Project No: 181714

Noise and Vibration Impact Assessment
Proposed Bark/Timber Processing Facility
Oberon, NSW

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EXECUTIVE SUMMARY

Spectrum Acoustics has prepared this report for Jackson Environment and Planning on behalf of Borg Plantations Pty Ltd (hereafter referred to as the Proponent) to prepare a noise and vibration impact assessment (NVIA) for the operation of the proposed Bark/Timber Processing and Landscape Supplies Production Facility (the Facility) at 26 Endeavour St, Oberon, NSW.

The objective of the NIA was to assess the potential noise and vibration impacts associated with construction, operation and transport activity associated with the Facility.

Noise criteria were established in accordance with procedures in the “Noise Policy for Industry”, “Interim Construction Noise Guideline” and “Assessing Vibration: a technical guideline”.

Noise levels associated with the operation of the Facility were theoretically determined by noise modelling using ENM noise modelling software for applicable atmospheric conditions. Noise levels associated with construction noise were theoretically determined by direct calculation.

Operational noise levels due to emissions from the Facility were predicted to comply with the project noise trigger levels at all receivers. The modelling of operational noise included the effects of 10m high and 2.5m high acoustic barriers around parts of the site boundary. No other noise control is recommended.

Noise levels associated with the construction of the Facility were found to comply with the construction noise management levels at all receivers. No specific noise mitigation measures for construction noise have been identified other than the general construction noise management practices (which are detailed in the report).

Noise from traffic generated by the operational and construction phases of the Facility will not exceed the relevant traffic noise criteria.

The predicted vibration levels associated with the construction of the Facility were found to comply with the adopted human comfort criteria and be significantly lower than any building damage criteria.

1.0 - INTRODUCTION

This report presents the results, findings and recommendations arising from a noise and vibration impact assessment (NVIA) of the operation of the Borg Plantations Pty Ltd (Borg) proposed Bark/Timber Processing and Landscape Supplies Production Facility (the Facility) at 26 Endeavour St, Oberon (Lot 33 and part Lot 34, DP1228591) as shown in **Figure 1**.

The proposed Facility is to process and recycle up to 99,000 tonnes per annum of pine bark residuals and sawdust, including pallets. The site may also accept timbers from other sources.

The site is on land that was previously used for agricultural purposes but is currently unused. It is well cleared and has no significant vegetation.

Figure 1 – Site Location

2.0 – BACKGROUND TO THE PROPOSAL

The proposal is to construct a bark/timber processing facility, including an office, weighbridge, wheel wash, waste tipping and storage areas, including processing and product storage areas. The development will also involve construction of a hardstand, roads, drainage infrastructure,

storm water treatment infrastructure, landscaping and noise attenuation mounds/barriers. Car parking will also be established as part of the development.

The project has been classified as a Designated Development. The current assessment is, therefore, to form part of an Environmental Impact Statement (EIS) which is required as part of the development application and planning approval for the development. The planning consent authority for the development will be the Western Joint Regional Planning Panel.

It is proposed that the facility will process and recycle up to 99,000 tonnes per annum of pine bark residuals and sawdust along with pallets. The site may also accept timbers from other sources.

The site is currently unoccupied. A new site entrance and driveway will be developed, with sufficient width to accommodate the largest expected vehicle (23m B-Double truck) and turning path.

A weighbridge and site office will be installed near site entry, and all non-staff vehicles entering the site will be required to enter the facility via the weighbridge. Parking will also be provided near the entrance to the site. A wheel wash will be installed at the entrance to the site to prevent sediment from leaving the facility.

An internal loop access roadway will be developed to enable vehicles to enter and exit the site in a forward direction. Loading and unloading areas will be separated and clearly allocated to minimise vehicle conflicts. Concrete bays will be used for flexible storage of material waiting to be processed and processed product. A separate waste tipping bay for pallets and timber waste only will be constructed, where incoming loads will be inspected for contamination (e.g. treated pallets and painted wood).

Site feedstocks will include bark residuals and sawdust, along with pallets. Pallets and timbers will also be trucked via backloading to Oberon from Borg's other sites for recycling. Delivery vehicles will enter the facility over the weighbridge. Pallets and timbers will be tipped into a dedicated waste tipping and inspection area, where treated timbers and manufactured timbers (e.g. MDF) will be removed and disposed lawfully off-site. Any other contaminants in loads will be removed.

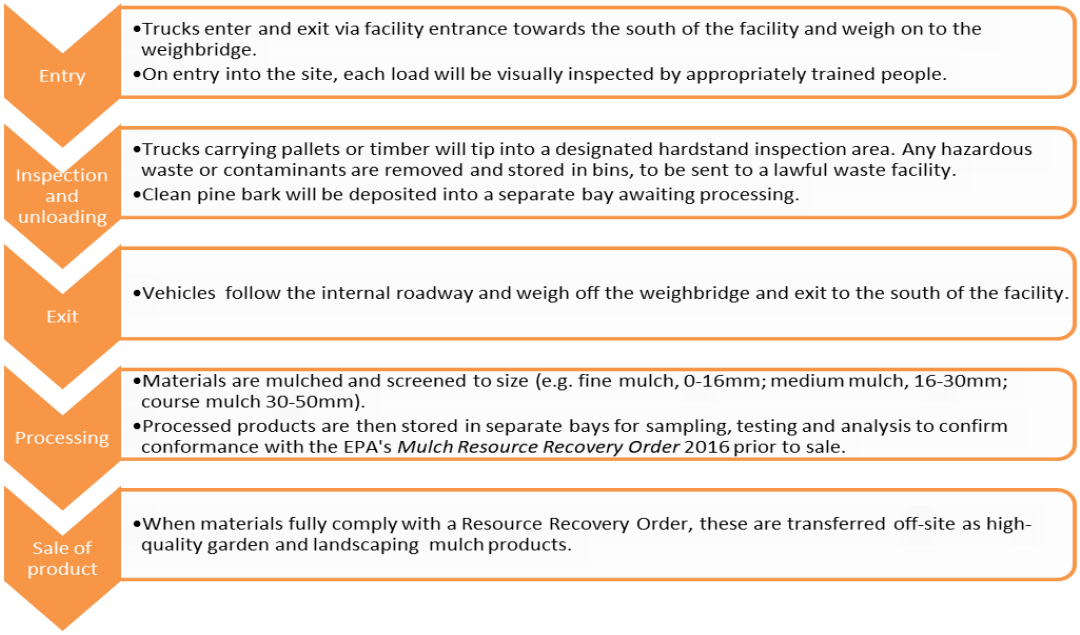
Incoming loads of bark from pine log processing in the MDF manufacturing facility will bypass the dedicated waste tipping and inspection area and be stored separately in a large concrete block storage bay, awaiting processing.

Processing of feedstock is expected to include mulching via grinders and shredders, with screening by a trommel for sizing processed material. No composting will take place on site, and products will be transported from the site shortly after processing.

Processed landscaping materials will be stored in dedicated concrete block bays.

The Facility is proposed to operate from 7am to 6pm, Monday to Friday, and 8am to 1pm on Saturdays. The site will be closed on Sundays and public holidays.

A schematic process flow chart for the operation of the Facility is shown below.



3.0 STUDY REQUIREMENTS

The purpose of this report is to provide an assessment of the potential for adverse noise impacts that may arise due to the construction and operations of the Project. The assessment presented in this report addresses planning and regulatory agency requirements, as set out below.

3.1 Secretary's Environmental Assessment Requirements

In preparing this NVIA, the Secretary's Environmental Assessment Requirements issued for the Project in July 2018 have been addressed. The key matters raised for consideration in this NVIA are outlined in **Table 1** along with a reference as to where the requirements are addressed in the report.

TABLE 1 Secretary's Environmental Assessment Requirements (SEAR No. 1238)	
General Requirement	Section
A description of all potential noise and vibration sources during construction and operation, including road traffic noise.	6.1, 6.3, 6.4, 6.5
A noise and vibration assessment in accordance with the relevant Environment Protection Authority guidelines.	6
A description and appraisal of noise and vibration mitigation, management and monitoring measures.	6.2, 6.4, 7, 8

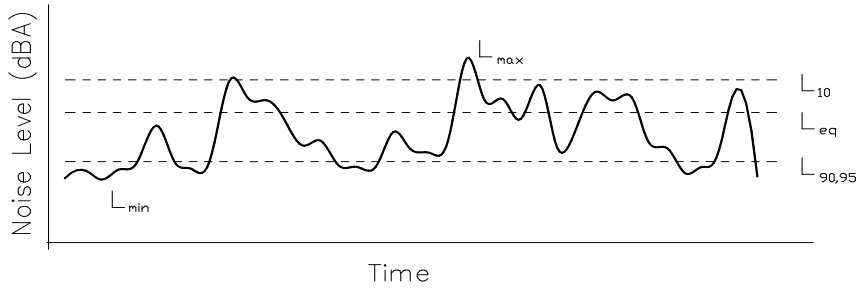
3.2 NSW Environmental Protection Authority

This NVIA has been prepared in general accordance with the NSW EPA document Noise Policy for Industry (NPI) and the specific requirements outlined in **Table 2** along with a reference as to where the requirements are addressed in the report.

