	83	-	105
Road truck	-	63	-	-	80	-	-	89	-	-	95	-	-	102	-	-	99	-	-	97	-	-	89	-	-	80	-	105
Excavator[1]	101	104	102	104	106	108	113	104	101	104	98	95	92	100	100	98	97	96	97	97	95	95	92	90	88	85	83	108
Excavator[1] (loading dump truck)	97	101	104	106	105	107	111	110	107	107	103	101	100	103	103	102	101	101	102	103	100	99	96	93	91	88	85	112
Dump truck[1]	-	66	-	-	85	-	-	99	-	-	106	-	-	104	-	-	105	-	-	105	-	-	97	-	-	86	-	111
Dozer CAT D11[1]	-	80	-	-	95	-	-	96	-	-	107	-	-	111	-	-	109	-	-	108	-	-	106	-	-	100	-	116
Drill 1500 (impact noise)[2]	-	69	-	-	90	-	-	102	-	-	100	-	-	103	-	-	109	-	-	112	-	-	111	-	-	103	-	116
Drill 1500 (engine noise)[2]	-	67	-	-	91	-	-	95	-	-	94	-	-	96	-	-	98	-	-	101	-	-	95	-	-	82	-	105
Grader[3]	64	63	62	66	69	73	85	82	85	95	91	90	91	92	94	95	95	94	93	92	91	88	85	82	78	75	72	104
Roller[3]	-	-	-	-	110	-	-	108	-	-	104	-	-	101	-	-	98	-	-	98	-	-	91	-	-	87	-	104

Table A.1 Single octave or 1/3 octave sound power level data

Modelled noise sources	1/1 or 1/3 octave (Hz) sound power levels, dB																											Total, dB(A)
	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k	
Asphalt truck and tipper[3]	-	-	-	-	100	-	-	105	-	-	102	-	-	100	-	-	99	-	-	98	-	-	95	-	-	88	-	105
Concrete agitator truck[4]	-	-	-	-	111	-	-	102	-	-	94	-	-	97	-	-	98	-	-	106	-	-	88	-	-	83	-	108
Crane[4]	-	-	-	-	113	-	-	101	-	-	95	-	-	99	-	-	100	-	-	97	-	-	91	-	-	84	-	104
Crane idling[4]	-	-	-	-	99	-	-	90	-	-	85	-	-	87	-	-	91	-	-	88	-	-	82	-	-	74	-	94

Notes: 1. Stripping.
2. Drilling.
3. New access road construction.
4. Creek crossing construction.