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Berrima Cement

Modification No. 9 - Waste Derived Fuels

Noise and Vibration Impact Assessment

Report Number 610.14460-R3

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Noise and Vibration Impact Assessment

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1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) was engaged by Boral Cement Limited (Boral) to conduct a Noise Impact Assessment of the proposed upgrade of Kiln 6 to incorporate the assessment of noise from the waste derived fuels project.

1.1 Terminology

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

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 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.

Boral has implemented a number of efficiency measures over the years in response to pressure from less expensive imported products and rising energy costs. The use of waste derived fuels is another such measure which would reduce energy costs and have associated environmental benefits.

Boral seeks approval to use waste derived fuel in Kiln 6. All waste derived fuels proposed to be used by Boral would be consistent with the EPA's NSW Energy from Waste Policy (2014).

In 2005, Boral was granted conditional approval to use some waste derived fuels including spent aluminium electrode carbon (Hi Cal 50), liquid oil residues (AKF-1) and waste tyres (AKF-5) (condition 1.4A, MOD 2-1-2004i). However, the use of these fuels has not been explored beyond trial stage as approval to construct the necessary infrastructure has not been pursued and emission limits have been too restrictive.

Due to a number of market pressures, Boral is now seeking to expedite the use of these and other waste derived fuels.

The fuels that are the subject of this modification are the following solid recovered fuels:

- Wood Waste - material left over from industrial processes like milling, furniture making and building and construction; and
- Refuse Derived Fuel (RDF) - fuel made from the combustible materials recovered and processed from waste streams, such as papers, cardboards, packaging and construction and demolition materials

These fuels are considered to be an ideal fuel source for Kiln 6 and would be sorted, tested and shredded by authorised waste suppliers in order to maintain compliance with relevant specifications.

Boral proposes to use up to 100,000 tonnes per year of waste derived fuels in its cement works operation. This will replace 15-20% of the coal used in the facility.