TABLE 2 NSW EPA Agency Comments for Noise (SEAR No. 1238)	
General Requirement	Section
Construction noise associated with the proposed development should be assessed using the *Interim Construction Noise Guideline* (DECC, 2009).	5.3, 6.3
Operational noise from all industrial activities to be undertaken on the premises should be assessed using the guidelines contained in the *Noise Policy for Industry* (EPA, 2017). This assessment should be undertaken for all proposed operational times (i.e. day, evening and night).	5.1, 6.1
Noise on public roads from increased road traffic generated by land use developments should be assessed using the guidelines contained in the *NSW Road Noise Policy* (DECCW, 2011).	5.5, 6.5
Noise from new or upgraded public roads should be assessed using the *NSW Road Noise Policy*(DECCW, 2011).	n/a
Vibration from all activities (including construction and operation) to be undertaken on the premises should be assessed using the guidelines contained in the *Assessing Vibration: a technical guideline* (DEC, 2006).	5.4, 6.4

4.0 - TERMS AND DEFINITIONS

Table 3 contains the definitions of commonly used acoustical terms and is presented as an aid to understanding this report.

TABLE 3 DEFINITION OF ACOUSTICAL TERMS	
Term	Definition
dB(A)	The quantitative measure of sound heard by the human ear, measured by the A-Scale Weighting Network of a sound level meter expressed in decibels (dB).
SPL or Lp	Sound Pressure Level. The incremental variation of sound pressure above and below atmospheric pressure and expressed in decibels. The human ear responds to pressure fluctuations, resulting in sound being heard.
STL	Sound Transmission Loss. The ability of a partition to attenuate sound, in dB.
SWL or Lw	Sound Power Level radiated by a noise source per unit time re 1pW.
Leq	Equivalent Continuous Noise Level - taking into account the fluctuations of noise over time. The time-varying level is computed to give an equivalent dB(A) level that is equal to the energy content and time period.
L1	Average Peak Noise Level - the level exceeded for 1% of the monitoring period.
L10	Average Maximum Noise Level - the level exceeded for 10% of the monitoring period.
L90	Average Minimum Noise Level - the level exceeded for 90% of the monitoring period and recognised as the Background Noise Level. In this instance, the L90 percentile level is representative of the noise level generated by the surrounds of the residential area.
RBL	Rating Background Level (RBL) + 5dB. RBL is the median value of each ABL (Assessment Background Level) over the entire monitoring period. The ABL is a single figure representing the "L_{90} of the $L_{90's}$" for each separate day of the monitoring period.
	

5.0 – NOISE ASSESSMENT CRITERIA

5.1 Operational Noise

The approval and control of noise emissions from commercial and industrial premises in NSW is usually based on procedures and criteria detailed in the NPI.

The NPI describes intrusive and amenity criteria applicable to potential impacts at residences as a result of industrial noise. These noise criteria depend on the existing background noise level at potentially affected residential receiver areas.

The proposed facility will be located within the Oberon Timber Complex (OTC) which is in the Oberon Industrial Area. The OTC is a collection of four individual timber processing facilities. The acoustic environment of the residential areas in and around Oberon is significantly influenced by noise emissions from the OTC.

Borgs currently operates an MDF manufacturing facility in the OTC at a location nearby to the site of the current assessment. The MDF facility operates in accordance with Environment Protection licence (EPL 3035) which contains noise limits as follows;

L4 Noise Limits

L4.1 Noise from the premises must not exceed

a) 55 dB(A) Leq (15 min) during the day (7am to 6pm); and
b) 50 dB(A) Leq (15 min) during the evening (6pm to 10pm); and
c) At all other times 45 dB(A) Leq (15 min), except as expressly provided by this licence.

To quantify the existing acoustic environment of the area unattended noise logging was undertaken in October 2018.

All logging measurements were done in accordance with relevant OEH guidelines and AS 1055-1997 “Acoustics – Description and Measurement of Environmental Noise”. The noise loggers used comply with the requirements of AS 1259.2-1990 “Acoustics – Sound Level Meters”, and had current National Association of Testing Authorities (NATA) calibration certification.

The loggers were programmed to continuously register environmental noise levels over the 15 minute intervals, with internal software calculating and storing Ln percentile noise levels for each sampling period.

The acoustic environment of the logger locations would have been influenced by noise from the existing industrial and commercial activity in the OTC and the Oberon Industrial Area.

Logger 1 was located at the residence at number 127 Hazelgrove Road, to the north east of the site (as shown in **Figure 2**). The residences in this area are the closest to the site. The logger was in place between 17 and 25 October, 2018. The relevant measured noise levels from Logger 1 are detailed in **Table 4** and shown graphically in Appendix I.

TABLE 4 MEASURED AMBIENT NOISE LEVELS dB(A) LOGGER 1 – HAZELGROVE RD		
Period	L90	Leq (15 min)
Day	35	52
Evening	31	43
Night	30	44

The results in Table 4 indicate that the acoustic environment of the residences in the Hazelgrove Road area is indicative of a rural residential area with low noise levels at night.

Logger 2 was located in the front yard of the residence at number 3 Stevenson Close to the south of the site (see Figure 2) for the period from 17 to 25 October, 2018. The relevant measured noise levels from Logger 2 are shown in **Table 5** and graphically in Appendix I.

Figure 2 – Noise Logging Locations

TABLE 5 MEASURED AMBIENT NOISE LEVELS dB(A) LOGGER 2 – STEVENSON CLOSE		
Period	L90	Leq (15 min)
Day	40	60
Evening	42	57
Night	41	54

The results in Table 5 show that the noise levels at the logger location were relatively constant throughout the day, evening and night time

periods. This is consistent with observations made in the area which indicated that the acoustic environment is significantly influenced by noise from all of the existing industries in the OTC and Industrial Area.

In setting noise goals for a particular project the NPI considers both Amenity and Intrusiveness criteria. The former is set to limit continuing increase in noise from industry, whilst the latter is set to minimise the intrusive impact of a particular noise source.

Amenity criteria are dependent upon the nature of the receiver area and the existing level of industrial noise.

Residential receivers in the Hazelgrove Road vicinity would be considered "suburban" as per the definitions in the NPI and shown below (extract from Table 2.3 of the NPI).

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 most potentially affected receivers to the south of the site, in Oberon, would be considered "urban" as per the definitions in the NPI and shown below (extract from Table 2.3 of the NPI).

Urban *– an area with an acoustical environment that:*

- *is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable, mostly traffic and/or industrial related sound sources,*
- *has through-traffic with characteristically heavy and continuous traffic flows during peak periods,*
- *is near commercial districts or industrial districts, or*
- *has any combination of the above.*

The project amenity noise level (as an Leq (15 min)) for an industrial development is equal to the recommended amenity noise level (from Table 2.2 in the NPI, and detailed above) minus 2 dB(A) (as detailed in the notes to **Table 6**, below).

The intrusiveness criteria are based on the Rating Background Level (RBL) for the time period, plus 5 dB(A). The RBL (L90) is defined as the overall single figure background level representing each assessment period.

The project noise trigger level (criterion) is the lower of the intrusiveness and amenity noise levels as specified in Table 6 for each

receiver area. As the facility will only operate during the day, only day time criteria have been determined.

TABLE 6
NOISE CRITERIA

Location	Criterion	Day (7am-6pm)
Hazelgrove Rd	Intrusiveness dB(A),Leq(15-min.)[1]	40
	Amenity dB(A),Leq(15 min)[2]	53
	Project Noise Trigger Level	**40 (15 min.)**
Oberon	Intrusiveness dB(A),Leq(15-min.)[1]	45
	Amenity dB(A),Leq(15 min)[3]	58
	Project Noise Trigger Level	**47 (15 min.)**

1 Rating Background Level (RBL) + 5dB.
2. Project amenity noise level (ANL) is suburban ANL (NPI Table 2.1) minus 5 dB(A) plus 3 dB(A) to convert from a period level to a 15-minute level.
3. Project amenity noise level (ANL) is urban ANL (NPI Table 2.1) minus 5 dB(A) plus 3 dB(A) to convert from a period level to a 15-minute level.

The NPI contains noise criteria for other potentially sensitive receivers which are based on absolute levels and do not relate to the existing ambient noise levels. These criteria are as;

- School classroom (internal) **35 dB(A) noisiest 1 hour**,
- Caravan Park (permanent resident) **60 dB(A) Leq (15 min).** This being 5dB above the recommended amenity criterion for the equivalent residential receiver,
- Industrial Premises **70 dB(A) Leq** for the period "when in use".

5.2 Sleep Disturbance

As the facility will not operate between 10pm and 7am, the potential for sleep disturbance need not be assessed as per procedures in the NPI.

5.3 Construction Noise

The assessment of potential construction noise impacts is undertaken in accordance with the *Interim Construction Noise Guideline* (ICNG, 2009) and *Assessing Vibration: A Technical Guideline* (AVTG, 2006). These guidelines are non-mandatory but are usually referred to by local councils and the NSW Department of Planning and Infrastructure (DP&I) when construction/demolition works require development approval.

The criteria in the ICNG cover all activities and machinery associated with construction on the site including, but not limited to, site preparation, excavation work and erection of buildings and related infrastructure. It is designed to ensure noise emissions resulting from

the construction are maintained to minimise potential impacts to nearby receivers.

5.3.1 Interim Construction Noise Guideline (ICNG)

Section 1.5 of the ICNG outlines the steps for management of construction noise impacts as follows:

1. **identify sensitive land uses** that may be affected.
2. **identify hours** for the proposed construction works.
3. **identify impacts** at sensitive land uses.
4. **select and apply the best work practices** to minimise noise impacts.

Each of the above four points is assessed in detail in the following sections.

5.3.2 Surrounding Land Uses

The subject site is within a commercial/industrial zone and the acoustic environment is influenced by noise from industrial and commercial sources, as confirmed by the background noise monitoring.

Reference and scaling from Google Earth indicates that the nearest residential receivers to the site are approximately 600m to the north east of the closest boundary, 750m to the south east of the closest boundary and 950m south-south west of the closest boundary.

Oberon High School is about 900m from the closest boundary (to the south).

