ACOUSTICS AND AIR

URBAN DESIGN STUDY
15 CLOSE STREET, CANTERBURY

NOISE & VIBRATION ASSESSMENT - CONCEPT DESIGN

REPORT NO. 14039
VERSION A

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PREPARED FOR

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DOCUMENT CONTROL

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GLOSSARY OF ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

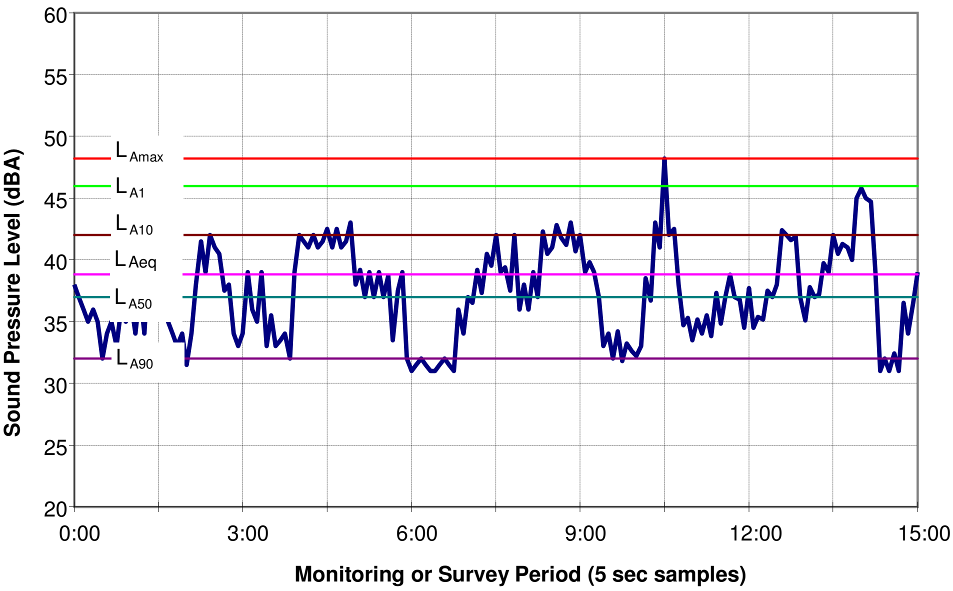
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10^{th} percentile (lowest 10^{th} percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

Typical Graph of Sound Pressure Level vs Time



1 INTRODUCTION

Canterbury City Council is considering the prospect of reclassifying and rezoning the existing Public Recreation (RE1) zoned site, located at 15 Close Street, Canterbury to provide for residential and/or community uses.

Based on the draft Master Plan for the site prepared by Olsson & Associates Architects, JBA Urban Planning Consultants (JBA) proposes to prepare and lodge an initial Planning Proposal for Gateway Determination for submission to the NSW Department of Planning on behalf of Council.

Wilkinson Murray Pty Limited (WM) has been commissioned to undertake an assessment of potential noise and vibration effects that may arise due to the proposal, given the site's proximity to the existing Bankstown rail corridor and Canterbury Road.

Monitoring has been undertaken on-site to assess the site's existing exposure to noise and vibration. Based on the monitoring results assessment of potential noise and vibration impacts on the proposed development has been undertaken in reference to the relevant assessment criteria set out in the NSW Infrastructure SEPP which is supplemented by the Department of Planning's document *Development* in *Rail Corridors and Busy Roads – Interim Guideline*.

Additionally, an assessment of on-site maximum noise levels arising from rail movements has been undertaken in reference to the sleep disturbance criteria recommended by the NSW EPA.

Further to this, based on the background noise levels measured on-site, recommended criteria for the management of noise generated within the subject site have been identified.

2 SITE DESCRIPTION

The site located at 15 Close Street, Canterbury comprises an area of approximately 10,780 m^2 and is owned in its entirety by Canterbury City Council. It is currently leased to the Canterbury Bowling Club and presently accommodates a club house, three bowling greens and an at grade car park.

