BERRIMA CEMENT WORKS

SWDF Increase & New Site Access Road
Operational and Construction Noise Impact Assessment Report

Prepared for:

Boral Cement Limited
PO Box 6041
NORTH RYDE NSW 2113

SLR Ref: 660.30127-R04
Version No: -v1.0
December 2021

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Tenancy 202 Submarine School, Sub Base Platypus, 120 High Street
North Sydney NSW 2060 Australia

T: +61 2 9427 8100
E: sydney@slrconsulting.com www.slrconsulting.com

BASIS OF REPORT

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
660.30127-R04-v1.0	2 December 2021	John Sleeman	Aaron McKenzie	John Sleeman

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1 Introduction

1.1 Background

SLR Consulting Australia Pty Ltd (SLR) was engaged by Boral Cement Limited (Boral) to conduct a Noise Impact Assessment of the proposed increase in Solid Waste Derived Fuels (SWDF) and New Site Access Road (the Project). The proposed new site access road connects the site directly to the Old Hume Highway, at New Berrima and therefore reduces Boral traffic on Taylor Avenue.

The proposal would not change the capacity of the cement works, with SWDF replacing coal, however would change offsite and on site traffic routes to and from the facility. The proposed development is covered under MOD 14 of the Cement Works.

Specific acoustic terminology is used in this assessment. An explanation of common terms used is included in **Appendix A.**

1.2 Assessment Requirements

The assessment of noise impacts for the proposal has been guided by the NSW Department of Planning and Environment (DP&E) Secretary's Environmental Assessment Requirements (SEARs) dated 6 August 2021. With respect to noise and vibration the SEARS require '*a quantitative noise and vibration impact assessment undertaken by a suitably qualified acoustic consultant in accordance with the relevant Environment Protection Authority guidelines and Australian Standards'*.

Key Policies are Guidelines used in the Assessment

- NSW Noise Policy for Industry (NPfI) (EPA, 2017)
- Interim Construction Noise Guideline (ICNG) (EPA, 2009)
- NSW Road Noise Policy (RNP) (DECCW, 2011)
- NSW Road Noise Policy - application notes (EPA, 2013)

2 Project Description

Berrima Cement Works has been operating since 1929 and produces cement products (cement and clinker) for sale in NSW, the ACT and for export. The facility is located approximately 500 m south of the New Berrima township and currently produces 1.4 million tonnes per annum of cement products and 60% of all of NSW's cement for building and construction. Cement products are dispatched to domestic customers by train and truck and international customers through Port Kembla.

Since 2018 SWDF have been adopted into the production process. The use of SWDF provide various advantages which include less consumption of coal, a reduction in waste to landfill and lower production costs. Boral seeks to increase the consumption of SWDF within the Kiln by 150%, thereby reducing the plant's reliance on coal. The delivery of SWDF is currently restricted to 6am – 6pm Monday to Friday and 7am – 1pm Saturday. Due to the lower relative energy properties of SWDF compared to coal increased truck movements are required over a 24-hour time period to ensure adequate fuel supply for efficient kiln operation.

Consequently, the modification seeks to allow unrestricted delivery times to facilitate the continual supply and consumption of SWDF in the kiln, removing the bottleneck experienced by a shortage of onsite storage capacity. Importantly the capacity of the cement works would not change, and accordingly operational noise, other than that from on and off site traffic would remain unchanged.

An alternate site access route, providing direct access to the Old Hume Highway from the cement works south of, and parallel to Taylor Avenue is proposed to help reduce environmental impacts on residences in New Berrima. In addition, two additional SWDF storage sheds are proposed for construction. The additional sheds will be used for SWDF storage and handling, and located on the south-eastern side of the site, adjacent to the traffic return loop. An aerial of the site and the proposed new site access road is shown in **Figure 1**.

The Project would result in a change in heavy vehicle movements, described in the SLR report 660.3017-R01-v1.1 '*Traffic Impact Assessment State Significant Development The Boral Berrima Cement Works SWDF Consumption Increase and New Access*'. Table 6 and Table 7 from that report are presented in **Table 1** and **Table 2** respectively as follows:

Table 1: Haulage of Energy Sources (Per Day)