Potential noise impacts at these receivers will require assessment.

5.3.3 Operating Hours

The recommended standard hours for construction works are shown in **Table 7** which is a reproduction of Table 1, section 2.2 of the ICNG.

TABLE 7
STANDARD CONSTRUCTION HOURS

Work Type	Recommended standard hours of work[1]
Normal construction	Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays
Blasting	Monday to Friday 9 am to 5 pm Saturday 9 am to 1 pm No blasting on Sundays or public holidays

1 The relevant authority (consent, determining or regulatory) may impose more or less stringent construction hours

Construction work outside the hours in Table 7 is normally only permissible for delivery of oversized structures, emergency works,

public infrastructure works that are supported by the affected community or where the proponent demonstrates and justifies a need to work outside the recommended standard hours (ICNG, p9).

5.3.4 Impacts at Sensitive Land Uses

The ICNG provides two assessment methodologies for construction noise impacts: a 'qualitative' assessment where works occur for less than three weeks and a 'quantitative' assessment for works of longer duration. As construction works on the site will take longer than three weeks, the quantitative methodology is applicable.

Noise Management Levels

Table 8 sets out noise management levels for construction works, (as reproduced from section 2.2 of the ICNG).

TABLE 8
NOISE AT RESIDENCES USING QUANTITATIVE ASSESSMENT

Time of day	Management level Leq (15 min)	How to apply
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 $L_{Aeq\ (15\ min)}$ 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 level and duration, as well as contact details.
	Highly noise affected 75 dB(A)	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. • For guidance on negotiating agreements see section 7.2.2.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

The day time ambient Leq and background noise level, obtained from the unattended logging are summarised in **Table 9**.

TABLE 9 MEASURED AMBIENT NOISE LEVELS dB(A)				
Period	Hazelgrove Road		Oberon	
	L90	Leq (15 min)	L90	Leq (15 min)
Day	35	52	40	60

Based on the daytime background noise levels (RBL), the construction noise management levels are;

- **45 dB(A),Leq (15 min)**, at residential receivers in Hazelgrove Rd, and
- **50 dB(A),Leq (15 min)**, at residential receivers in Oberon.

The ICNG also details that due to the broad range of sensitivities that commercial or industrial land can have to noise from construction, the process of defining management levels is separated into various categories as shown below. The external noise levels should be assessed at the most-affected occupied point of the premises:

- industrial premises: external - **75 dB(A) Leq (15 min)**
- offices, retail outlets: external - **70 dB(A) Leq (15 min)**

For a school the construction noise management levels are;

- classrooms at schools: internal – **45 dB(A) Leq (15 min)**

5.4 Assessing Vibration: A Technical Guideline (AVTG)

The AVTG recommends goals for assessing human response and potential disturbance to the occupants of buildings. **Table 10** presents a summary of acceptable levels (rms) relevant to third-octave frequency bands adjusted by multiplying factors (in brackets) for residential receptors referenced to human response (as sourced from British Standard BS 6472-1992, Figure B1.4).

TABLE 10 ACCEPTABLE VIBRATION LEVELS FOR ASSESSMENT OF HUMAN COMFORT				
Frequency (Hz)	Vibration level, mm/s			
	Continuous Vibration		Intermittent Vibration	
	Day (2)	Night (1.4)	Day (60)	Night (20)
1	3.2	2.2	95	31
1.25	2.3	1.6	68	22
1.6	1.6	1.1	47	15
2	1.1	0.8	33	11
2.5	0.8	0.6	24	8.0
3.15	0.6	0.4	17	5.8
4	0.4	0.3	19	4.0
5	0.3	0.2	9.5	3.2
6.6	0.3	0.2	7.6	2.5
8	0.2	0.1	6.0	2.0
10	0.2	0.1	6.0	2.0
12.5	0.2	0.1	6.0	2.0
16	0.2	0.1	6.0	2.0
20	0.2	0.1	6.0	2.0
25	0.2	0.1	6.0	2.0
31.5	0.2	0.1	6.0	2.0
40	0.2	0.1	6.0	2.0
50	0.2	0.1	6.0	2.0
63	0.2	0.1	6.0	2.0
80	0.2	0.1	6.0	2.0

Table 2.1 of AVTG defines vibration from construction works or passing heavy vehicles as an intermittent source, so the day time values in Table 8 for intermittent vibration will be adopted as a worst case for potential construction vibration impacts. For a comparison of vibration levels in terms of human response, **Table 11** presents a summary of vibration levels and likely perception.

TABLE 11 HUMAN PERCEPTION of VIBRATION	
Vibration Levels, mm/s	Likely Perception
0.15	Perception threshold
0.35	Barely noticeable
1.0	Noticeable
2.2	Easily noticeable
6.0	Strongly noticeable
14.0	Very strongly noticeable
Ref: German Standard DIN 4150 (1986)	

5.5 Traffic Noise

In NSW, noise from vehicle movements associated with an industrial source is assessed in terms of the NPI if the vehicles are not on a public road. If the vehicles are on a public road, the NSW Road Noise Policy (RNP) apply. Noise from traffic movements associated with the

proposal must, therefore, be assessed against the project specific noise goals of the NPI when on site and also the criteria in the RNP, when on public roads.

For vehicles travelling on public roads, the RNP recommends various criteria for different road developments and uses. Based on definitions in the RNP, Maher Drive would be classified as a sub-arterial road due to its function serving an industrial zoning. Albion Road would also be classified as a sub arterial road.

An extract from Table 3 in the RNP relating to land use developments with the potential to create traffic on sub arterial roads is shown in **Table 12**.

TABLE 12
TRAFFIC NOISE OBJECTIVE

Situation	Recommended Criteria	
	Day - (7am - 10pm)	Night (10pm – 7am)
3. Existing residences affected by **additional traffic** on existing freeways/arterial/sub-arterial roads generated by land use developments	60 Leq (15hr)	55 Leq (9hr)

The RNP also advises that, *for existing residences and other sensitive land uses affected by **additional traffic on existing roads generated by land use developments**, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion."*

6.0 - NOISE ASSESSMENT

6.1 Site Operations and Noise Levels

As described above the site is proposed to operate between 7am and 6pm, Monday to Friday and 7am to 1pm on Saturdays.

Construction and operational details have been obtained from Jackson Environment and Planning. Peak production is expected to occur in year 5 (2023).

Incoming raw materials will be delivered to site via trucks which will enter over the weighbridge. The raw materials will be stored on a dedicated tipping area or in concrete storage bays.

Processing of feedstock will be done using a grinder and shredder with further screening using a trommel. Material will be fed into the grinder

by an excavator. A conveyor will distribute the product material to the ground where it will be transferred by front end loader (FEL) to be stored in dedicated concrete storage bays prior to sale.

Sound pressure levels for the plant and equipment to be used at the facility were sourced from data obtained by Borgs from noise measurements made at the MDF facility, supplemented with spectral information in the Spectrum Acoustics technical database which contains data for similar plant items in typical operating conditions.

Table 13 shows the sound power level spectra of each of the modelled operational noise sources. In keeping with convention, spectral data are presented as unweighted (linear) decibel levels and the total is A-weighted.

The noise levels shown are for the various noise sources as an Leq over a 15 minute period.

TABLE 13
POWER LEVEL SPECTRA OF MEASURED NOISE SOURCES, dB

	TOTAL	Octave Band Centre Frequency, Hz							
Noise source	dB(A)	63	125	250	500	1k	2k	4k	8k
Full Processing Cycle	120	124	123	117	115	115	113	111	106
Trucks on site	93	103	97	91	85	90	87	74	66
FEL	105	100	110	97	102	100	99	93	89
Wheel Wash	91	92	95	88	89	84	83	69	65

The data in Table 13 labelled “Full Processing Cycle” is taken from a measurement supplied by the proponent of a similar processing facility as that proposed whilst in full operation with an excavator feeding the plant and product being removed to storage. This includes the noise from grinding, a trommel, shredders and stacker. The noise level was assumed to be constant over a full 15 minute assessment period.

There will be up to three x FELs used around the storage bays to load product into various vehicles for sale and to move material about the site. This loading and moving will not, typically, be undertaken continuously over a full 15 minute assessment period. For the calculation of a 15 minute Leq noise level an FEL was considered to be working for a total of 10 minutes in a 15 minute period. The Lw of this is that shown in Table 13. That is, the Leq noise level for an FEL has been adjusted by a factor of 10xlog 10/15 to account for the duration of the noise source.

Heavy vehicles delivering raw material will enter and leave the site via a driveway off Maher Drive. The vehicles will travel along the driveway via the weighbridge and into the site. For safety reasons these vehicles will move around the site slowly.

At maximum production it is envisaged that there will be up to approximately 21 vehicle movements per day to and from the site. This will include tippers, semi trailers and B-Doubles. This is a rate of approximately two heavy vehicle movements per hour for a typical working day.

For the current assessment a single heavy vehicle in a 15 minute period was considered. Any other vehicle movements will be limited to staff cars.

A truck arriving, unloading and departing will travel approximately 800m whilst on the site. A vehicle travelling at 10kph will traverse 800m in approximately five minutes. For the calculation of a 15 minute Leq noise level a 40t B-Double truck was considered to be moving slowly about the site for a total of five minutes in a 15 minute period.

To consider a realistic operational scenario a series of five point sources, representing a moving truck was modelled. The noise sources were modelled at each representative location for one minute out of a 15 minute assessment period, as shown in Figure 3.

The Lw of this is shown in Table 13. That is the Leq noise level for a truck travelling at 10kph has been adjusted by a factor of 10xlog 1/15 to account for the duration of the noise source at each location.

The layout of the proposed facility and the location of the modelled noise sources are shown in **Figure 3**.