Figure 1 Site Layout

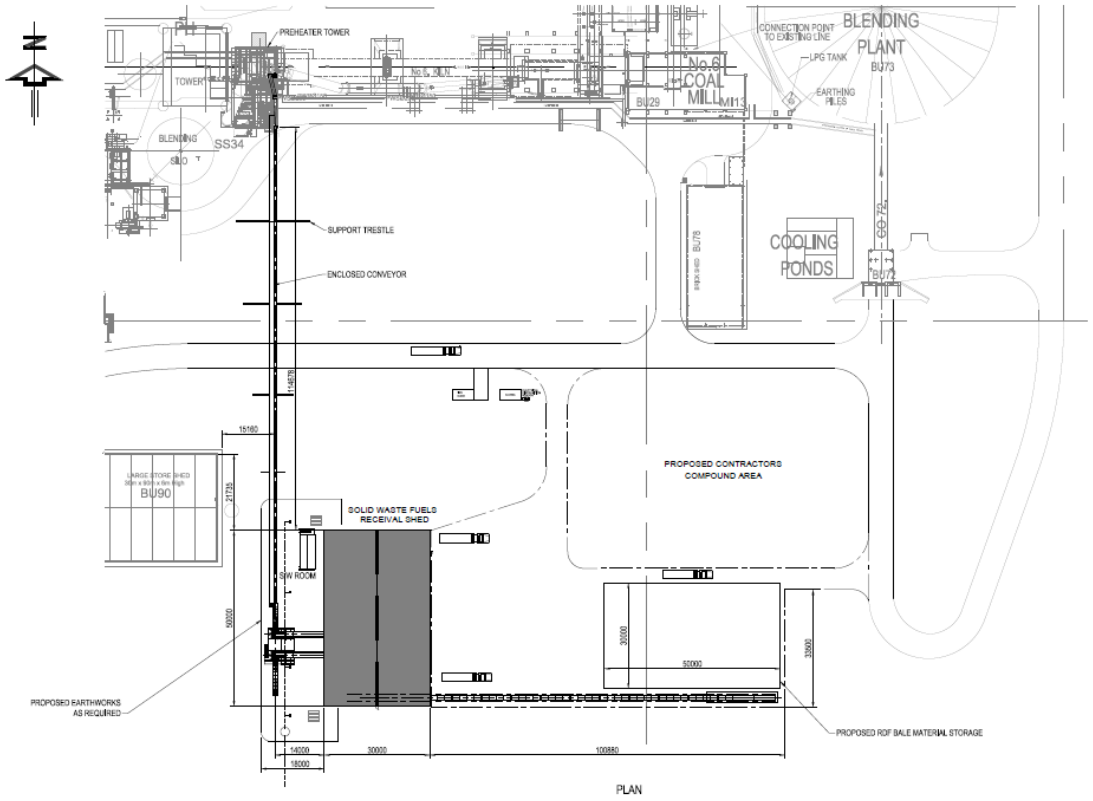


Figure 1 depicts the proposed layout and equipment required to store and feed the waste derived fuels proposed for Kiln 6. The storage and handling facility is designed to store and handle solid waste derived fuels such as waste tyres (AKF5), wood waste and RDF. The solid waste fuel storage, handling and feeding system comprises:

- a receival and storage building located on the southern side of the Kiln 6 pre-heater tower. The building will be 33m long, 50m wide and 13m high;
- a de-bailer and moving floor system at the back end of the storage shed;
- an enclosed conveyor from the storage building to the existing pre-calciner vessel located in the preheater tower;
- screw conveyor and air sealing device around the pre-calciner within the pre-heater tower; and
- a designated ground outdoor storage area for WDFs received in the form of covered (plastic wrapped) bails or within covered delivery vehicles.