Source of Energy Haulage	Existing	Proposed*
SWDF	16	39
Coal	22	12

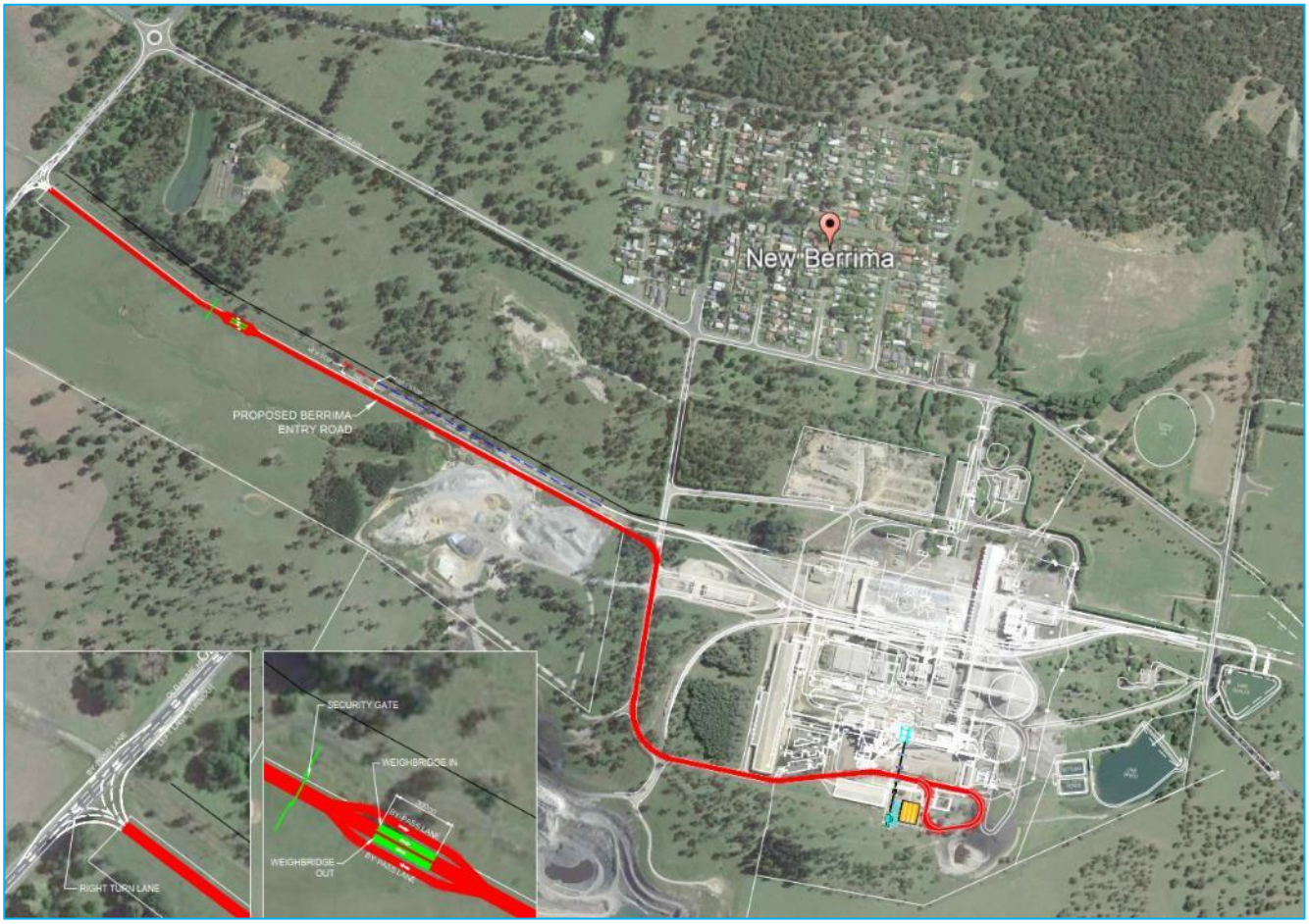
As identified in **Table 1**, it is understood that a decrease in 10 truck loads of coal will require 23 truck loads of SWDF material. This is due to the difference in energy densities of coal and SWDF.

Table 2: Total Heavy Vehicle Movements (Per Day)

Material / Access	Existing	Proposed [1]
Total Vehicles at Taylor Avenue Access	317	128
Total Vehicles at Old Hume Highway Access	0	202
Total (Site)	317	330

Notes: 1. Identified truck movements are subject to the availability of an alternative fuel source, with the requirement to maintain current consumption levels of coal should the full volume of the alternate supply not be available.

Figure 1 Aerial of the Cement Works and Proposed New Access Road



2.1 Construction

The proposed entry road would be constructed during ICNG standard construction hours and involve the following major works:

- Site Establishment;
- Enabling Works; and
- Road Works
- Shed Construction

Construction noise modelling scenarios for the four (4) construction scenarios have been developed with the proposed equipment and associated sound power levels (SWL) presented in **Appendix B**.

3 Noise Assessment Criteria

3.1 Construction Noise Assessment Criteria

The NSW EPA's Interim Construction Noise Guideline (ICNG) (EPA, 2009) recommends a construction noise management level (CNML) equivalent to the daytime RBL plus 10 dBA within standard hours (ie daytime) and RBL plus 5 dBA outside standard hours (ie evening and night-time). The ICNG also contains "highly noise affected" daytime CNMLs which are set at 75 dBA $L_{Aeq(15minute)}$.