The site is bounded by:

- Medium density residential properties to the east;
- A large open space (RE1 zoning) to the south;
- The Bankstown rail corridor to the north; and,
- A warehouse to the west (which is proposed to be developed as a 6-8 storey residential property in the future), with a light industrial area beyond.

Figures 2-1 and 2-2 show aerials views of the existing site and the surrounding area.

Figure 2-1: Location Plan Showing Site in Relation to the Canterbury Town Centre

Figure 2-2: Location Plan Showing Site Boundary and Surrounding Land Uses

Note: Bankstown rail corridor to the north of the site.

2.1 Proposed Development

The draft Master Plan presents two site configuration options (Option 1 and Option 2). Option 1 is favoured by Canterbury City Council and this option has been considered for the purpose of this assessment. The Option 1 layout is shown in Figure 2-3 and described further in Table 2-1.

Table 2-1: Master Plan Option 1 - Building Details

Site	Buildings	Use	Storeys
Site 1	1a	Multi Purpose Community Art/ Cultural Facility	3 Storeys
Site 2	2a	Commercial on ground floor with 5 storeys of Residential above	6 Storeys
	2b	Residential Use	8 Storeys
	2c	Residential Use	6 Storeys
Site 3	3a	Residential Use	6 Storeys
	3b	Residential Use	8 Storeys
	3c	Residential Use	6 Storeys
	3d	Residential Use	8 Storeys
	3e	Residential Use	6 Storeys

Figure 2-3: Master Plan Option 1 Building Layout

3 NOISE MEAUREMENTS

A site inspection was conducted on 19 March 2014 in order to evaluate the potential noise and vibration exposure to the various uses within the proposed development.

The principal sources that influence noise levels on the site were noted to be passenger and freight train movements on the Bankstown rail line; vehicle movements on Canterbury Road and other nearby roads; distant construction works; fauna (birds and insects); and wind disturbed vegetation.

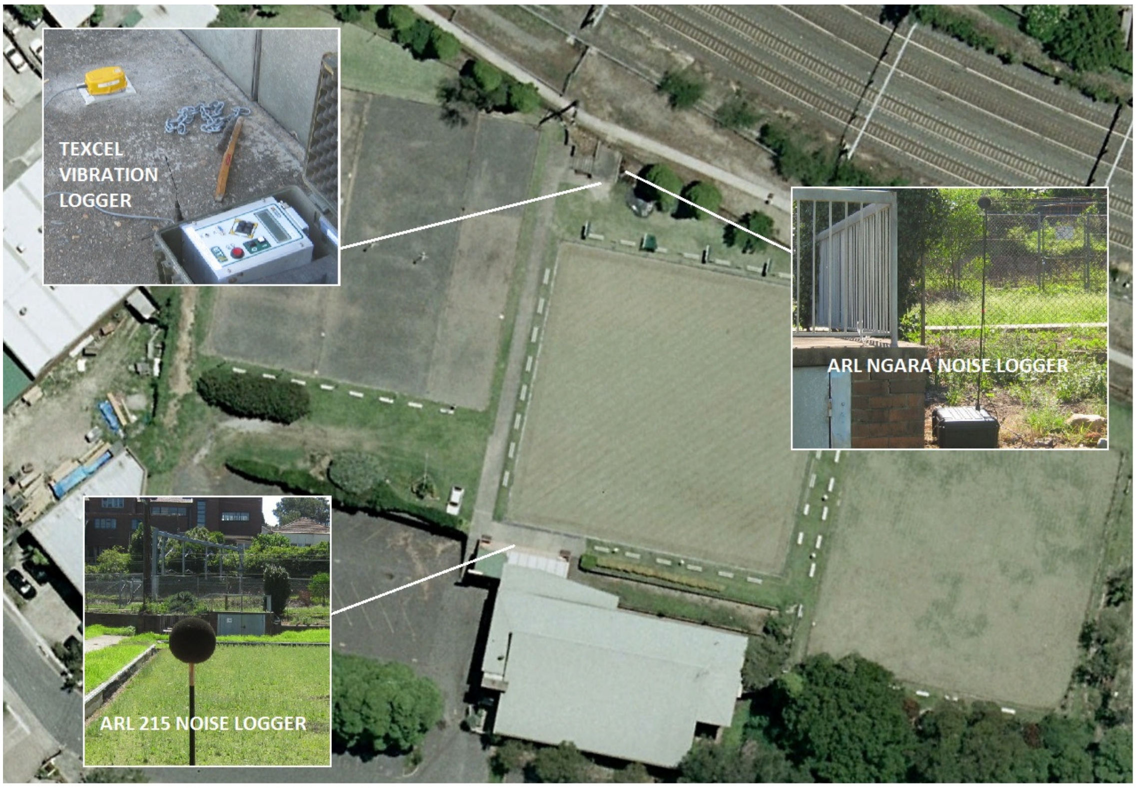
No noticeable noise contribution from the industrial area to the west was observed during the site visit.

