HEGGIES

REPORT 10-3015-R2

Revision 2

Vincentia District Centre
Noise Impact Assessment

PREPARED FOR

Stockland
Level 29
133 Castlereagh Street
SYDNEY NSW 2000

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HEGGIES PTY LTD
ABN 29 001 584 612

Incorporating New Environment Graeme E. Harding & Associates Eric Taylor Acoustics

Vincentia District Centre

Noise Impact Assessment

PREPARED BY:

Heggies Pty Ltd
2 Lincoln Street Lane Cove NSW 2066 Australia
(PO Box 176 Lane Cove NSW 1595 Australia)
Telephone 61 2 9427 8100 Facsimile 61 2 9427 8200
Email sydney@heggies.com Web www.heggies.com

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1 INTRODUCTION

Heggies Pty Ltd (Heggies) has been commissioned by Stockland to conduct noise investigations into the potential impacts that the operation of Stage 1 (Year 2009) and Stage 3 (Post 2020) of the Vincentia Commercial District would have on the residential receivers associated with the development to the west of the site. There is an intermediary stage in the project (Stage 2) that is due for completion in Year 2016, however this is encompassed in the Stage 3 assessment.

The District Centre will incorporate three Supermarkets, a Discount Department Store (DDS) and an extensive array of specialty stores. It is proposed that Supermarkets one and two will be constructed for completion in Stage 1 in 2009 with the third supermarket and DDS to be completed during Stage 2 and Stage 3. It is proposed that on-site customer parking will be upgraded during each stage of the project.

The investigations include an assessment of mechanical plant noise, on site traffic noise as well as noise from the operation of the loading docks associated with the DDS and each of the supermarkets (excluding Stage 2).

The nearest potentially affected noise sensitive receivers would be located to the west of the site and adjacent to Moona Creek Road. The proposed residential dwellings that are to be located opposite to the southern car park have been included as part of this assessment.

There are also a small number of existing residential dwellings located to the west of the proposed development site adjacent to Jervis Bay Road. These receivers have also been included in this assessment.

Specific acoustic terminology is used within this report. An explanation of common terms is included as **Appendix A**.

A site plan presenting the proposed Masterplan and the noise assessment locations (Prediction Points) is provided in **Appendix B**.

2 OPERATIONAL NOISE GOALS

2.1 General Operational Noise

Unattended ambient noise monitoring has been carried out at three representative locations within and surrounding the undeveloped site as part of Heggies previous studies, reported in Heggies Report 10-3015R1 Revision 1 *"Vincentia Master Plan Noise Impact Assessment"* dated 13 January 2006. It should be noted that the proposed residential subdivision will result in increased ambient noise levels and that the previously low ambient noise levels will not be maintained. The NSW Government's Industrial Noise Policy (INP) recognises land usage can change, for example as a result of residential sub-divisions in a rural area, and recommends the assessment of noise sources for control purposes be made against the acceptable Amenity Criteria relevant to the new land use (i.e. suburban in this instance). Note the INP is applicable for commercial as well as industrial developments and provides appropriate guidelines for the assessment of noise associated with a commercial district.

The corresponding design noise goals are therefore based on the INP's Acceptable Amenity Criteria for suburban land use. These are presented in **Table 1**.

Table 1 Design Criteria based on INP's Acceptable Amenity Criteria

Indicative Noise Amenity Area	L_{Aeq} Design Noise Goals (dBA re 20 µPa)		
	Daytime (7am - 6pm)	Evening (6pm - 10pm)	Night-time (10pm - 7am)
Suburban	55	45	40

2.2 Sleep Disturbance

Noise emanating from the site during the night-time period between 10 pm and 7 am has the potential to cause sleep disturbance. The potential for noise to result in sleep disturbance is not directly addressed within the body of the INP. The Department of Environment and Climate Change (DECCC) recommends guidelines contained within the Environmental Noise Control Manual (ENCM) (1994) for the assessment of the potential for sleep disturbance. This guideline recommends that the $L_{A1(1\ minute)}$ noise level outside a bedroom window should not exceed the Rating Background Level (RBL) or L_{A90} noise level by more than 15 dBA during the night-time period. The $L_{A1(1\ minute)}$ noise descriptor may be interpreted at the typical maximum noise level for a noise event. The L_{Amax} noise level has been conservatively applied for this assessment.