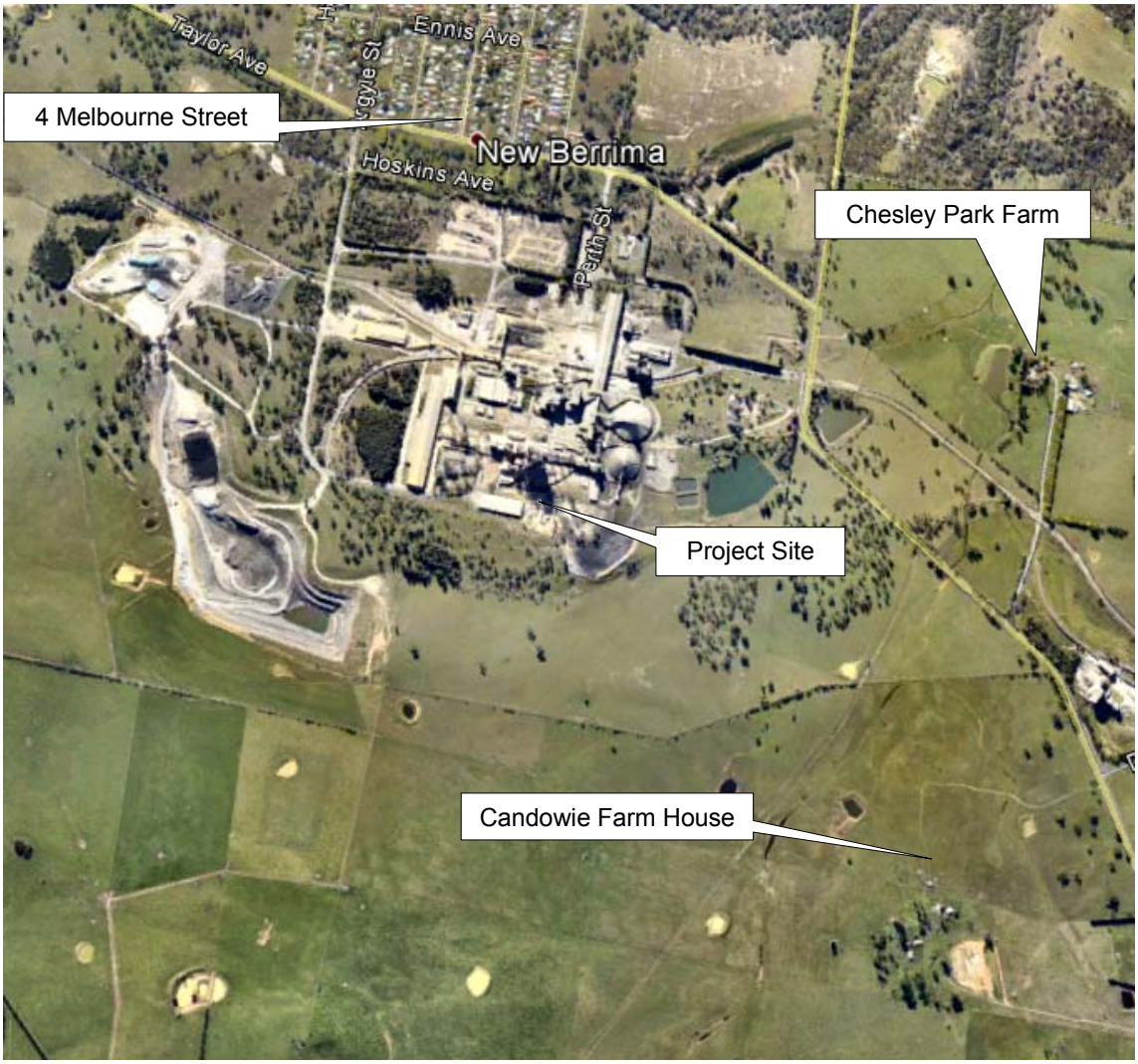
2.1 Noise Sensitive Receivers

The sensitive receiver locations surrounding the project site have been identified in **Table 1** and are presented in **Figure 2**.

Table 1 Sensitive Receiver Locations

Receiver ID	Location
R1	4 Melbourne Street
R2	Chesley Park Farm
R3	Candowrie Farm House

Figure 2 Sensitive Receiver Locations



3 EXISITNG PROJECT APPROVAL

3.1 Kiln 6 Consolidated Approval 2012

Condition 3 refers to noise limits applicable to Kiln 6.

Noise Impacts

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.

3.2 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 The Applicant shall design, construct, operate and maintain all new and upgraded components forming part of the cement works upgrade to ensure that for each receiver location listed in **Table 2** below, the noise level at each receiver location does not exceed the maximum allowable noise contribution limit at the receiver location specified.

Table 2 Maximum Allowable Noise Contribution Limit (dBA)

Location	Day $L_{Aeq(15minute)}$	Evening $L_{Aeq(15minute)}$	Night $L_{Aeq(15minute)}$
4 Melbourne Street	37	37	37
Chesley park Farm	30	30	30
Candowrie Farm House	37	37	37

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

Note: Noise contributions specified in **Table 2** are to be interpreted as contributions from the new and upgraded components forming part of cement works upgrade only and not as noise limits for the site as a whole.

3.4 The maximum allowable noise contributions identified in Condition 3.3 apply under all meteorological conditions, except:

a. during wind speeds greater than $3ms^{-1}$ measured at 10 metres above ground level; or

b. during temperature inversion conditions of greater than $3^{o}C$/ 100m and wind speeds of greater than $3ms^{-1}$ measured at 10 metres above ground.

3.5 For the purpose of assessment of noise contribution specified under Condition 3.3, noise from the cement works upgrade shall be:

a. measured at the most affected receptor on or within the receptor site boundary or at the most affected point within 30m of the dwelling (rural situations), where the dwelling is more than 30m from the property boundary; and

b. where applicable, subject to the modification factors provided in Section 4 of the *New South Wales Industrial Noise Policy* (EPA, 2000).

3.6 Notwithstanding Condition 3.5 of this consent, should direct measurement of noise from the site be impractical, the Applicant may employ an alternative noise assessment method deemed acceptable by the EPA (refer to Section 11 of the *New South Wales Industrial Noise Policy* (EPA, 2000)). Details of such an alternative noise assessment method accepted by the EPA shall be submitted to the Director-General prior to the implementation of the assessment method.

4 IMPACT ASSESSMENT PROCEDURES

4.1 Assessing Road Traffic Noise

4.1.1 Guideline Overview

For traffic operating on public roads, the NSW Government's *Road Noise Policy* (RNP) (DECCW, 2011) is appropriate for assessing potential road traffic noise impacts.

The RNP identifies strategies that address the issue of road traffic noise from:

- Existing roads;
- New road projects;
- Road redevelopment projects; and
- New traffic-generating developments.

The RNP noise criteria aim to protect amenity inside and immediately around permanent residences, schools, hospitals and other sensitive land uses, rather than at all points in a given locality, which would not be practical or possible. Although it is not mandatory to achieve the noise assessment criteria in the RNP, project proponents need to provide justification if it is not considered feasible or reasonable to achieve them.