Noise source details are shown in **Table 14**. The modelled noise source heights are also shown in Table 14 as the height above the finished ground level at that location.

TABLE 14
NOISE SOURCE DETAILS (per Fig. 3)

Annotation	Noise Source Details and source height
T1	Truck 1 at site entry +2.5m
T2	Truck 2 on delivery circuit +2.5m
T3	Truck 3 on delivery circuit +2.5m
T4	Truck 4 on delivery circuit +2.5m
T5	Truck 5 on delivery circuit +2.5m
WW	Wheel Wash +1.0m
FEL 1 & 2	FELs at storage bins +2.0m
FEL 3	FEL at shredder +2.0m
PF	Processing Facility (grinder, shredder, trommel, excavator) +2.5m

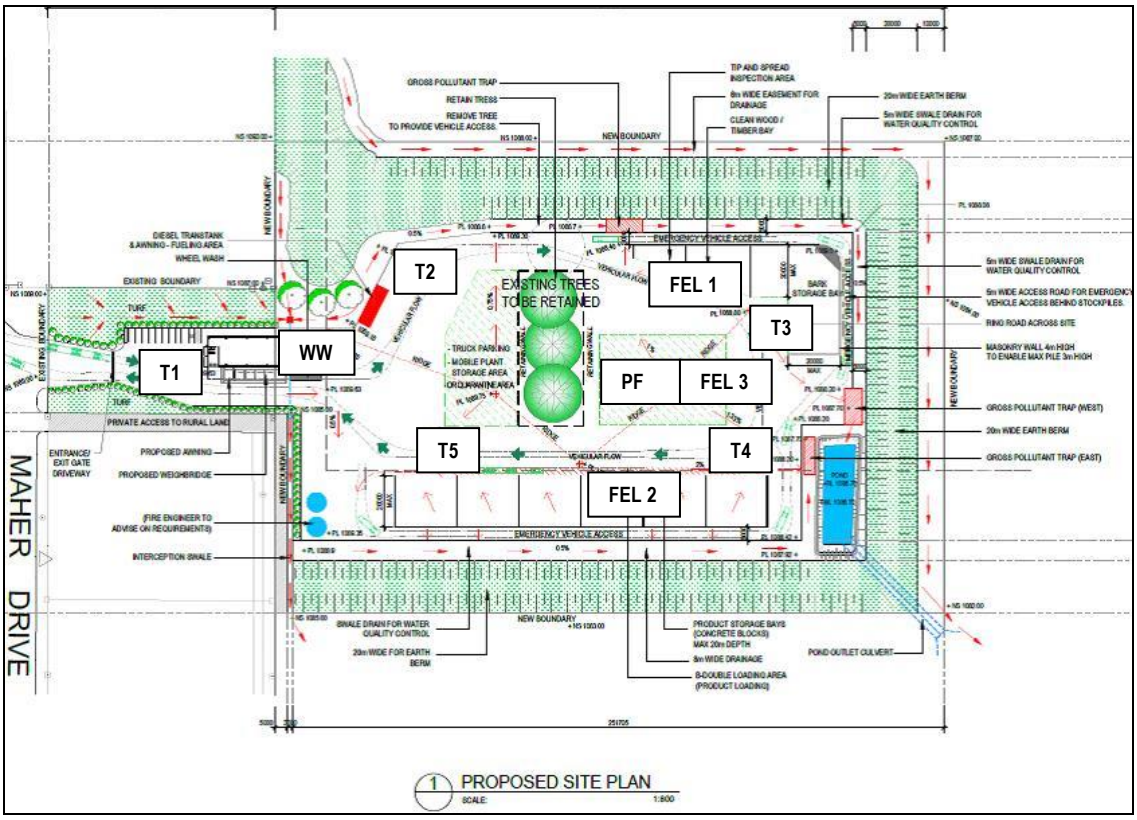


Figure 3 – Site Layout and Noise Source Locations

6.2 Predicted Operational Noise Levels

Assessment of operational noise was conducted using RTA Technologies Environmental Noise Model (ENM) v3.06. Noise contours of equal sound pressure level were generated out to the 20 dB(A) level.

The atmospheric conditions most relevant to noise assessments are temperature inversions, gentle winds (indicative of possible wind shear) and relative humidity.

The following meteorological features are, therefore, the most significant with respect to noise propagation for the proposal:

- Extremes of relative humidity (RH) are rarely experienced. For modelling purposes, a value of 70% RH was adopted;

- The NPI states that wind from any direction need only be considered in the assessment process if it occurs for more than 30% of the time (at wind speeds of less than 3m/s). An annual wind rose for the site for the 2017 is shown in **Figure 4**.

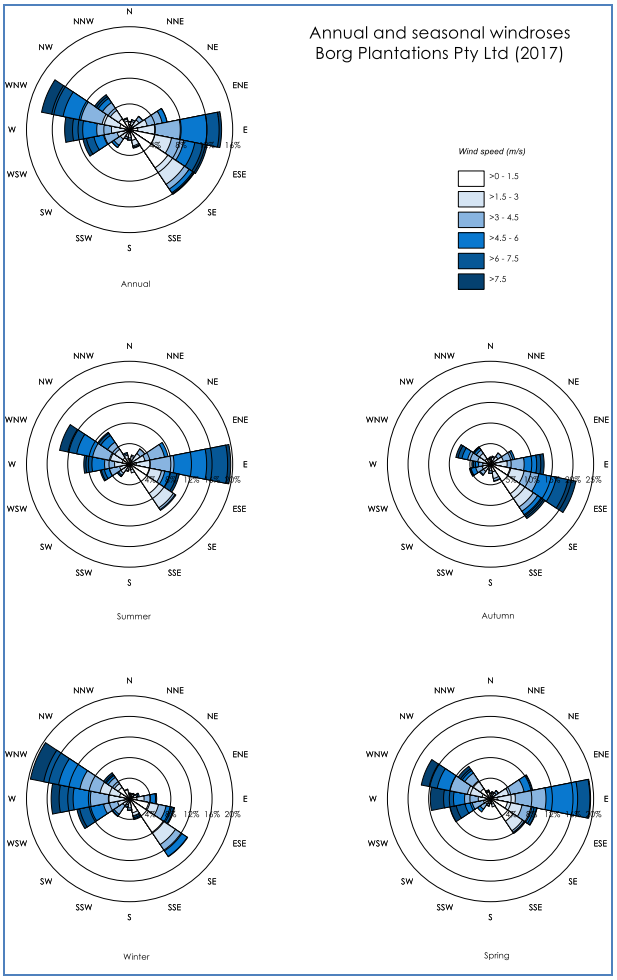


Figure 4 Daily Average Wind Rose (m/s) 2017

- Analysis of the wind rose data indicates that there are no winds at speeds of less than 3m/s from any quadrant for more than 30% of the time. Typical calm daytime conditions of no wind, 70% RH and -1^{o}C/100m vertical temperature gradient (i.e., dry adiabatic lapse rate, DALR) were, therefore, modelled to represent daytime noise levels under calm (neutral atmospheric) conditions.

- The wind rose does show, however, that light winds from the east to southeast are a relatively significant feature of the area. A wind speed of 3m/s (at 10m above ground level) from the east south east (112.5^{o}) was modelled to determine the noise impact under each of these 'prevailing' wind conditions.

As the facility will not operate during the night, temperature inversions do not need to be assessed.

Preliminary modelling showed the potential for an exceedance of the noise criterion under some circumstances. Analysis of the modelling results showed that the worst case received noise was from emissions

from the processing facility operating that is, grinder/shredder/screen and excavator.

In order to minimise the noise from these activities and achieve compliance with the criterion it is intended to construct an acoustic barrier (earthen mound) around parts of the site.

It is proposed that a 10m high earthen bund be constructed around the majority of the site as depicted in green on the site plan in **Figure 5**. The top of the proposed bund is shown schematically as a blue line on Figure 5.

In addition to the earthen bund it is recommended that an acoustic barrier fence be constructed as shown in red on Figure 5. For the noise modelling the top of the fence was considered to be must be a minimum of 2.5m above ground level.

An acoustic barrier fence is one that is impervious from ground level to the required height (with no gaps for the passage of noise). It must be constructed of material with minimum surface density of 15kg/m^2.