The assessment goal for loading dock and other intermittent related noise has therefore been determined to be RBL + 15 dBA based on the 1994 ENCM guidelines. Given that the relevant night-time RBL level reported in Heggies report 10-3015R1 is 36 dBA, the corresponding **Sleep Disturbance Criterion** is therefore **51 dBA**.

3 OPERATIONAL NOISE ASSESSMENT

3.1 Operational Noise Sources

Noise sources associated with the operation of the Vincentia District Centre consist of mechanical plant noise, loading dock noise associated with the DDS and Supermarket buildings and on-site vehicle traffic. The on-site vehicle traffic comprises of cars using the car park and heavy vehicle traffic associated with the operation of the loading docks. The mechanical plant is assumed to be continuous for the purpose of the $L_{Aeq(15minute)}$ INP assessment. On-site vehicle movements and loading dock noise are of a short duration not operating continuously for the 15 minutes. Such noise sources (of non-continuous nature) have been "normalised" to the 15 minute INP noise assessment period.

A summary of the noise sources and levels implemented in this assessment is provided below.

Mechanical Plant

Given that no specific mechanical plant information is available at this preliminary planning stage, we have allowed for a single large air cooled chiller and 2 axial fans to be located on the roof of the DDS building and each of the supermarket buildings. Typical sound power levels of the above equipment are listed in **Table 2**.

Table 2 Assessed Mechanical Plant Noise Levels

Mechanical Plant		
Air Conditioning Air Cooled Chiller	1	109 dBA[1]
Axial Fan	2	85 dBA

Note 1 It should be noted that the operation of the air conditioning chillers is intermittent in nature, as these can cycle on, depending on cooling requirements. A 5 dBA modifying correction factor is therefore applied to the noise level to account for its potential to cause greater annoyance, in accordance with the NSW Industrial Noise Policy (INP) guidelines

On-Site Traffic

Assessment of on-site vehicle traffic is based on internal traffic flow predictions provided by Masson, Wilson & Twiney (Traffic and Transport Consultants). Peak hourly internal traffic flows for Stage 1 and Stage 3 operations are presented in **Table 3**.

Table 3 Vincentia District Centre Peak Hour Traffic Volume

Car Park Entry Point	**Daytime (7am - 6pm) Vehicles/Hour**		**Evening (6pm - 10pm) Vehicles/Hour**		**Night-time (10pm - 7am) Vehicles/Hour**	
	Light	**Heavy**	**Light**	**Heavy**	**Light**	**Heavy**
Stage 1 - Year 2009						
North Car Park	283	15	260	3	48	1
South Car Park	403	0	351	0	17	0
Stage 3 – Year 2020						
North Car Park	251	8	241	3	44	1
South Car Park	360	10	314	1	21	0
The Wool Road	146	10	127	1	55	0

On-site vehicles are modelled as line sources based on the sound power levels presented in **Table 4** and taking into consideration the assumed on-site vehicle speed of 20 km/h.

Table 4 Summary of Vehicle Speeds & Sound Power Levels

Noise Source	**Sound Power Level**	**Vehicle Speed**
Heavy Vehicle Traffic (Loading Dock)	105 dBA	20 km/h
Light Vehicle Traffic (Car Park Traffic)	95 dBA	20 km/h

Loading Dock

Given that Stage 1 will house Aldi and Woolworths, we can use generic available information to assess the potential impact from loading dock activities. The typical noise sources associated with loading docks are presented in **Table 5**.