The guideline recognises that there are generally more opportunities to minimise noise impacts from new roads and road corridors, especially those in greenfield locations, through judicious road design and land use planning. The scope to reduce noise impacts from existing roads and corridors is more limited.

4.1.2 Residential Land Uses

Taylor Avenue is considered to be a sub-arterial road. The RNP specifies this class of road as the following:

> *Sub-Arterial Road*
> *A road that collects local traffic leaving a locality and connects to another local road, freeway or arterial or sub-arterial road.*

The RNP describes a minor impact to be an increase of up to 2 dB, which is considered to be a barely perceptible change to the average person.

The RNP provides the following with regard to assessment of private haul roads:

> *Noise from vehicles travelling on private roads associated with an industrial activity, such as a mine or quarry, is to be assessed as an industrial noise source under the NSW Industrial Noise Policy. Further guidance on this approach is provided in the 'Application Notes' to the policy.*

4.2 Assessing Construction Noise

4.2.1 Noise Management Levels

The *Interim Construction Noise Guideline (ICNG) (DECC,2009)* contains procedures for management of noise in relation to construction type activities for residential and other sensitive receivers by defining Noise Management Levels (NMLs) and how they are applied. A summary of the derivation of NML's from the ICNG is contained in **Table 3** for residential receivers.

Table 3 Interim Construction Noise Guideline (Residences)

Time of day	Management level LAeq(15minute)	How to apply
Recommended standard hours Monday to Friday 7am to 6pm Saturday 8am to 1pm No work 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 LAeq (15 min) 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 dBA	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(A) above the noise affected level, the proponent should negotiate with the community.

The ICNG states that where construction works are planned to extend over more than two consecutive nights, the impact assessment should consider the maximum noise level from the proposed works. In addition to the NMLs, where construction would be required during the night-time period the potential for sleep disturbance to residential receivers should therefore be assessed.

The EPA's current approach to assessing potential sleep disturbance (*Application Notes to Industrial Noise Policy)* is to apply an initial screening criterion of background plus 15 dB and to undertake further analysis if the screening criterion cannot be achieved. The sleep disturbance screening criterion applies outside bedroom windows during the night-time period.

4.3 Assessing Construction Vibration

The effects of vibration in buildings can be divided into two main categories - those in which the occupants or users of the building are inconvenienced or possibly disturbed and those in which the integrity of the building or the structure itself may be prejudiced.

4.3.1 Human Comfort Vibration

The EPA's *Assessing Vibration: a technical guideline* (DEC 2006) provides guideline values for continuous, transient and intermittent events that are based on a Vibration Dose Value (VDV) rather than a continuous vibration level. The VDV is dependent upon the level and duration of the short-term vibration event, as well as the number of events occurring during the daytime or night-time period.

The VDVs recommended in the document for vibration of an intermittent nature (ie construction works where more than three distinct vibration events occur) are presented in **Table 4**.

Table 4 Acceptable Vibration Dose Values for Intermittent Vibration (m/s$^{1.75}$) (Assessing Vibration: a technical Guideline)

Location	Daytime[1]		Night-time[1]	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Critical Areas[2]	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	0.8	1.6	0.8	1.6

Note 1: Daytime is 7:00 am to 10:00 pm and night-time is 10:00 pm to 7:00 am.

Note 2: Examples includes hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas.

4.3.2 Structural Damage Vibration

Structural damage vibration limits are based on Australian Standard AS 2187: Part 2-2006 *Explosives - Storage and Use - Part 2: Use of Explosives* and British Standard BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2*. These standards provide frequency-dependent vibration limits related to cosmetic damage, noting that cosmetic damage is very minor in nature, is readily repairable and does not affect the structural integrity of the building. The recommended vibration limits from BS7385 for transient vibration for minimal risk of cosmetic damage to residential and industrial buildings are shown in **Table 5**.

Table 5 Transient Vibration Guide Values for Minimal Risk of Cosmetic Damage (BS 7385-2)

Line	Type of Building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures	50 mm/s at 4 Hz and above	

	Industrial and heavy commercial buildings		
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

4.3.3 Ground-borne (Regenerated) Noise

Ground-borne (or regenerated) construction noise can be present on construction projects where vibration from activities such as rock breaking, road heading, rotary cutting and rock drilling/sawing can be transmitted through the ground and into the habitable areas of nearby buildings. Ground-borne noise occurs when this vibration in the ground and/or building elements is regenerated as audible noise within areas of occupancy inside the building.