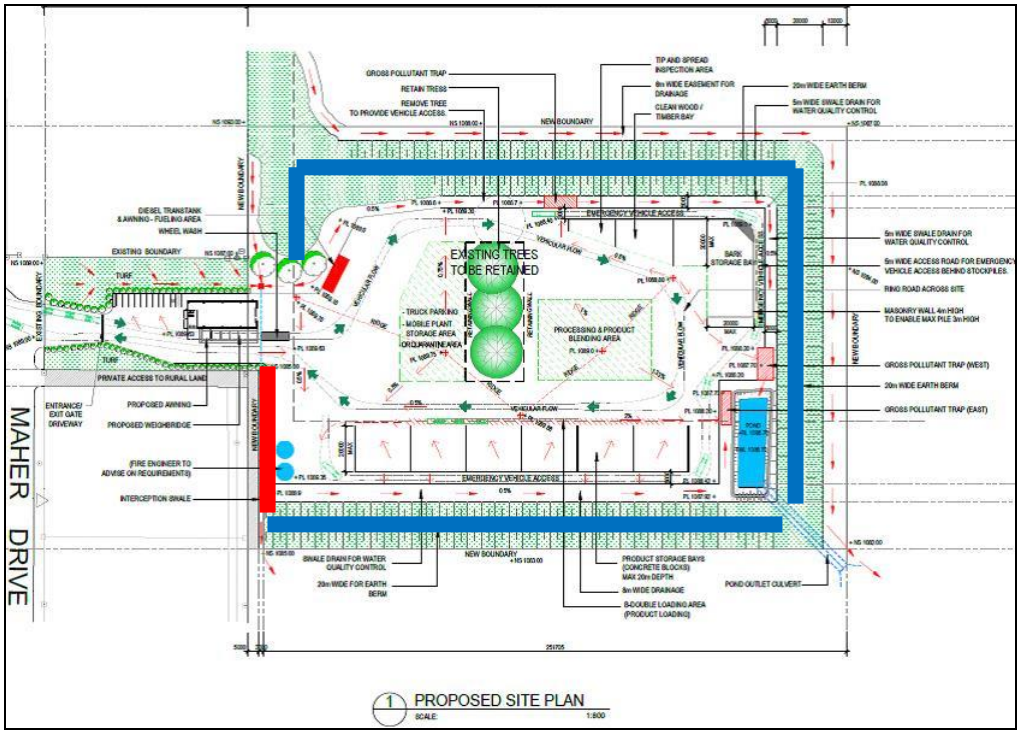
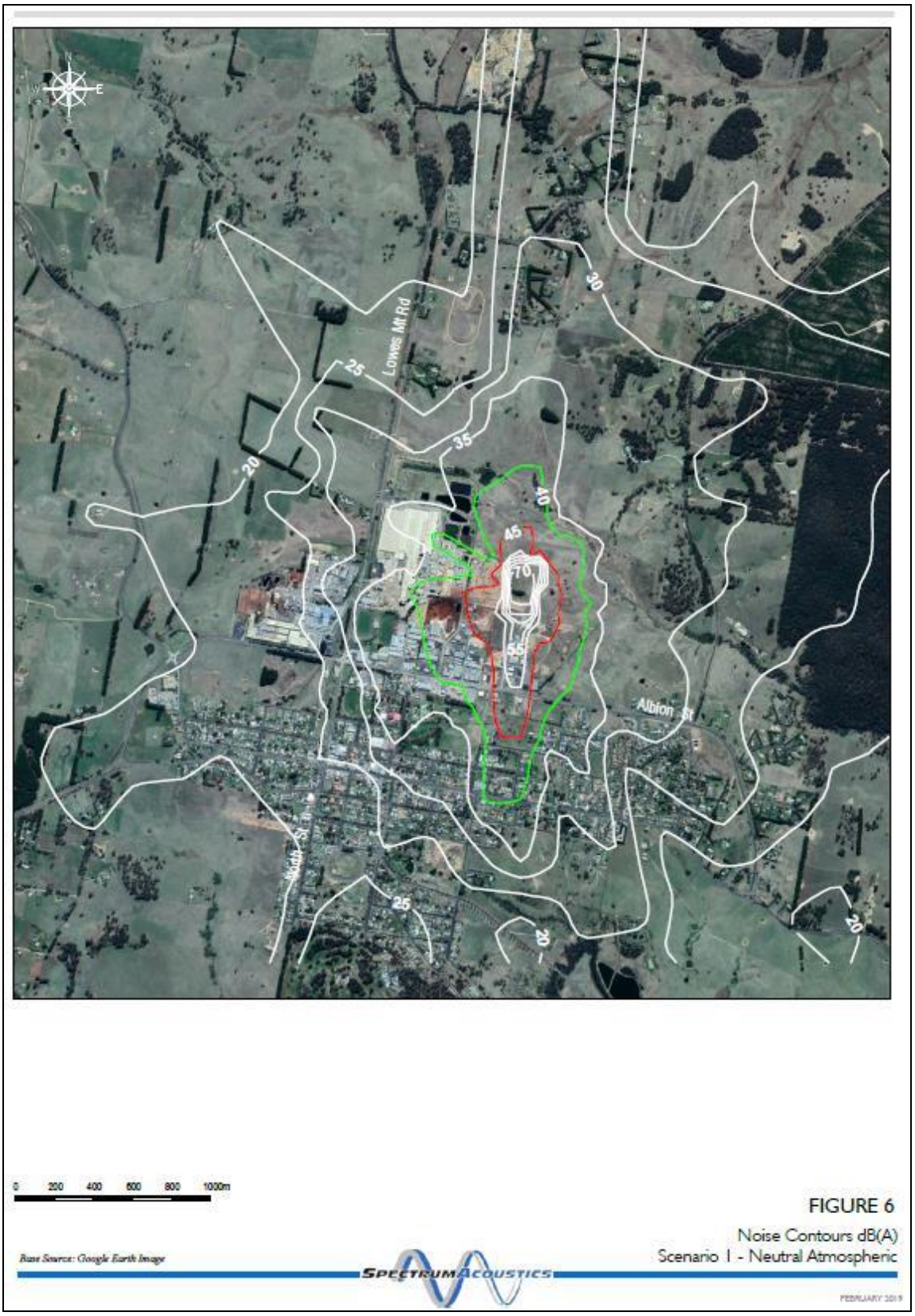


Figure 5 - Noise Barrier Locations

Noise levels were modelled using ENM for each of the atmospheric conditions described below:

Scenario 1 – Neutral Atmospheric - Day time operations - 20^{0}C, 70% R.H., Calm wind. Resulting noise contours are shown in **Figure 6**.

The 40 dB(A) Leq (15 min) contour is shown green and the 47 dB(A) Leq (15 min) contour is red.



Scenario 2 – South Wind - Day time operations - 20^{0}C, 70% R.H., 3m/s south wind. Resulting noise contours are shown in **Figure 7** with contour colours as for Figure 6.

FIGURE 7
Noise Contours dB(A)
Scenario 2 - East South East Wind

The contours shown in Figures 6 and 7 represent the modelled scenarios, for peak production rates, with the relevant acoustic barriers in place.

Figures 6 and 7 show the noise contours for all receivers in the vicinity of the Facility. The ENM noise model was also utilised in point calculation mode to determine the actual predicted noise level at the closest representative receivers to the site. These receiver locations are shown in **Appendix II** and described as;

- Receiver 1 Fox Lane,
- Receiver 2 Hazelgrove Road,
- Receiver 3 Albion Street,
- Receiver 4 cnr Ross Street and Cunynghame Street West.

The results of the point calculations for the modelled neutral atmospheric and southerly wind scenarios are shown in **Tables 15** and **16**. The receivers included in the tables are considered representative of the worst case received noise at each residential area in the vicinity

TABLE 15
ENM POINT CALCULATION RESULTS (dB(A) Leq (15 min))
SCENARIO 1 - NEUTRAL

Location	Scenario 1	Criterion
R1	24.2	40
R2	32.6	40
R3	38.1	45
R4	35.0	45

TABLE 16
ENM POINT CALCULATION RESULTS (dB(A) Leq (15 min))
SCENARIO 2 – EAST SOUTH EAST WIND

Location	Scenario 2	Criterion
R1	28.9	40
R2	33.0	40
R3	37.4	45
R4	36.2	45

The results of the point calculations can be seen to vary slightly from the contours. This is due to the manner in which the ENM noise model deals with the various modelling procedures. Point calculations are carried out to a specific ground location, whereas the contours are an interpolation of noise values between arbitrary radial calculation points. For this reason, the point calculations are considered more accurate and the contours should be viewed as indicative only.

The results of the point calculations show that, under the assessed atmospheric conditions, the predicted noise levels at all receivers will be in compliance with the relevant noise trigger levels.

The contours show that the worst case predicted noise at the Oberon High School is under the modelled neutral atmospheric conditions (Scenario 1). The worst case predicted noise is approximately 37 dB(A) Leq (15 min).

It is generally accepted that for a broad band noise sources (such as road traffic noise) the attenuation through the façade of a solid masonry building, with windows closed, is approximately 25 dB(A). With the windows open the loss into a room is approximately 10 dB(A) (source: Environmental Noise Management Manual).

As the noise from the Facility will be relatively broad band, it is of similar character to road traffic noise and the above assumptions are considered applicable to the current assessment. This would mean that the worst case received noise inside the rooms in the school which are closest, and most exposed to, the Facility would be approximately 27 dB(A) Leq with windows open, which is in compliance with the adopted noise criterion. With windows closed the internal noise would be approximately 12 dB(A) Leq which would be virtually inaudible in that situation.

At the Jenolan Holiday Park the worst case noise levels will be less than 40 dB(A) Leq (15 min) which is significantly below the applicable noise criterion for any permanent residents at the site.

The noise contours show that the predicted noise levels at nearby industrial receivers will be less than 70 dB(A) Leq (15 min) which is in compliance with the applicable noise criterion for industrial receivers.

6.3 Construction Noise Assessment

The proponent has advised that the construction works will be carried out over several phases.
This will entail;

- Site preparation, including ground clearing and levelling,
- Construction of concrete hardstands, storage bays and roadways etc. (this would include acoustic barriers and/or mounds), and
- Erection of the office and shed and fitout.

The excavation phase of the works will be done using an excavator, dozer and trucks.

Appendix B of the ICNG provides references for published databases of noise levels for construction equipment. Data for maximum noise emissions from the above equipment were provided in the *Roadway construction noise model user's guide*, Federal Highway Administration (FHWA), US Department of Transport, 2006 and the NSW RTA's Environmental Noise Management Manual (ENMM). Calculated Leq (15 min) sound power levels (Lw dB(A)) based on the FHWA and ENMM data are summarised in **Table 17**.

The Spectrum Acoustics technical database has been referenced to determine the sound power level most applicable to the actual equipment proposed to be used on the site. This level is also shown in Table 17.