Table 5 Typical Loading Dock Activities, Noise Levels and Duration of Operation

Noise Source	**Sound Power Level**	**Typical Duration of Operation**	**Source Height**
Reversing Alarm	110 dBA	3 Seconds	1 m
Roller Door	94 dBA	60 Seconds	4 m
Trolley	93 dBA	5 Minutes	0.5 m
People Talking	78 dBA	5 Minutes	1.6 m
Raised Voices	83 dBA	60 Seconds	1.6 m

Assessment Noise Source Levels

It should be noted that noise sources listed in **Table 4** and **Table 5** would be in operation for less than 15 minutes at a time. Where the anticipated duration of operation is less than 15 minutes, the quoted sound power level is normalised to 15 minutes for the purpose of the INP noise assessment. The 15 minute normalised sound power levels for line and point sources are presented in **Table 6** and **Table 7** respectively**.**

Table 6 Line Sources - 15 Minute Normalised Sound Power Levels

Car Park Entry Point	**Daytime (7am - 6pm) dBA/m**		**Evening (6pm - 10pm) dBA/m**		**Night-time (10pm - 7am) dBA/m**	
	Light[1]	**Heavy[2]**	**Light[1]**	**Heavy[2]**	**Light[1]**	**Heavy[2]**
Stage 1 - Year 2009						
North Car Park	77	68	76	65	69	65
South Car Park	78	N/A	77	N/A	64	N/A
Stage 3 - Year 2016						
North Car Park	76	68	76	65	68	65
South Car Park	78	72	77	68	65	N/A
The Wool Road	74	72	73	68	69	N/A

Note 1 Light Vehicle movements associated with car park activities with a source height of 0.5 m.

Note 2 Heavy Vehicles associated with loading dock activities with a source height of 1.5 m.

Table 7 Point Sources – 15 Minute Normalised Sound Power Levels

Noise Source	**15 min Normalised SWL dB(A)**	**Source height**
Air Conditioning Chiller	109 dBA	2 m above building height
Axial fan	85 dBA	1 m above building height
Reversing Alarm		
Daytime (7am - 6pm)	93 dBA	1 m
Evening (6pm - 10pm)	93 dBA	1 m
Night-time (10pm - 7am)	85 dBA	1 m
Roller Door	82 dBA	4 m
Trolley	88 dBA	0.5 m
People Talking	73 dBA	1.6 m
Raised Voices	71 dBA	1.6 m

Noise Sources with Potential for Sleep Disturbance

Night time noise emissions between the hours of 10.00 pm and 7.00 am have the potential to cause sleep disturbance at the nearest noise sensitive receivers. It is for this reason that Stockland will not allow the Supermarkets or the DDS to operate their loading docks during these hours. A summary of L_{Amax} sound power levels typical of loading dock and car park activities used to assess the potential for sleep disturbance is presented in **Table 8**.

Table 8 Summary of L_{Amax} Equivalent Sound Power Levels

Noise Source	LAmax SWL dB(A)	Source height
Truck Movement	108 dBA	1 m
Reversing Alarm	110 dBA	1 m
Roller Door	94 dBA	4 m
Trolley	93 dBA	0.5 m
Raised Voices	83 dBA	1.6m
Car Movement	92 dBA	0.5 m

3.2 Noise Level Predictions

SoundPLAN V6.4 software was used for modelling the noise emissions from the proposal. The model includes ground topography, buildings and representative noise sources as discussed in **Section 3.1**. At the relatively small distances between the proposed development site and nearest potentially affected receivers, weather effects have little influence on noise propagation and hence neutral meteorological conditions were assumed. The assessment has been undertaken on the basis of the CONCAWE industrial noise algorithm.

The model was used to predict $L_{Aeq(15minute)}$ noise levels for the INP assessment and L_{Amax} noise levels for the sleep disturbance assessment.

The predicted $L_{Aeq(15minute)}$ mechanical plant noise levels for Stage 1 and Stage 3 are presented in **Table 9**. The predicted $L_{Aeq(15minute)}$ car park and loading dock noise levels for Stage 1 and Stage 3 are presented in **Table 10** and **Table 11** respectively. Exceedances are shown as shaded in the tables.