The NSW EPA's ICNG defines internal ground-borne noise goals for residential receivers of 40 dBA $L_{Aeq(15minute)}$ during the evening 6.00 pm to 10.00 pm and 35 dBA $L_{Aeq(15minute)}$ during the night-time (10.00 pm to 7.00 am). The goals are only applicable when ground-borne noise levels are higher than airborne noise levels.

5 PROJECT SPECIFIC NOISE LEVELS

5.1 Operational Noise Targets

The operational noise targets have been established from the existing noise limits stated in the development consent for the Kiln 6 upgrade project only. In order for the proposed modification to Kiln 6 to incorporate the Waste Derived Fuels modification, the noise targets have been established in order to have a minimal effect on the existing noise levels from the Kiln 6 project.

In order for the modifications to have a minimal impact on the total noise emissions from the operation of Kiln 6, the noise targets have been established to be a minimum of 6dB below the existing noise limits and are presented in **Table 6**.

Table 6 Operational Noise Targets

Location	Day $L_{Aeq(15minute)}$	Evening $L_{Aeq(15minute)}$	Night $L_{Aeq(15minute)}$
4 Melbourne Street	31	31	31
Chesley park Farm	24	24	24
Candowrie Farm House	31	31	31

Based on these noise targets, a maximum noise increase from the total operation of Kiln 6 will be less than 1 dB.

5.2 Road Traffic Noise Criteria

The RNP describes a minor impact to be an increase of up to 2 dB, which is considered to be barely perceptible to the average person. The operational noise assessment in this report considers whether the proposed modification has the potential to increase noise at any residential receiver by 2 dB or more.

5.3 Construction Noise Goals

As background noise data in the absence of the existing operations was not available, based on the typical nature of the area (and as a worst case scenario), a background noise level of 30 dBA has been assumed for the purpose of the construction noise assessment. The resulting construction Noise Management Levels are presented in **Table 7**.

Table 7 Construction Noise Goals

Receiver Area	Estimated Ambient Noise Levels			Noise Management Levels - NMLs (dBA)					
	Daytime[1]	Evening[1]	Night-time[1]	Standard Hours Daytime	Highly Noise Affected	Out of Hours Daytime	Out of Hours Evening	Out of Hours Night-time	Sleep Disturbance Screening Criterion
4 Melbourne Street	30[2]	30[2]	30[2]	40	75	35	35	35	45
Chesley Park Farm	30[2]	30[2]	30[2]	40	75	35	35	35	45
Candowrie Farm House	30[2]	30[2]	30[2]	40	75	35	35	35	45

Note 1: Standard hours are 7.00 am to 6.00 pm Monday to Friday, 8.00 am to 1.00 pm on Saturdays with no work on Sundays or Public Holidays. Evening is 6.00 pm to 10.00 pm. Night-time is 10.00 pm to 7.00 am Sundays to Saturday and 10.00 pm to 8.00 am on Sunday.

Note 2: A minimum background noise of 30 dBA has been assumed as per the NSW Industrial Noise Policy.

5.4 Vibration Goals

The relevant applicable human comfort and damage vibration criteria for the nearest residential and commercial receivers are presented in **Table 8** and **Table 9** respectively.

Table 8 Acceptable Vibration Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime		Night-time	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Residences	0.20	0.40	0.13	0.26

Source - Assessing Vibration: a technical guideline

Table 9 Transient Vibration Guide Values for Minimal Risk of Cosmetic Damage (BS 7385-2)

Type of Building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
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

6 OPERATIONAL NOISE ASSESSMENT

A computer model was developed in order to predict noise emissions from the operation of the Waste Derived Fuels Project which forms part of Kiln 6 operations. The noise modelling was undertaken using SoundPlan v7.1 software developed by Braunstein and Berndt Gmbh in Germany, using the Concawe algorithm for predicting noise. The model used terrain data extracted from Google earth.

Predictions of noise emission levels were modelled for calm meteorological conditions only.

6.1 Operational Noise Modelling Scenario

Noise levels from the additional infrastructure associated with the Waste Derived Fuels Project have been modelled for the scenarios summarised in **Table 10**.