For this assessment the measured long term average L_{A90} noise levels provided in the PRP-7 Response Report as reproduced in **Table 4** will be adopted as representative of RBLs for the nearest receivers.

As the Facility construction works would be limited to daytime only, the ICNG construction noise management levels are as presented in the **Table 3**.

Table 3 Intrusive $L_{Aeq(15minute)}$ CNMLs (dBA re 20 µPa)

Location	Daytime CNML (noise affected) RBL plus 10 dBA [1]	Daytime CNML (highly noise affected)
Taylor Avenue near Adelaide St	57	75
4 Melbourne Street	55	
12 Brisbane Street	54	

Notes : 1. ICNG - Recommended standard working hours: Monday to Friday: 7:00 am to 6:00 pm, Saturday 8:00 am to 1:00, no work on Sundays and Public Holidays.

3.2 Construction Vibration

The nearest residences are located 400 m from the proposed works, and the commercial structures 125 m from the works. Accordingly no vibration impacts are anticipated, and has not been considered further in this report.

3.3 On Site Road Traffic Noise

On site traffic noise is part of the operational noise of the facility and covered under the project approval and the Environment Protection Licence.

3.3.1 Kiln 6 Consolidated Approval

The NSW Government Department of Planning, Industry and Environment (DPIE) project approval for the upgrade of Kiln 6 and associated works at the existing cement works was determined 12 May 2002. Since the original approval there have been a number of modifications, up to MOD 12 of 7 April 2020.

Schedule 2, Condition 3 of the approval refers to noise limits applicable:

3. ENVIRONMENTAL PERFORMANCE

NOISE

Construction Noise

3.1 Construction activities associated with the cement works upgrade shall only be carried out:
a) between 7:00 am and 6:00 pm, Monday to Friday inclusive, during periods in which the cement works is shut-down, and construction noise is audible at the boundary of the site;
b) between 7:00 am and 1:00 pm on Saturdays, during periods in which the cement works is shut-down, and construction noise is audible at the boundary of the site;
c) at no time on Sundays or public holidays, during periods when the cement works is shut-down, and construction noise is audible at the boundary of the site;
d) at any time during periods in which the cement works is in operation; and e) at any time if construction noise is inaudible at the boundary of the site.

3.1A The Development shall be constructed with the aim of achieving the construction noise management levels detailed in the Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009). All feasible and reasonable noise mitigation measures shall be implemented and any activities that could exceed the construction noise management levels shall be identified and managed in accordance with the CEMP.

Note: The Interim Construction Noise Guideline identifies 'activities that require the addition of 5dB(A) to the predicted level before comparing to the construction NML

3.1B Where Feasible and Reasonable, operation noise mitigation measures shall be at the start of Construction (or at other times during construction) to minimise construction noise impacts.

Operational Noise

3.2 Subject to compliance with the requirements of this consent, the cement works upgrade may be operated 24 hours per day, 7 days per week.

3.3 Noise generated at the site must not exceed the noise limits at the times and location specified in Table 2 below.

Table 2 - Maximum Allowable Noise Limit (dB(A))

Location	Day[a] $L_{A90(15\ minute)}$	Evening[b] $L_{A90(15\ minute)}$	Night[c] $L_{A90(15\ minute)}$
The Noise Compliance Point (Point 20) – Store Yard Close	58	58	58

a. Day is defined as the period from 7:00am to 6:00pm Monday to Saturday and 8:00am to 6:00pm on Sundays and public holidays.

b. Evening is defined as the period from 6:00pm to 10:00pm.

c. Night is defined as the period from 10:00pm to 7:00am Monday to Saturday and 10:00pm to 8:00am on Sundays and public holidays

3.3A Any new or upgrade development projects the subject of any modification to this consent must give consideration to the Project Specific Noise Levels identified in the document titled 'PRP-7 Response – Identifying Environmental Noise Objectives For Berrima Cement Plant' dated 27 March 2018, prepared by Recognition Research.

3.3.2 Environmental Noise Objectives - Recognition Research Report

Further to the above item 3.3A of the Project Approval, the Project Specific Noise Level (PSNLs) have been identified in the document titled '*PRP-7 Response – Identifying Environmental Noise Objectives For Cement Plant*' (PRP-7 Response Report). These PSNLs from Table 3.1 of the PRP-7 Response Report are reproduced as follows:

Table 4 PRP-7 Response Report - Recommended PSNLs calculated for representative receiver locations

Receiver location	Period	Recommended PSNL $L_{Aeq(period)}$	Measured long- term average L_{A90}	Recommended PSNL for Night-time $L_{A1(1minute)}$
Taylor Avenue near Adelaide Street	Day Evening Night	48 44 43	47 44 44	58
4 Melbourne Street	Day Evening Night	46 42 40	45 44 43	56
Chesley Park Farm [1]	Day Evening Night	49 45 40	44 43 42	54
12 Brisbane St	Day Evening Night	51 45 40	44 42 42	56

Notes: 1. The PRP-7 Response Report notes '*the receiver location for Chesley Park Farm no longer exists and is considered not relevant for residential receivers. The site was acquired for a quarry development and the residence demolished in 2015'.*

Accordingly consideration will be given to the PSNLs presented in **Table 4** in determining PSNLs for on site traffic noise.