Table 9 Predicted $L_{Aeq(15minute)}$ Mechanical Plant Noise Levels

Prediction Point	Daytime (55 dBA) / Evening (45 dBA) / Night-time (40 dBA)[1] $L_{Aeq(15minute)}$ Noise Levels (dBA)			
	Ground Floor		1st Floor	
	Stage 1	Stage 3	Stage 1	Stage 3
1	52	58	54	60
2	52	59	55	60
3	56	61	57	62
4	57	62	58	63
5	57	63	59	64
6	57	63	59	65
7	58	64	60	65
8	58	64	61	65
9	59	64	61	65
10	60	64	62	65
11	59	63	63	65
12	59	62	62	64
Existing Receiver 1	48	53	49	54

Note 1 Criteria are shown in brackets.

Table 10 Stage 1 - Predicted $L_{Aeq(15minute)}$ Car Park and Loading Dock Noise Levels

Prediction Point	$L_{Aeq(15minute)}$ Noise Levels (dBA)					
	Ground Floor			First Floor		
	Day (55 dBA)[1]	Evening (45 dBA)[1]	Night (40 dBA)[1]	Day (55 dBA)[1]	Evening (45 dBA)[1]	Night (40 dBA)[1]
1	47	46	33	51	50	37
2	48	47	35	53	52	39
3	49	48	35	53	52	39
4	48	47	35	52	51	39
5	48	47	34	51	50	38
6	46	45	33	50	49	37
7	45	44	32	49	48	36
8	43	42	31	47	46	35
9	42	41	31	46	45	34
10	41	40	30	45	44	33
11	41	40	30	44	43	33
12	41	40	30	43	42	33
Existing Receiver 1	41	40	28	41	40	28

Note 1 Criteria are shown in brackets.

Note 2 Loading Docks are not operational during the night.

Table 11 Stage 3 - Predicted $L_{Aeq(15minute)}$ Car Park and Loading Dock Noise Levels

Prediction Point	$L_{Aeq(15minute)}$ Noise Levels (dBA)					
	Ground Floor			First Floor		
	Day (55 dBA)[1]	Evening (45 dBA)[1]	Night (40 dBA)[1]	Day (55 dBA)[1]	Evening (45 dBA)[1]	Night (40 dBA)[1]
1	53	52	39	56	55	43
2	52	51	39	57	55	43
3	48	47	35	52	51	39
4	46	45	34	49	48	37
5	45	44	33	48	47	36
6	44	42	32	47	45	35
7	43	42	32	45	44	34
8	42	41	31	44	43	34
9	41	40	31	44	43	34
10	41	40	31	43	42	34
11	41	40	31	43	42	35
12	41	40	33	43	42	36
Existing Receiver 1	49	48	37	49	48	37

Note 1 Criteria are shown in brackets.

Note 2 Loading Docks are not operational during the night.

The predicted night-time L_{Amax} noise levels at the nearest receivers for Stage 1 and Stage 3 are presented in **Table 12** and **Table 13** respectively.

Table 12 Stage 1 - Summary of Predicted L_{Amax} Noise Levels (dBA)

Noise Source	Predicted L_{Amax} Noise Levels[2]		Sleep Disturbance Criterion Exceedance[1]	
	Ground Floor	First Floor	Ground Floor	First Floor
Truck Movement	36 - 61	36 - 70	No Exceedance	No Exceedance
Reversing Alarm	25 - 57	25 - 57	No Exceedance	No Exceedance
Roller Door	17 - 35	13 - 35	No Exceedance	No Exceedance
Trolley	15 - 37	15 - 37	No Exceedance	No Exceedance
Raised Voices	15 - 28	15 - 28	No Exceedance	No Exceedance
Car Movement	20 - 44	21 - 48	No Exceedance	No Exceedance

Note 1 The sleep disturbance criterion is applicable during the night-time period (10 pm - 7am). The loading docks will not be operational during this period and therefore not trigger any exceedances.

Note 2 The range of LAmax levels shown is for the worst affected residence for each noise source.