TABLE 17
MEASURED AMBIENT NOISE LEVELS dB(A) Leq

Equipment	Range of Indicative Lw dB(A)	Range of Indicative Lp @ 10m dB(A)	Lw for Assessment as Leq (15 min)
Dozer	102 - 114	74 - 86	105
Grader	105	81	105
Excavator	97 - 117	69 - 89	102
Dump Truck	112	89	103
Truck	107	79	100
Concrete Agitator	99 - 104	71 - 76	104
Concrete Pump	103 - 108	75 - 80	106
Vibrator	91 - 106	63 - 78	103

Noise emissions from the construction works will vary throughout individual days and also throughout the length of the overall project. The noise level at individual receivers will also be dependent upon the location of the various works, relative to those receivers, at different times.

During the construction work the mobile plant, such as that detailed in Table 17 will, by definition, move about and will be, be at various operating levels (and thus producing various levels of noise) throughout any 15 minute period.

Noise emission from the construction works will vary throughout individual days and also throughout the length of the overall project. The noise level at individual receivers will also be dependent upon the location of the various works, relative to those receivers, at various times.

To gauge some potential construction noise impacts a typical operational scenario for the site preparation phase of construction has been considered where an excavator, dump truck and dozer were all working in close proximity to each other. All three items were

considered to be at the worst case Leq (15 min) noise levels shown in Table 17.

Table 18 shows the results of a sample calculation of potential noise impacts at receivers at various distances from the site, as a result of the assessed operations taking place. The calculation shown in Table 18 does not include any barrier insertion loss.

TABLE 18 GENERAL CONSTRUCTION NOISE – as dB(A) Leq (15 min)				
	@ 100 m	@ 200 m	@ 400 m	@ 600 m
Construction works noise source	106	106	106	106
Distance loss to receiver	48	54	60	64
Received noise	**58**	**52**	**46**	**42**

The closest residential receivers to the construction works are approximately 600m to the north east in Hazelgrove Road. The results in Table 16 show the construction noise levels at this location will be in compliance with the relevant construction noise management level of 45 dB(A) Leq (15 min).

The closest residential receivers to the construction works in Oberon are approximately 750m away. The results in Table 18 show the construction noise levels at this location will be in compliance with the relevant construction noise management level of 50 dB(A) Leq (15 min).

Oberon High School is approximately 900m to the south of the closest parts of the proposed construction works. At this distance the received noise from the assessed construction activities will be approximately 39 dB(A) at the external areas of the school. As the construction noise management level for a school is 45 dB(A) Leq inside a classroom, the predicted noise levels will be in compliance.

Further calculations show that, for the assessed construction activities, compliance with the construction noise management level for industrial premises will be achieved at distances of greater than about 10 or 15m.

The scenario considered in Table 18 represents the worst case for construction noise emissions from the site. The typical operating noise levels detailed in Table 17 show that the noise from other plant and machinery to be used on the site will be at lower levels than those calculated in Table 18. Resultant received noise at the nearby receivers would, therefore, also be at lower levels.

6.4 Vibration Assessment

Table 19 presents some published typical values of vibration for construction equipment sources, in terms of peak particle velocity (ppv)

expressed as mm/sec, for various ground types at a distance of 30m from the source.

TABLE 19
GENERAL VIBRATION LEVELS ppv mm/sec (at 30m)

	Hard Competent Rock	Hard soils, dense compacted sands	Competent soils, most sands, gravel	Weak or soft soils, top soil
Vibratory Roller	1.3	1.2	0.9	0.8
Large Bulldozer	0.6	0.5	0.4	0.3
Loaded Trucks	0.5	0.4	0.3	0.3

The worst case vibration levels would occur whilst a vibratory roller was working on site, say, compacting the base for hardstands or road way construction.

It is generally accepted that the attenuation of vibration through most ground types is inversely proportional to distance (that is, a halving of vibration with doubling of distance).

Based on the data presented in Table 19 this indicates that the vibration levels from the vibratory roller working about on the site will be “noticeable” at distances of about 30m as per the detail in Table 11. This will decrease to be “barely noticeable” at distances greater than about 100m. The closest any construction work will be to a residence is approximately 600m.

The vibration levels will be significantly lower than any building damage criteria.

6.5 Traffic Noise

Heavy vehicles will be used to haul raw materials to and product from the site. In relation to noise from heavy vehicles, there are many methods available for calculating the cumulative noise impact arising from intermittent signals of various shapes.

The methodology employed in this section was sourced from the commonly accepted US Environmental Protection Agency document No. 550/9-74-004 “Information on Levels of Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, March 1974”.

The document refers to ‘triangular’ and ‘trapezoidal’ time signals, which are illustrated in **Figure 8**. A triangular time signal rises from the background level to a peak noise level and then immediately begins to subside. A trapezoidal time signal rises from the background level to a maximum level and sustains that level for a period of time before subsiding.

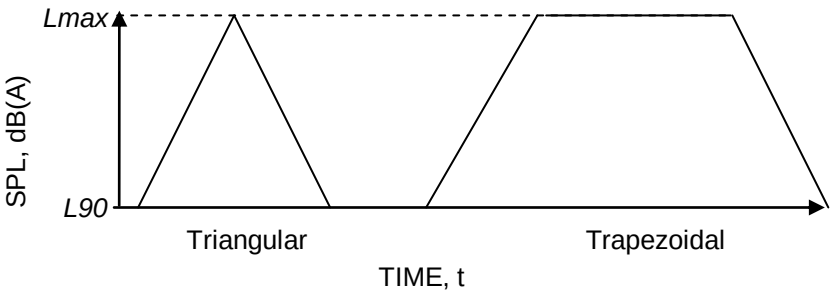


FIGURE 8. - *Triangular and Trapezoidal Time Signals*

A triangular time signal is a good approximation to the SPL signal of a car or truck as it passes an observation point. The value of Leq,T for a series of identical triangular time patterns having a maximum level of Lmax is given by **Equation 1.**

$$L_{eq},T = L_b + 10\log\left[1+\frac{ND}{T}\left(\frac{10^{(L\,\max - Lb)/10}-1}{2.3}-\frac{\left(L_{\max}-L_b\right)}{10}\right)\right] \quad \textbf{(1)}$$

where,

L_{max} = maximum vehicle noise at residence, dB(A)
L_b = existing Leq noise level, dB(A)
T = assessment period (minutes)
D = duration of noise from each vehicle (minutes)
N = number of vehicle trips during assessment period

As detailed earlier in this report, vehicles on the site are considered site noise whilst those on public roads are assessed separately. The noise from the truck movements on site is included in the operational noise modelling (shown in Figures 6 and 7).

The proponent has indicated that at maximum production rate there may be up to approximately 21 heavy vehicle movements per day associated with the operation. The heavy vehicles will include 12 tonne tippers, 32 tonne semi trailers (or trucks and dogs) and B-Doubles.

The proponent has also indicated that there will be an average of approximately 5 B-Double movements per day during construction (for delivery of fill).

For the assessment of vehicles on public roads, the sound pressure levels of a number of B-Double trucks (both laden and unladen) transporting various materials were sourced from the Spectrum Acoustics technical database.

Received noise was calculated on the basis of half of the vehicles being in the near lane of traffic and half in the far lane, with the total being the log addition of the two levels.

The results are shown in **Table 20**. Vehicles were assumed to be travelling at an average speed of 60km/hr on Albion Road. A nominal distance to a theoretical reception point 20m from the centre of the road was assessed.

TABLE 20 TRAFFIC NOISE	
Typical Maximum Sound Power, dB(A)	110
Distance Loss to Receiver, (20m)	34
Received Noise dB(A)Lmax	77
Traffic Volume, (trucks/day)	21
Time each vehicle audible at 60 kph (mins)	0.1
Background Noise Level dB(A)	35
Calculated Traffic Noise, dB(A) (Leq 15 hr)	47
Criteria dB(A) (Leq 15 hr/Day-Leq 9 hr/Night)	60-55

Table 20 shows that traffic noise levels will be below the road noise criterion, for either day or night time, for all residential receivers greater than 20m from the centreline of the road. There are no residences closer to the road than this within Oberon or surrounds.

As construction traffic will involve much fewer vehicle movements per day than that assessed for the operational activity (at maximum production) the noise from construction traffic will not exceed the noise criterion.

The results in Table 20 are based on measured noise levels for trucks travelling on typical public roads. The measurements include a mixture of road configurations including where vehicles were travelling up and down hill and slowing to turn, then accelerating away etc.

As such, the results are the theoretical calculated noise levels considered applicable to the majority of conditions and scenarios that may be encountered on the haul route. In reality road conditions may vary from those modelled due to specific localised circumstances. Examples may include long straight stretches of road, or sections of particularly steep gradient. Road conditions may also vary over time due to deterioration or maintenance.

The calculations also assume a full line of sight of the road (through approximately 135^0) and do not allow for the shielding effects of intervening structures or topography (such as where the road is in cut). As a result, the received noise levels may differ slightly from those shown in the tables. This variation may be to a level either higher or lower than that shown.

The predicted noise level is significantly lower than the applicable noise criterion and, therefore, and variation to the received noise is not likely to have any significant impact.

7.0 – CONSTRUCTION NOISE MANAGEMENT

The mechanisms available for control of construction noise are limited due to the necessary and mostly unchangeable location of the works and the size and type of plant and machinery which, by necessity, must be used. This is particularly the case when considering noise emissions from hammer or pier drilling.

Noise control, planning and management options are discussed below and applicable recommendations are included.

7.1 Construction Noise Control

The best ways to minimise construction noise impacts are to employ quiet work practices and use the quietest available construction equipment.