Table 10 Operational Noise Modelling Scenarios

Plant and Equipment	Day	Evening	Night-time
Waste Derived Fuels Reception Shed			
Internal Conveyors	✓	✓	✓
Frontend Loader (FEL)	✓	✓	✓
Debaler Unit	✓	✓	✓
Road Truck	✓	✓	✓
External Plant and Equipment			
External Conveyors	✓	✓	✓
Hydraulic Power Packs	✓	✓	✓
Road Trucks (4 Movements)	✓	✓	-
Road Trucks (2 Movements)	-	-	✓
Conveyor Drive (located at WDFR Shed)	✓	✓	✓
Hoppers	✓	✓	✓
Fork Lift	✓	✓	✓

6.2 Sound Power Levels

Table 11 provides the relevant acoustically significant plant and equipment and associated sound power levels incorporated into the noise model.

Table 11 Sound Power Levels (SWLs)

Plant and Equipment	Sound Power Level (SWL) dB re 1pW
Waste Derived Fuels Reception Shed	
Internal Conveyors (per metre)	78 dBA

Front End Loader	108 dBA
Debaler Unit	100 dBA
Road Truck	102 dBA
External Plant and Equipment	
External Conveyors (per metre)	78 dBA
Road Trucks (per truck)	102 dBA
Conveyor Drive (1 unit)	102 dBA
Hoppers	90 dBA
Hydraulic Power Pack[1]	84 dBA
Fork Lift[2]	94 dBA

Note 1: Measurement of a similar Hydraulic Power Pack performed by Manufacture.
Note 2: Measurement of fork lift performed by Boral at Berrima.

6.3 Operational Noise Modelling Results

6.3.1 Assumptions

The following assumptions have been used in the noise modelling process.

- The Waste Derived Fuels Reception Shed will be constructed from corrugated steel (achieving a minimum Rw of 25).
- The opening for the internal Refuse Derive Fuel (RDF) Conveyor will be 2 metres by 2 metres and will remain open for all scenarios.
- A forklift will be operating intermittently between the RDF Bale Storage and the AF Reception Shed.
- Only one (1) RDF Reception Shed vehicle access door will be open when the FEL is operating.
- The external conveyor transferring material to the pre-heater tower will be enclosed on three sides (top and sides).
- The material will go straight into the enclosed surge bin within the pre-heater tower and is unlikely to have any noise impact.
- As the existing number of truck movements per 15 minute period (4 movements) will remain the same after the modification, the trucks are considered as contributors to the existing noise limits and consequently will not cause an increased impact on the surrounding residents. Accordingly, the noise levels below do not include contribution from truck movements.

Table 12 presents the predicted noise emissions from the operation of the additional infrastructure with no mitigation measures in place.

Table 12 Predicted Operational Noise Levels – One Vehicle Access Door Open

Location	Predicted Noise Level ($L_{Aeq(15minute)}$)			Noise Target
	Day	Evening	Night	
4 Melbourne Street	31 dBA	31 dBA	31 dBA	31 dBA
Chesley Park Farm	24 dBA	24 dBA	24 dBA	24 dBA
Candowrie Farm House	23 dBA	23 dBA	23 dBA	31 dBA

Table 13 Predicted Operation Noise Levels – All Vehicle Access Doors Closed

Location	Predicted Noise Level ($L_{Aeq(15minute)}$)			Noise Target
	Day	Evening	Night	
4 Melbourne Street	31 dBA	31 dBA	31 dBA	31 dBA
Chesley Park Farm	23 dBA	23 dBA	23 dBA	24 dBA
Candowrie Farm House	21 dBA	21 dBA	21 dBA	31 dBA

6.4 Discussion

Based on the results of the noise modelling, the predicted noise levels at the surrounding receiver locations are expected to achieve the noise targets established.

The predicted noise level at 4 Melbourne Street is expected to be lower than predicted, as the noise model does not consider any barrier effect that the pre-heater tower may have on the conveyor noise emissions.

Truck movements were excluded from the calculation as the total truck movements from the existing operation (243 during the day, 74 during the night or 4 movements per 15 minute period during the day and 2 movements during the night-time) are the same as the proposed operation (223 during the day, 74 during the night or 4 movements per 15 minute period during the day and 2 movements during the night-time).

The Sound Power Levels reported in **Table 11** must be achieved in order for the noise levels at the receiver locations to meet the construction noise management levels nominated.