3.3.3 Environment Protection Licence

In addition to the DPID Project Approval, the NSW EPA's Environment Protection Licence 1698 (version date 18 Dec 2019) provides noise limits to the site in Section L5, as follows:

L5 Noise Limits

L5.1 Noise generated at the premises must not exceed the noise limits at the times and locations in the table below. The locations referred to in the table below are indicated by Figure 4.1A, within PRP-7 Response – Identifying Environmental Noise Objectives for Berrima Cement Plant, dated 27 March, 2018 (Ref RRRep:004) by Recognition Research.

Location	*Day, Evening & Night LA90(15 minute) in dB(A)*
The Noise Compliance Point (Point 20) - Store Yard Close	*58*

L5.2 For the purposes of Conditions 5.1:

a) Day means the period from 7am to 6pm Monday to Saturday and the period from 8am to 6pm Sunday and public holidays.

b) Evening means the period from 6pm to 10pm.

c) Night means the period from 10pm to 7am Monday to Saturday and the period from 10pm to 8amSunday and public holidays.

L5.3 Standard Meteorological Conditions

a) The noise emission limits identified in condition L5.1 apply under the following meteorological conditions for the Day, Evening and Night assessment period:

- Stability Categories A, B, C and D with wind speeds up to and including 0.5m/s at 10m above ground level.

b) For those meteorological conditions not referred to in condition L6.3(a), the noise limits that apply are the noise limits in condition L6.1 plus 5dB

L5.4 For the purposes of condition L5.3:

a) The meteorological conditions are to be determined from meteorological data obtained from the nearest, representative Bureau of Meteorology weather station

b) Stability category shall be determined using the following method from Fact Sheet D of the Noise Policy for Industry (NSW EPA, 2017):

i. Use of sigma-theta data (section D1.4).

L5.5 For the purpose of determining the noise generated from the premises, the modifying factor corrections in Table C1 in Fact Sheet C of the Noise Policy for Industry (NSW EPA, 2017) may be applied, if appropriate, to the noise measurements by the noise monitoring equipment.

L5.6 Noise measurements must not be undertaken where rain or wind speed at microphone level will affect the acquisition of valid measurements

In summary the EPA Noise Limits are as per the Maximum Allowable Noise Limit of the Project Approval, with the EPA providing additional information on the applicable meteorological conditions and modifying factors. For the Licence Condition L5.3 b) which refers to other meteorological conditions such as an enhancing temperature inversion, as the distance to the compliance point is approximately 400 m, the increase will be less than 5 dB, hence this is not required to be considered further.

Additionally, as this project is an upgrade, consideration has been given to the Project Specific Noise Levels identified in the PRP-7 Response Report.

3.3.4 Operational On Site Traffic Noise Targets

The operational noise limits of the Project Approval and EPA licence apply at the Noise Compliance Point (Point 20), and are specified as an $L_{A90(15\ minute)}$ in order to be unaffected by short term on-site traffic noise. Never the less operational noise targets for on site traffic, as distinct from continuous noise from the facility, have been based on the Recommended PSNLs calculated for representative receiver locations from the PRP-7 Response Report as presented in **Table 4**.

In order for the modification to have a minimal impact on the total noise emissions from the operation of the cement works, the noise targets have been established to be a minimum of 6 dB below the existing noise limits and are presented in **Table 5**. This approach has previously been used in the Chloride Bypass System assessment (MOD 13) of the Cement Works.

It is also noted the PSNLs of the PRP-7 Response Report are $L_{Aeq(period)}$ noise levels, and in this instance, on site traffic noise will not be constant over the period, with the worst case 15 minute period being calculated as based on peak hourly traffic flows. The approach to calculate the worst case 15 minute period of traffic noise is consistent with intrusive noise assessment as defined inthe NSW EPAs Noise Policy for Industry (NPfI).

Furthermore this assessment focuses on the change between existing on site traffic noise, and proposed on site traffic noise as a result of the new access road, hence comparison with the noise targets will indicate the relative impact of the proposal.