There are four main methods of controlling noise. These are;

1. Controlling noise at the source. Examples are; sound proof covers, sound reducing mufflers on plant etc. Also included here is the substitution of processes or equipment with less noisy items,

2. Controlling the transmission of noise in its path. Examples are noise barriers (such as appropriate fencing) or portable barriers which may be used around static equipment like generators,

3. Controlling noise at the receiver. Examples are insulation on buildings and thicker glazing, and

4. In addition to the above noise mitigation can involve scheduling of the more noisy activities to less sensitive periods of the day or times of the year.

For the current construction works there is little scope for the feasible and reasonable application of methods in items 2 or 3 in relation to residential and commercial receivers.

Section 6.1.1 details noise management procedures to enable identification of particularly noise sensitive times (re: item 4).

Section 6.1.2 contains recommendations on noise management procedures in relation to item 1.

7.1.1 Noise Planning

The proponent should undertake noise control planning as part of project pre-planning. This will identify potential noise problems and eliminate them in the planning phase prior to site works commencing.

The contact name and phone number of a responsible person should be available so that any potentially affected residents may comment on the works and indicate any particularly significant noise sensitive times.

Similarly the name of the person responsible for accepting and dealing with complaints should be readily available. All complaints or communications should be answered promptly and a record kept of all responses and actions.

The main contractor should plan to co-ordinate subcontractors so that there are no unnecessary cumulative impacts arising from the simultaneous activities of more than one subcontractor. That is, planning to avoid, if practical, having more than one noisy activity taking place in close proximity. It is good practice to appoint a single co-ordinator to oversee all significant noise producing activities.

7.1.2 Construction Noise Management

Construction activity is allowed only during the period 7.00am to 6.00pm Monday to Friday and 8.00am to 1.00pm Saturday, with no work on Sundays or public holidays. All personnel working on the site must be made aware of these hours.

All personnel working on the job including subcontractors and their employees must be made aware of their obligations and responsibilities with regard to minimising noise emissions.

Site inductions and toolbox meetings to all employees and subcontractors must include information about the need to minimise noise impacts to surrounding areas.
Contractors should familiarise themselves with methods of controlling noisy machines and alternative construction procedures. These are explained in AS2436-1981 “Guide to Noise Control on Construction, Maintenance and Demolition Sites”.

Mechanical plant should be silenced using best available control technology. Noise suppression devices should be maintained to manufacturer’s specifications.

All equipment used on the site shall have exhaust systems that have been recommended by the manufacturer as having the lowest associated noise for that machine.

Machines which are used intermittently such as rollers or other earthmoving machinery should either be shut down in the intervening periods between works or throttled down to a minimum.

Any portable equipment with the potential to create high levels of noise e.g. compressors, generators etc. should only be selected for use if it incorporates effective noise control. This equipment should be located where practical so that site sheds, or previously erected structures are between it and the nearest potentially affected receivers. Where no such barriers are present this machinery should be located behind a portable screen or enclosure.

The effectiveness of a noise barrier or screen depends on its length, height and its position relative to the source and the receiver. A screen designed to reduce noise from a stationary source should, where possible, extend a distance of twice the length of the noise source beyond the direct line of sight between the source and the receiver.

Plant known to emit noise strongly in one direction should, where possible, be oriented such that the noise is directed away from the closest or the most noise sensitive receivers.

Regular and effective maintenance of all equipment including vehicles moving on and off the site should be conducted. Prompt attention must be given to repair of loose or rattling parts and broken equipment. All maintenance work should only be carried out by qualified persons.

When selecting contractors and/or equipment for the job, preference must be given to those with capacities best suited to the task at hand. That is the use of larger machines with excess capacity should be avoided unless these can be shown to be quieter than smaller capacity machines.

Site access should be designed such that delivery vehicles, and other heavy vehicles moving through the site can do so with minimum need to reverse.

Where possible loading and unloading of plant and materials should be carried out away from potentially affected receivers. No delivery of plant or materials should be accepted before 7 am Monday to Friday or 8 am on Saturday.

Care should be taken not to drop materials from height either into, or out of trucks or other rigid surfaces. The surface to which the materials are being moved should be covered by some resilient material. Particular care should be taken during the loading or unloading of any scaffolding.

8.0 - ADMINISTRATIVE PROCEDURES

8.1 Construction Subcontractor Management

It is the responsibility of the main contractor to ensure that all subcontractors comply with site requirements as well as statutory requirements. No subcontractor should be allowed on site without being able to prove duty of care for the safety of their employees and bystanders with regard to noise emissions.

9.0 – CONCLUSION

An assessment has been carried out into the potential for adverse noise impacts due to the operation of a proposed Bark/Timber Processing and Landscape Supplies Production Facility at 26 Endeavour St, Oberon.

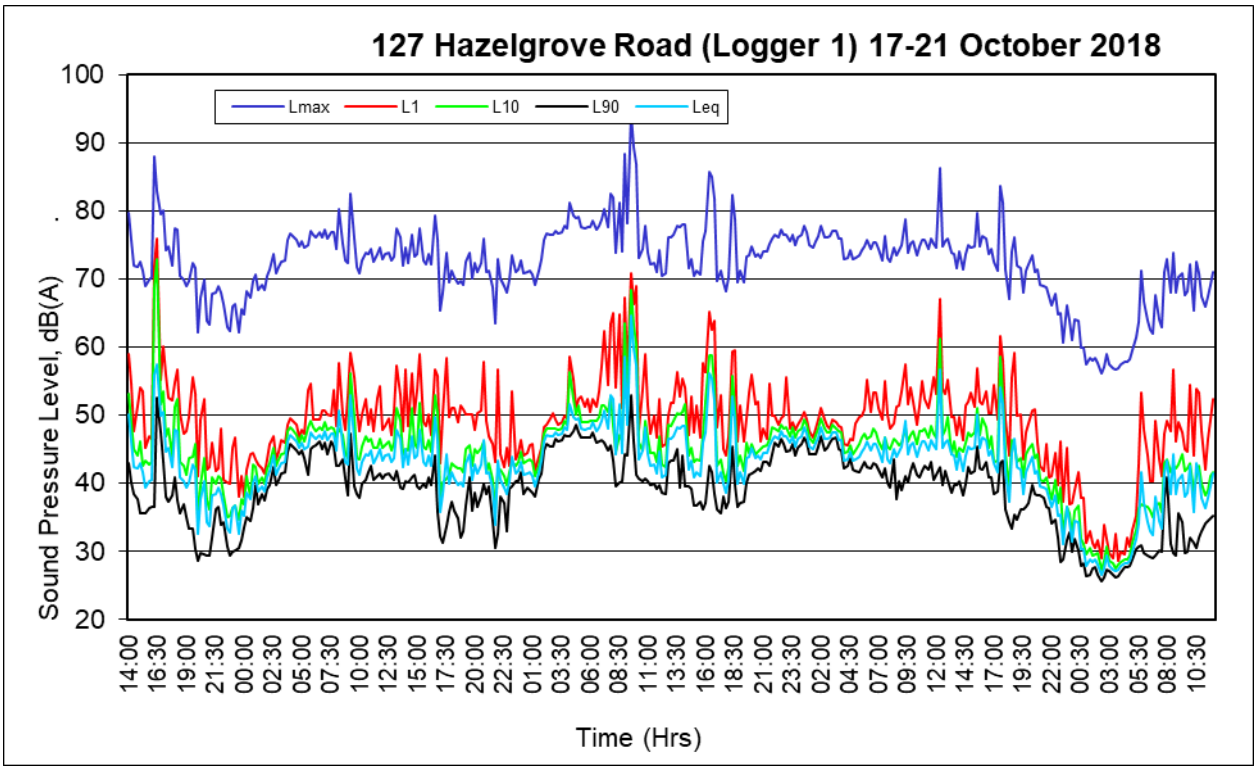
A typical operational scenario has been modelled, under various atmospheric conditions, and the results have shown that the predicted levels will not exceed the relevant noise criteria at any residential or industrial receivers.

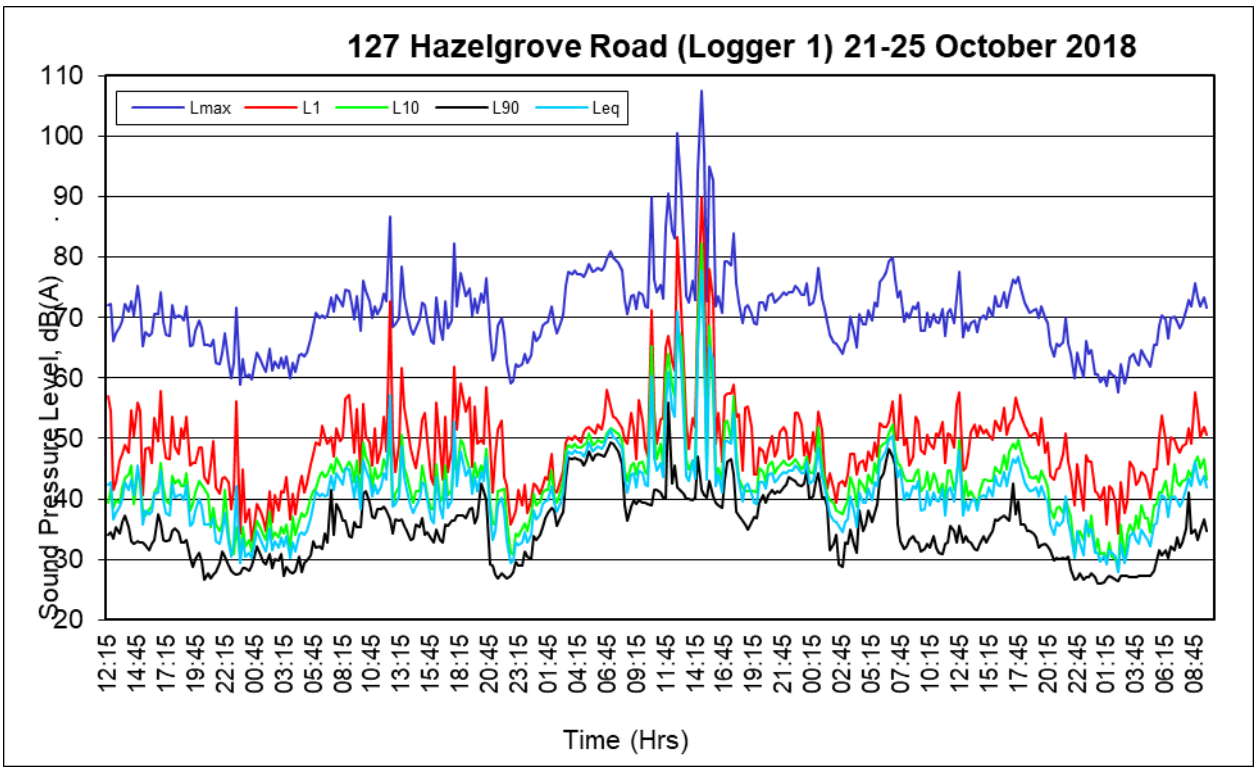
Calculations of the predicted noise levels from typical construction activities have shown that the received noise will comply with the relevant construction noise management levels.