The reverberant sound pressure level within the Waste Derived Fuel Receiving Shed has been calculated to be 86 dBA based on the SWL's provided in **Table 11**.

7 ROAD TRAFFIC NOISE ASSESSMENT

As a general rule, traffic noise associated with the proposed modification would not increase the existing traffic noise levels by more than 2 dBA as long as the increase in light and heavy vehicles (HVs) movements for the proposed modification is no greater than 60%.

Based on the data provide by Traffix Pty Ltd, the expected increase in project related vehicles is expected to be 7%, as detailed in **Table 14**.

Table 14 Project Traffic Increase

Period	Existing HV Traffic	Proposed HVs Increase	Total Proposed	Increase %

Daytime	223	20	243	9%
Night-time	74	0	74	0%

Based on this increase, the overall noise level is expected to increase by less than 2 dB and therefore no further assessment is required.

8 CONSTRUCTION NOISE ASSESSMENT

8.1 Construction Scenarios and Associated Equipment

The construction scenarios and associated equipment presented in **Table 15** are likely to be required during the construction phase of the project. **Table 15** also includes typical L_{Amax} SWLs associated with each item of equipment.

Table 15 Construction Scenarios and Equipment

Construction Scenario	Plant and Equipment	Maximum Sound Power Level (L_{Aeq})	
		Individual Item	Likely Maximum for Activity
S1 Compound Establishment	Light Vehicle	98 dBA	105 dBA
	Trucks (12-15 tonne)	103 dBA	
	Hand Tools	96 dBA	
S2 Earthworks	Excavator (Ripping)*	105 dBA	114 dBA
	Excavator (20 Tonne)	99 dBA	
	Trucks (12-15 tonne)	103 dBA	
	Dozer	110 dBA	
	Grader	108 dBA	
S3 Concrete Foundations	Concrete Truck/ Agitator (2)	106 dBA[2]	106 dBA
	Hand Tools (Electric)	96 dBA	
	Concrete Pump	106 dBA	
S4 Crane Works	Mobile Crane	102 dBA[2]	102 dBA
	Hand tools (electric)	96 dBA	
S5 Truck Movements	Trucks (12-15 tonne)	103 dBA	103 dBA

Note 1: * denotes annoying items of equipment, as defined in the ICNG, and as such includes a +5dBA penalty to predictions.

Note 2: Overall Sound Power Level assumes a maximum of 7.5 minutes operating time in any 15-minute period.

8.2 Predicted Construction Noise Levels

The construction activities are proposed to occur during standard construction hours (7.00 am and 6.00 pm Monday to Friday and 8.00 am to 1.00 pm on Saturday).

Based on the scenarios and SWL's outlined in **Table 15**, construction noise levels have been predicted at the nearest receiver locations. The resultant daytime, evening and night-time $L_{Aeq(15minute)}$ construction noise predictions are presented in **Table 16** for the various activities together with the relevant noise management levels.

In practice, the construction noise levels will depend on the number of plant items and equipment operating at any one time and their location relative to the receiver of interest. Noise levels will vary due to the movement of plant and equipment about the worksites and the concurrent operation of plant. In some cases, reductions in noise levels will occur when plant are located in cuttings or behind embankments, buildings or other items of equipment.

Notwithstanding, the predictions in **Table 16** are representative of the worst-case scenario with all plant and equipment likely to operate simultaneously at the point of works closest to the affected sensitive receiver.

Table 16 Summary of Construction Noise Predictions

Scenario	Receiver ID	Noise Level - $L_{Aeq(15minute)}$ dBA			
		Worst Case Predicted	Assumed Rating Background Level (RBL)	Noise Management Level	Exceedance
			Standard Daytime Hours	Standard Daytime Hours	Standard Daytime Hours
S1 Compound Establishment	R1	26	30	40	-
	R2	25	30	40	-
	R3	25	30	40	-
S2 Earthworks	R1	35	30	40	-
	R2	34	30	40	-
	R3	34	30	40	-
S3 Concrete Works	R1	27	30	40	-
	R2	26	30	40	-
	R3	26	30	40	-
S4 Crane Works	R1	39	30	40	-
	R2	22	30	40	-
	R3	21	30	40	-
S5 Traffic Movements	R1	35	30	40	-
	R2	35	30	40	-
	R3	35	30	40	-

8.3 Discussion

The predicted construction noise levels at the residential receivers surrounding the project site are not expected to exceed the daytime (standard construction hours) $L_{Aeq(15minute)}$ noise management level of 40 dBA. The reported construction noise level predictions are representative of the worst case scenarios with the loudest plant and equipment operating simultaneously at the point of works closest to the affected receiver.