Table 5 On Site Traffic Operational Noise Targets

Location	Period	$L_{Aeq(15minute)}$
Taylor Avenue near Adelaide St	Day Evening Night	42 38 37
4 Melbourne Street	Day Evening Night	40 36 34
12 Brisbane Street	Day Evening Night	45 39 34

3.4 Off Site Road Traffic Noise

The NSW Road Noise Policy P and associated Application Notes (**Section 1.2**) present road traffic noise impact assessment procedures for setting acceptable $L_{Aeq(period)}$ noise levels and assessing any impacts from both new and the redevelopment of existing road networks, and sets out noise mitigation strategies for residences affected by:

- Noise from the development of new road corridors;
- Noise from the redevelopment of existing roads; and
- Noise from additional traffic on roads generated by land use developments.

The RNP adopts a road classification scheme for assessing road traffic noise from arterial, sub-arterial and local roads, and then identifies noise “assessment” and “relative increase” criteria which aim to maintain an acceptable level of road traffic noise associated with traffic-generating developments.

As described in **Section 2**, the Facility will be accessed by a new access road from the Old Hume Highway, resulting in a reduction in traffic on Taylor Avenue. In accordance with the RNP these roads are classified as arterial/sub-arterial roads. The applicable noise criteria are presented in **Table 6**.

Table 6 Road Traffic Noise Assessment Criteria for Residential Land Uses (dBA re 20 µPa)

Road	Land Use	Total Traffic Noise Criteria[1]	Relative Increase Criteria[2]
Taylor Avenue; Old Hume Highway; Medway Street;	Existing residences affected by additional traffic on existing arterial/sub-arterial roads generated by land use developments	Daytime 60 $L_{Aeq(15hour)}$	Existing $L_{Aeq(15hour)}$ plus 12 dBA
		Night-time 55 $L_{Aeq(9hour)}$	Existing $L_{Aeq(9hour)}$ plus 12 dBA

Note 1: Daytime 0700 hours to 2200 hours, Night-time 2200 hours to 0700 hours.

Note 2: Application Notes state that the relative increase criteria are primarily intended to protect existing quiet areas.

It is noted that in all cases, where the nominated criteria are already exceeded, traffic associated with a development should not be permitted to lead to an increase in the existing noise traffic levels of more than 2 dBA and this generally arises from a more than 60% traffic increase due to a project.

4 Construction Noise Assessment

A computer model was developed in order to predict noise emissions from the construction of the proposed new access road. The noise modelling was undertaken using SoundPlan v8.0 software developed by Braunstein and Berndt Gmbh in Germany, using the Concawe algorithm for predicting noise. The noise modelling takes into account source sound level emissions and locations, screening effects, receiver locations, ground topography and noise attenuation due to spherical spreading and atmospheric absorption.

The model used 1 m terrain data provided by GIS. The noise model also included the details of surrounding buildings with the potential to provide acoustic shielding of construction noise to surrounding receivers.

4.1 Modelling Scenarios and Sound Power Levels

As outlined in **Section 2** construction works would involve civil works for site preparation followed by the erection of structures and installation of plant. The significant stages or scenarios are summarised as follows:

- Scenario 1 – Site Establishment
- Scenario 2 – Enabling Works
- Scenario 3 – Road Works
- Scenario 4 – Shed Construction

Construction equipment for scenarios for these scenarios have been determined and these are presented in **Appendix B** with the associated equipment sound power levels (SWL) used in the modelling.

4.2 Construction Noise Impact Residential Receivers

Construction noise from each of the construction scenarios presented in **Appendix B** was predicted at the nearest residential receivers as presented in **Table 7**.

Table 7 Predicted Daytime Construction Intrusive $L_{Aeq(15minute)}$ Noise Levels (dBA re 20 µPa)

Receiver [1]	L_{Aeq} Noise Level				
	Daytime Project Specific NML	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Taylor Avenue near Howard Street [2]	54	42	47	49	28
Taylor Avenue near Adelaide Street	57	38	42	44	44
4 Melbourne Street	55	39	44	46	42
12 Brisbane Street	54	37	42	44	43

Notes 1. In addition to the Taylor Avenue receiver near Adelaide Street from the Recognition Research Report, a Taylor Street receiver near Howard Street at the most impacted western end of New Berrima has been included
2. The lower NML for 12 Brisbane Street has been adopted for Taylor Avenue near Howard Avenue.

Discussion

The predicted noise levels presented indicate compliance for the four construction scenarios considered. This is consistent with the proposed construction activities and distances to the receivers.

5 Operational Noise Assessment

The SoundPlan v8.0 computer model developed for construction activities has been used to predict operational noise.

5.1 On Site Traffic Noise

For on site traffic noise emission levels were modelled using the Concawe prediction algorithm, and for the standard meteorological conditions specified in the EPA licence, of stability class D under calm conditions. The following sound power levels were used for heavy and light vehicles, and consistent with the Boral Cement Limited '*Traffic Management Plan*' speeds were modelled at 50 km/hr.