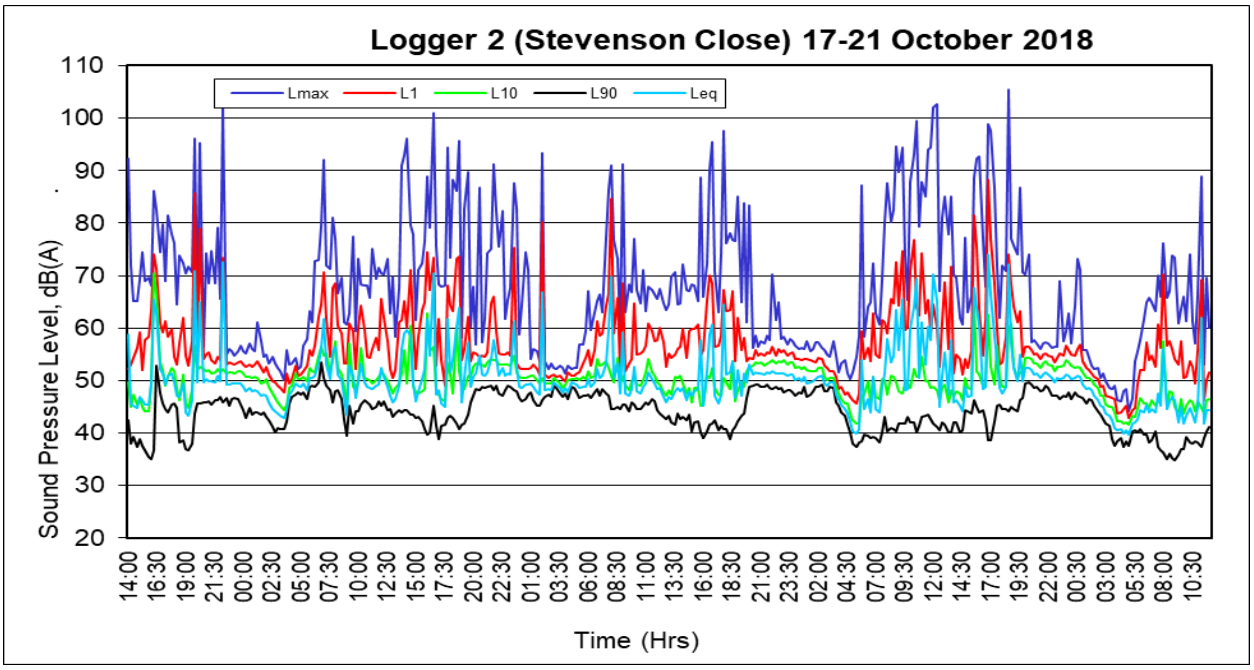
Calculations of the predicted vibration levels from typical construction activities have shown that vibration levels will be barely perceptible and will be significantly lower that any building damage criteria.

APPENDIX I

NOISE LOGGER CHARTS


127 Hazelgrove Road (Logger 1) 17-21 October 2018
Lmax
L1
L10
L90
Leq
Sound Pressure Level, dB(A)
Time (Hrs)


127 Hazelgrove Road (Logger 1) 21-25 October 2018
Lmax
L1
L10
L90
Leq
Sound Pressure Level, dB(A)
Time (Hrs)


Logger 2 (Stevenson Close) 17-21 October 2018
Lmax
L1
L10
L90
Leq
Sound Pressure Level, dB(A)
110
100
90
80
70
60
50
40
30
20
14:00
16:30
19:00
21:30
00:00
02:30
05:00
07:30
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22:30
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08:30
11:00
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16:00
18:30
21:00
23:30
02:00
04:30
07:00
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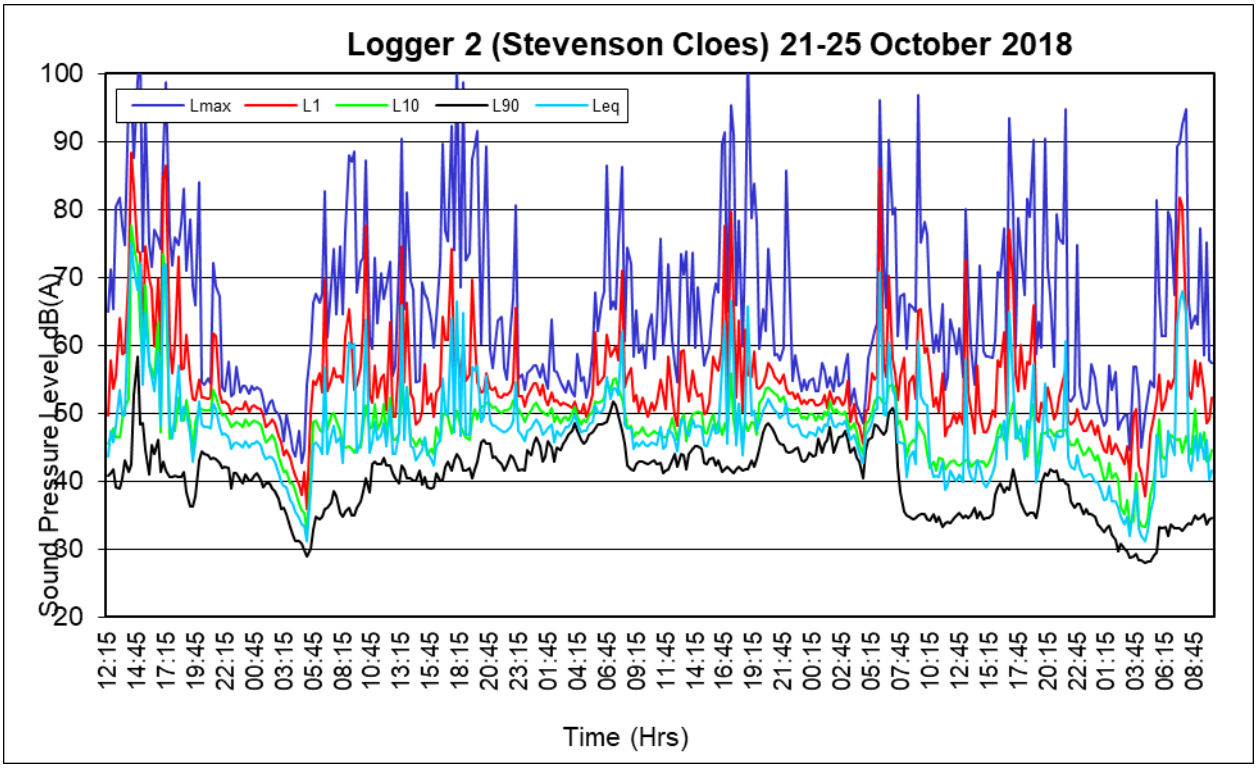
19:30
22:00
00:30
03:00
05:30
08:00
10:30
Time (Hrs)


Logger 2 (Stevenson Cloes) 21-25 October 2018
Lmax
L1
L10
L90
Leq
Sound Pressure Level, dB(A)
100
90
80
70
60
50
40
30
20
12:15
14:45
17:15
19:45
22:15
00:45
03:15
05:45
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04:15
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11:45
14:15
16:45
19:15
21:45
00:15
02:45
05:15
07:45
10:15
12:45
15:15
17:45
20:15
22:45
01:15
03:45
06:15
08:45
Time (Hrs)

APPENDIX II

RECEIVER LOCATIONS


Google Earth
R1
R2
R3
R4
Hazelgrove Rd
Fox Ln
Lowes Mt Rd
Oberon
Duckmaloi Rd
Queen St
Oberon St
Curtis St
Hawken St
Tasman St
Sirius St
Endeavour St
Horace St
North St
Prine St
Albion St
Creek St
Dalfour St
Springfield St
Dillon St
Rupert St
O'Connell Rd
The Reef Rd
Abercrombie Rd
Bennelong Ave
Glyndwr Ave
Tarana Rd
Fairfax St
Dart St
Wallys Ln
Image © 2018 DigitalGlobe
© 2018 Google


R1
R1
R2
R2
Hazelgrove Rd
© 2018 Google
Image © 2018 DigitalGlobe
Google Earth


Albion St
R3
R3
R4
R4
Brennan Crescent
Parkes St
Tasman St
Dart St
Leopard St
Jarra St
© 2018 Google
Image © 2018 DigitalGlobe
Google Earth