Table 13 Stage 3 - Summary of Predicted L_{Amax} Noise Levels (dBA)

Noise Source	Predicted L_{Amax} Noise Levels[2]		Sleep Disturbance Criterion Exceedance[1]	
	Ground Floor	First Floor	Ground Floor	First Floor
Truck Movement	39 - 61	39 - 70	No Exceedance	No Exceedance
Reversing Alarm	25 - 64	19 - 64	No Exceedance	No Exceedance
Roller Door	18 - 48	20 - 51	No Exceedance	No Exceedance
Trolley	13 - 43	20 - 45	No Exceedance	No Exceedance
Raised Voices	13 - 31	15 - 35	No Exceedance	No Exceedance
Car Movement	24 - 44	23 - 45	No Exceedance	No Exceedance

Note 1 The sleep disturbance criterion is applicable during the night-time period (10 pm – 7 am). The loading docks will not be operational during this period and therefore not trigger any exceedances.

Note 2 The range of LAmax levels shown is for the worst affected residence for each noise source.

3.3 Discussion

Mechanical Plant

As presented in **Table 9** L_{Aeq} noise levels from the mechanical plant may exceed the limiting night-time criterion of 40 dBA for Stage 1 and Stage 3. The exceedances may occur as a result of the roof plant located unshielded to residences or in the event that un-silenced plant items are utilised.

It is noted that the roof plant areas will be located behind raised roofs and or upper levels of adjacent buildings and as a result, some additional shielding is likely. Further analysis and the consideration of noise controls will be required during the detailed design phase when exact details in regard to plant selection and specification are known.

Car Park Traffic, On-site Truck Movements and Loading Dock Activities

Combined noise emissions from car park traffic, on site truck movements and associated loading dock activities for Stage 1 and Stage 3 are presented in **Table 10** and **Table 11** respectively.

In relation to the predicted noise levels for **Stage 1** of the proposal, the daytime $L_{Aeq(15minute)}$ criterion is complied with at all locations at both the ground and first floors. Marginal exceedances (1 dBA to 3 dBA) of the evening and night-time $L_{Aeq(15minute)}$ criteria are predicted at the ground floor receivers of Prediction points 1 and 2 and prediction points 5 to 3. Exceedances of up to 7 dBA are predicted at the first floor during the evening period at prediction points 1 and 2 and prediction points 8 to 3.

The predicted L_{Amax} noise levels from the loading dock area comply with the sleep disturbance criterion at all locations.

In relation to L_{Amax} noise levels associated with car and truck movements on site, no exceedance of the criterion is predicted from cars. It is noted that the loading docks will not be operational during the night-time period and hence no exceedances of the sleep-disturbance criterion are predicted in relation to on-site truck movements.

In relation to the predicted noise levels for **Stage 3** of the proposal, the daytime $L_{Aeq(15minute)}$ criterion is complied with at all ground floor receivers with marginal exceedances of 1 dBA to 2 dBA at first floor receivers located on prediction points 1 and 2.

Exceedances of up to 7 dBA are predicted during the evening period at ground floor receivers located on Prediction points 1, 2 and 3. Exceedances of up to 10 dBA are predicted at the first floor receivers located on prediction points 1, 2 and 5 to 3. A 3 dBA exceedance of the night-time criterion is predicted at the first floor receivers located on prediction points 1 and 2.

The noise levels are predicted to comply with the daytime and night-time $L_{Aeq(15minute)}$ design criteria at the nearest existing residential receiver located on the Jervis Bay Road to the south west of the site. A 3 dBA exceedance of the evening $L_{Aeq(15minute)}$ design criteria is predicted.

The predicted L_{Amax} noise levels from the loading dock area comply with the sleep disturbance criterion at all locations.

In relation to L_{Amax} noise levels associated with car and truck movements on site, no exceedance of the criterion is predicted from cars. It is noted that the loading docks will not be operational during the night-time period and hence no exceedances of the sleep-disturbance criterion are predicted in relation to on-site truck movements.

The Stage 3 noise emissions will be higher than for Stage 2 due to increased traffic flows and noise from an additional loading dock associated with Supermarket 3. On this basis, there is no need to model the Stage 2 scenario separately. The recommendations in relation to potential noise mitigation measures are therefore based upon the Stage 3 noise level predictions.