- Heavy vehicle SWL 108 dBA
- Light vehicle SWL 96 dBA

Traffic volumes on the onsite routes used were based on information provided by the SLR Transport Authority conducting the Traffic Impact Assessment, and are summarised in **Table 8.** Taylor Avenue volumes correspond to the existing on site routes which enter and leave the site via Taylor Avenue. Old Hume Highway volumes correspond to the proposed new access route.

Table 8 Boral Base Vehicles 2021 and Proposal Operating Road Traffic

Roadway	Time Period	Existing Peak Hour Movements		Proposal Peak Hour Movements	
		Light	Heavy	Light	Heavy
On site to Taylor Avenue	Daytime	22	53	22	18
	Evening	22	0	22	0
	Night-time	22	53	22	18
	Daytime	0	0	0	34

Roadway	Time Period	Existing Peak Hour Movements		Proposal Peak Hour Movements	
		Light	Heavy	Light	Heavy
On site to Old Hume Highway	Evening	0	0	0	3
	Night-time	0	0	0	34

Notes 1. The night-time peak hourly flows correspond to the 6am to 7am period.

On site traffic noise levels were predicted to the nearest residences to the facility on or near Taylor Avenue and are presented in **Table 9**.

Table 9 Predicted On Site Intrusive $L_{Aeq(15minute)}$ Traffic Noise Levels (dBA re 20 µPa)

Location	Period	Noise Target	Predicted Noise Level $L_{Aeq(15minute)}$		
			Existing	Proposal	Compliance
Taylor Avenue near Howard Street	Day Evening Night	45 39 34	37 37	36 25 36	Achieved
Taylor Avenue near Adelaide Street	Day Evening Night	42 38 37	45 45	41 30 41	Achieved
4 Melbourne Street	Day Evening Night	40 36 34	39 39	41 30 41	Achieved
12 Brisbane Street	Day Evening Night	45 39 34	41 41	38 27 38	Achieved

Discussion

As expected due to the change in on site access routes, there is a reduction in the on site traffic noise at the nearest residences, of typically 1 to 4 dB, with the closer residences to the facility receiving the maximum benefit. Note these predicted noise levels reflect peak hourly movements, with the 6am to 7am volumes influencing the night-time predicted noise levels

Whilst the noise targets as based on the PRP-7 Response Report have been exceeded by up to 4 dB during the night-time, there is an overall reduction in noise compared to the existing case which is of benefit to ongoing noise reduction initiatives.

5.2 Off Site Traffic Noise

Off site traffic noise predictions of noise emission were modelled using the Calculation of Road Traffic Noise (CORTN) model, which has the advantage of having been specifically validated under Australian conditions. The modelling predicts traffic noise levels at the receiver based on existing and projected traffic volumes, percentage of light and heavy vehicles, vehicle speed and distance to the receiver.

The existing base traffic flows (2021) and the estimated proposed operating traffic flows on the arterial road network are presented in **Table 10** for the daytime and night-time traffic noise assessment periods. The traffic volumes for Taylor Avenue and the Old Hume Highway were based on traffic counts conducted by SLR as part of the Traffic Impact Assessment. Modelled vehicle speeds were based on the posted speed limits.

Table 10 Base Vehicles 2021 and Proposal Operating Road Traffic

`	Time Period	Existing Base Flows		Proposal Operating Flows	
		Light	Heavy	Light	Heavy
Taylor Avenue	Daytime 0700 hrs to 2200 hrs	1858	787	2264	396
Old Hume Highway		779	290	-	-
Hume Highway		11581	1359	11581	1359
Taylor Avenue	Night-time 2200 hrs to 0700 hrs	275	156	275	121
Old Hume Highway		90	40	-	-
Hume Highway		2044	240	2044	240

Notes 1. Hume Highway (motorway flows) were based on Transport for NSW permanent counters/classifiers.

The receivers of interest for the noise assessment are those in New Berrima on Taylor Street, two receivers on the Old Hume Highway, between the new intersection and the Hume Highway underpass to the south, and one receiver on Medway Street between the Taylor/Old Hume Hwy/Medway round about and the Hume Highway underpass to the west. The flows presented in **Table 10** were used to predict the existing and proposed traffic noise levels for Taylor Street residences.

For the Old Hume Highway receivers, as the proposal generates an additional 13 heavy vehicle movements, a worst case of 75 percent of these using the Old Hume Highway was assumed, with 60 percent day and 40 percent night assumed. Similarly for Medway Street a worst case of 75 percent of the additional heavy vehicles was assumed, with a 60 percent day and 40 percent night split.