Consequently, no residential receivers will be highly noise affected as defined by the *Interim Construction Noise Guideline* (ICNG).

8.4 Mitigation Measures

The ICNG describes strategies for construction noise mitigation and control that are applicable to this project. Construction noise control options include time restrictions, level restrictions and other feasible and reasonable mitigation measures.

Specific mitigation measures which are considered appropriate for these works are:

- Scheduling of the higher noise management level exceedance activities to be undertaken during less noise-sensitive periods, where possible.
- Avoiding the coincidence of noisy plant working simultaneously.
- Briefing of the work team in order to create awareness of the locality of sensitive receivers and the importance of minimising noise emissions.
- Using of less noise intensive equipment, where reasonable and feasible.
- Use of non-tonal reversing alarms fitted to all construction vehicles.
- Conducting loading and unloading away from sensitive receivers, where practical.
- Liaising with affected residents and informing them when noisy works will occur and what is being done to minimise the noise.
- Using localised acoustic hoarding around all significantly noise generating items of plant. This would be expected to provide between 5 dB and 10 dB of additional noise attenuation as long as the line-of-sight between the receivers and construction equipment is broken. Barriers are most affective when located either close to the noise source or the receiver.

8.5 Ground-Borne (Regenerated) Noise

The ground-borne noise goals are only applicable when ground-borne noise levels are higher than airborne noise levels. The airborne noise is expected to dominate in the case of the works assessed and further consideration of ground-borne noise is therefore not warranted.

9 VIBRATION ASSESSMENT

Energy from construction equipment is transmitted through the ground and transformed into vibration, the amplitude of which attenuates with distance. The magnitude and attenuation of ground vibration is dependent on the following:

- The efficiency of the energy transfer mechanism of the equipment (i.e. impulsive; reciprocating, rolling or rotating equipment).
- The frequency content of the vibration source.
- The stiffness of the ground.
- The type of wave transmitted through the ground (surface or body).
- The ground type and topography.

Due to the above factors, there is an inherent variability in ground vibration predictions without site-specific measurement data.

Indicative safe working distances to typical items of vibration intensive plant are listed in **Table 17** for both structural damage and human response.

Table 17 Indicative Working Distances for Vibration Intensive Plant

Plant Item	Rating/Description	Indicative Working Distance	
		Structural Damage	Human Response[1]
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	10 m	15 m
	< 100 kN (Typically 2-4 tonnes)	15 m	20 m
	< 200 kN (Typically 4-6 tonnes)	25 m	40 m
	< 300 kN (Typically 7-13 tonnes)	30 m	60 m

Plant Item	Rating/Description	Indicative Working Distance	
		Structural Damage	Human Response[1]
	> 300 kN (Typically 13-18 tonnes)	40 m	90 m
	> 300 kN (> 18 tonnes)	50 m	120 m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	5 m	10 m
Medium Hydraulic Hammer	(900 kg - 12 to 18t excavator)	15 m	25 m
Large Hydraulic Hammer	(1600 kg - 18 to 34t excavator)	40 m	75 m
Vibratory Pile Driver	Sheet piles	8 m	20 m
Pile Boring	≤ 800 mm	4 m	8 m
Jackhammer	Hand held	2 m	Avoid contact with structure

Note 1: The working distances for Human Response assume that the source of the vibration is continuous throughout the daytime period. Higher levels of vibration are acceptable when the vibration levels are intermittent or impulsive. The safe working distances are therefore considered to be conservative and it is likely that the safe working distances corresponding to a "low probability of adverse comment" would be lower than indicated.

For the construction scenarios presented in **Table 15**, there are no proposed plant and equipment items with the potential to generate significant levels of vibration that would have any effect on the surrounding residences and therefore no further assessment has been conducted.

10 CONCLUSION

SLR has undertaken an assessment of potential noise and vibration impacts associated with the operation and construction of the Berrima Cement Modification No. 9 - Waste Derived Fuels. The assessment of the proposed operation is expected to achieve the nominated operational noise targets for the modification and consequently do not have a significant impact on the overall noise emissions.