4 CONCEPT MITIGATION MEASURES

4.1 Mechanical Plant

The assessment of noise emissions from the mechanical plant indicates potential exceedances of the INP noise criteria. In order to meet the criteria, control measures may be required to be incorporated in to the design. Indicatively, these control measures may include:

- A low noise air cooled chiller (and other plant where applicable) be used; and/or
- Roof mounted mechanical plant is located in a purpose built enclosure incorporating acoustic louvers.
- Plant to be located in a position that provides maximum shielding from surrounding structures.

The details of the acoustic control measures would occur during the detailed design phase. It is at this point that all reasonable and feasible noise control measures be considered to ensure compliance with the INP criterion. In order to prevent the combination of on site traffic noise and mechanical plant noise exceeding the criteria, it is recommended that the target noise emission from the mechanical plant be reduced to at least 5 dBA below the night-time noise criterion (in addition to accounting for the 5 dBA penalty for the intermittent nature of the source).

4.2 Loading Dock and Onsite Traffic

Restricting Truck Movements and Loading Dock activities to Daytime and Evening Periods

It is noted that the operation of the loading docks have been restricted to the daytime and evening periods (7 am to 10 pm), thereby eliminating the risk of sleep disturbance from the associated sources.

In addition, with respect to combined car park traffic and loading dock traffic $L_{Aeq(15minute)}$ noise levels, removing the truck and loading dock contribution reduces night-time noise levels by up to 3 dBA. The net effect is a reduction in the number of residences with residual exceedances. However, as exceedances of the evening criterion are unchanged (as noise levels during the evening are dominated by cars), there is no reduction in the number of residences affected.

Architectural Treatments

Residual exceedances may be addressed by applying property treatments to habitable rooms of potentially affected residential dwellings (depending upon the detailed design of the residential development). In general a dwelling of standard construction will conservatively provide an "outside to inside" noise reduction of 20 dBA with the windows closed, and nominally 10 dBA with the windows open. Therefore potential architectural treatments generally considered during the project detailed design phase are effectively limited to:

- Fresh air ventilation systems that meet Building Code of Australia requirements with the windows and doors shut;
- Upgraded windows and glazing and solid core doors on the exposed facades;
- Upgrading window and door seals; and
- The sealing of wall vents.

In order to comply with the design criteria set in accordance with the DECC's INP it is recommended consideration be given to the inclusion of architectural treatments to residential dwellings that may be located on prediction points 1, 2, and 8 to 3, and to the nearest existing receiver located on Jervis Bay Road, during the project detailed design phase.

5 CONCLUSION

Noise emissions from plant items associated with the Stage 1 and Stage 3 of the Vincentia District Centre proposal including on-site vehicle traffic and the operation of the loading dock have been assessed against the INP.

It was determined that there is potential for noise annoyance due to modelled activities at nearby residential properties. Exceedances of the $L_{Aeq(15minute)}$ criteria in relation to car park and loading dock activities were predicted to occur during the evening period, and car park activities during the night-time period at a number of the nearest residences west of Moona Creek Road. It is recommended that architectural treatments, as discussed in **Section 4**, be considered for habitable rooms of potentially affected dwellings during detailed design.

The modelled noise emissions from indicative roof top mechanical plant were predicted to exceed the $L_{Aeq(15minute)}$ criterion during the day, evening and night-time periods. The predicted exceedances indicate that it will be necessary to incorporate a reasonable and feasible noise control strategy into the design and operation of the roof top mechanical plant systems. The reasonable and feasible noise control strategy would be actioned during the detailed design stage (when specific items of plant have been selected). The reasonable and feasible process would involve the consideration of noise control measures such as the use of “quiet plant” and acoustic enclosures. During the detailed design stage, it is recommended that target noise emission from the mechanical plant be reduced to at least 5 dBA below the night time noise criterion.

Acoustic Terminology

1 Sound Level or Noise Level

The terms "sound" and "noise" are almost interchangeable, except that in common usage "noise" is often used to refer to unwanted sound.