Note at the two Old Hume Highway and one Medway Street receivers the traffic noise environment is dominated by traffic on the Hume Highway Motorway to the west, rather than the Old Hume Highway and Medway Street. Never the less predicted noise levels for the existing and proposal scenarios have been included. Predicted noise levels are presented in **Table 11**.

Table 11 Predicted Total Existing and Proposal Traffic Noise Levels (dBA re 20 µPa)

Access Road	Daytime $L_{Aeq(15hour)}$ Noise Levels[1]				Night-time $L_{Aeq(9hour)}$ Noise Levels[1]			
	Noise Criteria	Existing Traffic	Proposed Traffic	Change	Noise Criteria	Existing Traffic	Proposed Traffic	Change
Taylor Avenue near Howard Street	60 dBA	66	64	-2.0	55 dBA	62	61	-0.9
Taylor Avenue near Adelaide Street		66	64	-2.0		61	60	-0.9
4 Melbourne Street		62	59	-2.1		57	56	-0.9
12 Brisbane Street		57	55	-1.9		52	52	-0.8
Old Hume Highway		52	52	+ <0.1		47	47	+ <0.1
Medway Street		55	55	+ <0.1		50	50	+ <0.1

Note 1: Total traffic noise level inclusive of 2.5 dBA facade correction.

Discussion

Due to the existing flows and proximity of the dwellings the arterial road criteria is exceeded on residences facing Taylor Street. The proposed new access road reduces traffic and associated residential noise levels by 2 dB during the daytime and 1 dB during the night-time at these residences.

At residences on Old Hume Highway noise levels are below the base criteria due to distance from the Old Hume Highway, and also the Hume Highway motorway. Negligible increases in traffic noise levels of less than 0.1 dB during both the daytime and during the night-time are predicted at these residences on the Old Hume Highway. These increases comply with the 2 dB allowance criteria of the RNP.

Similarly for the residence on Medway Street, negligible increases in traffic noise levels of less than 0.1 dB during the daytime and during the night-time are predicted, with predicted noise levels also below the base criteria.

6 Conclusion

SLR has undertaken an assessment of potential noise impacts associated with the construction and operation of a new site access road from the Old Hume Highway to the Berrima Cement Works. The results of the study are summarised in the following points:

- Construction noise is expected to comply with noise management levels which were set in accordance with the EPA's Interim Construction Noise Guideline.
- Operational noise targets for on site traffic noise were nominated as guided by the Consent Conditions. These noise targets are marginally exceeded by existing on site traffic, with the proposed new access road resulting in a reduction in on site traffic noise at the nearest receivers in New Berrima to the north. The noise reductions are typically 1 dB to 4 dB.
- Existing traffic noise levels exceed the RNP baseline noise levels for an arterial road at residences on Taylor Avenue. The proposed new access road to the Old Hume Highway results in a reduction in traffic noise levels at Taylor Avenue residences of typically 2 dB during the daytime and 1 dB at night.
- Existing traffic noise levels comply with the RNP baseline noise levels for an arterial road at residences on The Old Hume Highway and Medway Street. The proposed new access road and associated increase in heavy vehicles results in negligible increases in traffic noise levels of less than 0.1 dB during the daytime and during the night-time. The resultant noise levels remain below the RNP baseline noise levels for an arterial road.

APPENDIX A

Acoustic Terminology

1. Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that 'noise' often refers to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure. The human ear responds to changes in sound pressure over a very wide range with the loudest sound pressure to which the human ear can respond being ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2 x 10^{-5} Pa.

2. 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4,000 Hz), and less sensitive at lower and higher frequencies. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

3. Sound Power Level

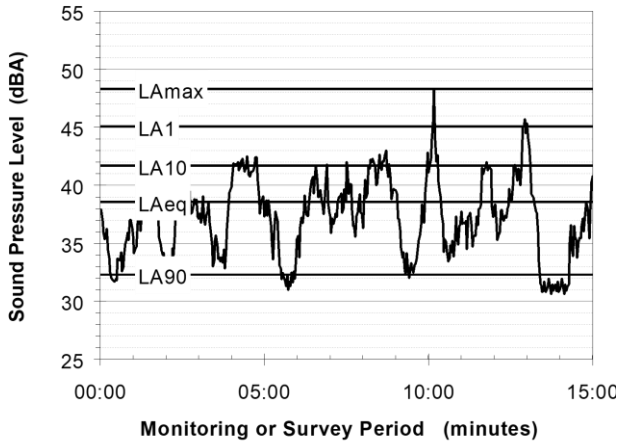
The Sound Power (SWL or LW) of a source is its acoustic energy. Sound Power Levels are expressed in decibel units (dB or dBA), or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure is similar to the effect of an electric radiator, which is characterised by a power rating but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4. Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels LAN, where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time, LA10 the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

LA1 The noise level exceeded for 1% of the 15 minute interval.