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

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

2 "A" Weighted Sound Pressure Level

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

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

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

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

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

3 Sound Power Level

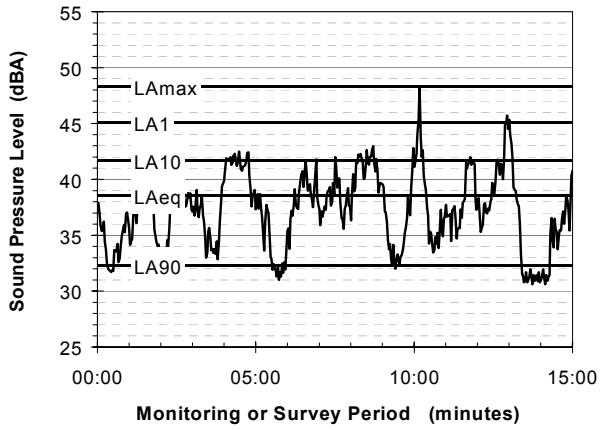
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or L_W, or by the reference unit 10^{-12} W.

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

4 Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{AN}, where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} the noise exceeded for 10% of the time, and so on.

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



Of particular relevance, are:

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

L_{A10} The noise level exceed for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

L_{A90} The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

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

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the "repeatable minimum" L_{A90} noise level over the daytime and night-time measurement periods, as required by the EPA. In addition the method produces mean or "average" levels representative of the other descriptors (L_{Aeq}, L_{A10}, etc).

5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components), and is normally regarded as more offensive than "broad band" noise.

6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

7 Frequency Analysis

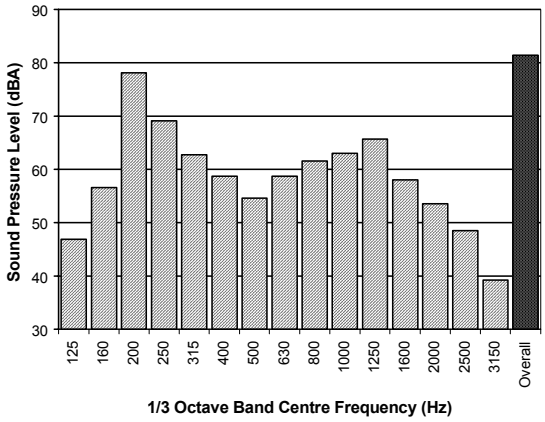
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

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

Frequency analysis can be in:

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

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



8 Vibration

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

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

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements. Where triaxial measurements are used, the axes are commonly designated vertical, longitudinal (aligned toward the source) and transverse.

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

9 Human Perception of Vibration

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

10 Over-Pressure

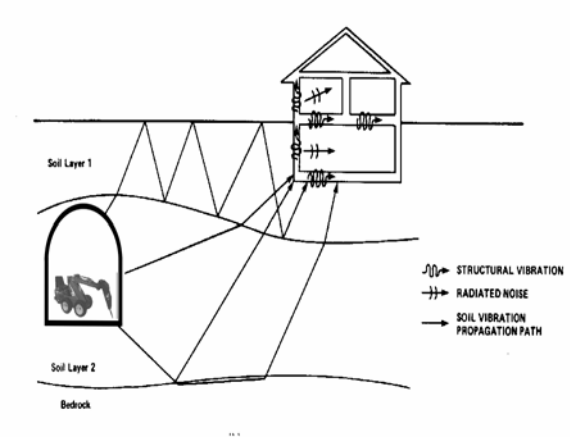
The term "over-pressure" is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

11 Ground-borne Noise, Structure-borne Noise and Regenerated Noise

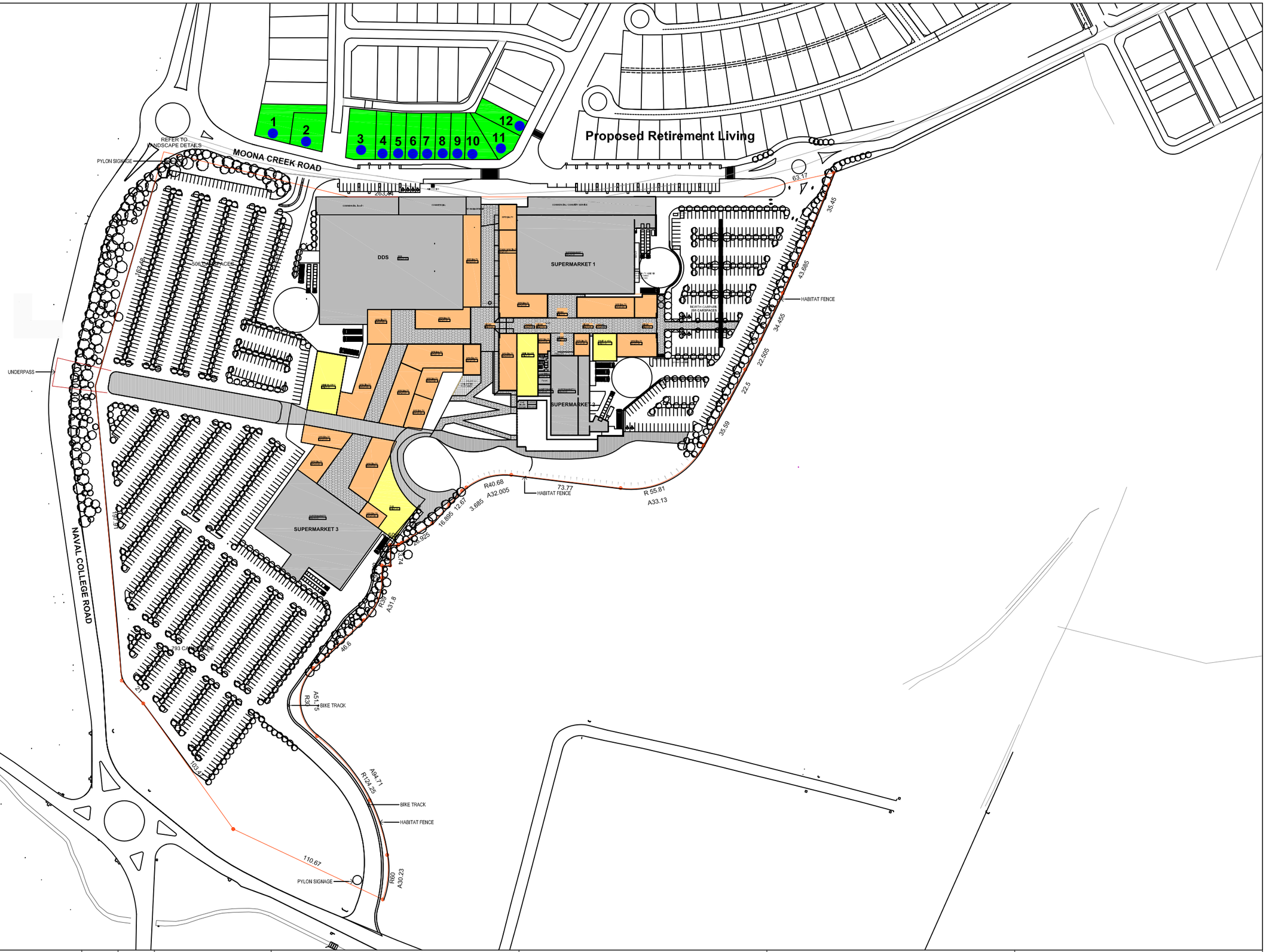
Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed "structure-borne noise", "ground-borne noise" or "regenerated noise". This noise originates as vibration and propagates between the source and receiver through the ground and/or building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

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

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



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



REV.	DATE	AMENDMENT / ISSUE DESCRIPTION	PREPARED	CHECKED
1	01/10/08	General Issue	AP	MA
0	29/01/08	General Issue	AP	JS

0 100 200
Not to Scale

Receiver

Heggies Pty Ltd
2 Lincoln Street
Lane Cove NSW 2066 Australia
PO Box 176 Lane Cove NSW 1595
Email address sydney@heggies.com.au
Telephone 02 9427 8100 Facsimilie 02 9427 8200

Vincentia District Centre
Appendix B
Site Plan - Stage 3

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DRAWING No.
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REVISION
0

75 mm ON ORIGINAL
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75