LA10 The noise level exceeded for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

LA90 The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

LAeq The A-weighted equivalent noise level (basically, the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

5. Frequency Analysis

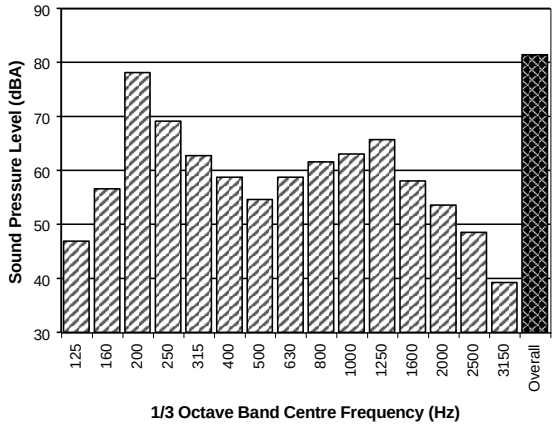
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (three bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



6. Annoying Noise (Special Audible Characteristics)

A louder noise will generally be more annoying to nearby receivers than a quieter one. However, noise is often also found to be more annoying and result in larger impacts where the following characteristics are apparent:

- **Tonality** - tonal noise contains one or more prominent tones (ie differences in distinct frequency components between adjoining octave or 1/3 octave bands), and is normally regarded as more annoying than 'broad band' noise.
- **Impulsiveness** - an impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.
- **Intermittency** - intermittent noise varies in level with the change in level being clearly audible. An example would include mechanical plant cycling on and off.
- **Low Frequency Noise** - low frequency noise contains significant energy in the lower frequency bands, which are typically taken to be in the 10 to 160 Hz region.

7. Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements (ie vertical, longitudinal and transverse).

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/Vo), where Vo is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used.

8. Human Perception of Vibration

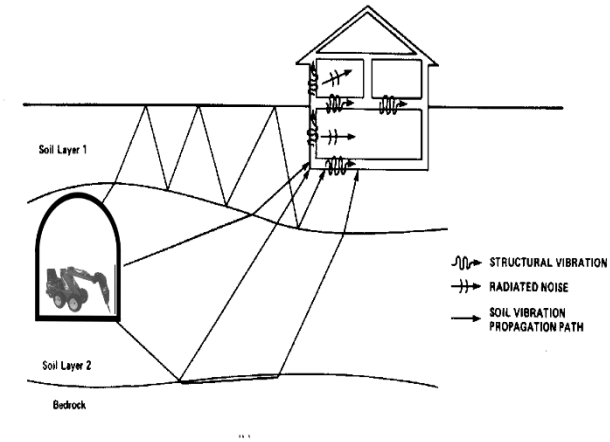
People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

9. Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents an example of the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise.

APPENDIX B

Construction Scenarios and Equipment Sound Power Levels

Table A1 CONSTRUCTION NOISE MODELLING SCENARIOS

Construction Component	Construction Period	Equipment Involved at each Work Site	
		Equipment Type	Number of Items
Site Establishment	Daytime	Bobcat	1
		15t excavator	1
		12-15t Trucks	1
		Hand tools Site Establishment	1
Enabling	Daytime	30t excavator	1
		Grader	1
		Water cart	1
		12-15t Trucks	2
		Hand tools Enabling	3
Road works		Concrete Trucks / Agitator	2
		12-15t Trucks	1
		Vibrating Smooth Drum Roller	1
		Bobcat	1
		Water Cart	1
		Asphalt Paving Machine	1
		Hand tools	4
Storage Shed Construction		Concrete Trucks / Agitator	2
		12-15t Trucks	2
		100 Tonne mobile Crane	1
		Hand tools	4

Table EQUIPMENT SOUND POWER LEVELS

Facility Construction Equipment	Overall SWL $L_{Aeq(15minute)}$ (dBA re 1ρW)
Bobcat	104
Excavator (15 tonne)	103
Excavator (30 tonne)	110
12-15t Trucks	108
Water Cart	103
Mobile Crane (100 tonne)	113
Vibrating Smooth Drum Roller	109
Asphalt Paving Machine	114
Hand tools	94

ASIA PACIFIC OFFICES

BRISBANE
Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
F: +61 8 9370 0101

GOLD COAST
Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Suite 2, 2 Domville Avenue
Hawthorn VIC 3122
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
2 Lincoln Street
Lane Cove NSW 2066
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
Level 1, 514 Sturt Street
Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

TOWNSVILLE SOUTH
12 Cannan Street
Townsville South QLD 4810
Australia
T: +61 7 4772 6500

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 404 939 922

AUCKLAND
68 Beach Road
Auckland 1010
New Zealand
T: +64 27 441 7849

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628