The main sources that influence vibration levels on the site were noted to be passenger and freight train movements on the Bankstown rail line.

3.1 Noise and Vibration Monitoring

Two noise loggers and one vibration logger were installed within the site to measure the existing on-site levels. Figure 3-1 shows the locations these instruments.

Figure 3-1: Noise and Vibration Logger Locations



The ARL Ngara noise logger and Texcel ETM vibration logger were located approximately 5 m from the northern boundary of the site and 20 m from the nearside track of the Bankstown rail line, in a location considered to be subjected to the highest on-site levels of rail noise and vibration. A secondary noise logger (ARL 215) was located on the clubhouse external deck at approximately 70 m from the nearside rail line.

The noise monitoring methodology and noise assessment is discussed further below, whilst the vibration measurements and assessment is discussed in Section 6.

3.2 Noise Measurement Methodology

The noise loggers were set to A-Weighting and fast response with their microphones at 1.2 m above ground level and programmed to process and store statistical noise levels every 15 minutes for a period of five days. The Ngara logger was additionally set to continuously record audio to assist with the identification of noise sources during analysis.

The data collected by the noise loggers has been used to determine the long-term ambient noise levels. Additionally, attended noise measurements were undertaken during the site visit using a Bruel & Kjaer Type 2260 sound level meter, to supplement the long term monitoring.

The noise loggers and sound level meter used comply with *AS IEC 61672.1:2004: Electroacoustics – Sound Level Meters – Specifications* and have recent calibration certificates traceable to a NATA certified laboratory.

Calibration checks were carried out on all of the identified equipment before and after the survey measurements and no significant drift occurred between the measurements. For calibration a Bruel & Kjaer Type 4231 acoustic calibrator was used, which conforms with *AS IEC 60942:2004: Electroacoustics – Sound Calibrators*.

All measurements were undertaken in general accordance with *AS1055:1997: Acoustics – Description and Measurement of Environmental Noise*.

Noise loggers determine a variety of descriptors such as $L_{A90,}$ L_{Aeq} and L_{A1} which are used to describe the existing noise environment. The L_{A90} level is taken as the background noise level and is used to derive Rating Background Levels (RBLs). The L_{Aeq} is the energy average of the varying noise over the sample period and the L_{A1} level is the noise level which is exceeded for 1% of the sample period and taken to represent the maximum level.

3.3 Measured Noise Levels

3.3.1 Background Noise Levels

Table 3-1 provides a summary of the daytime, evening and night time Rating Background Noise Levels (RBLs) and ambient L_{Aeq} levels derived directly from the unattended logging at the northern boundary of the site and the clubhouse deck. The RBLs have been calculated in accordance with the procedure defined by the NSW *Industrial Noise Policy (INP)*.

The RBLs have been used to establish specific noise criteria for the control of noise generated on the subject site so that the future development would not adversely impact on the surrounding land uses, including the existing residential properties.

The established criteria are discussed further in Section 7.

As required by the INP, in deriving the RBLs, any effects due to extraneous noise sources or adverse weather (rain and wind greater than 5m/s at a height of 1.5m) have been excluded from the analysis.

Table 3-1: Unattended Background and Ambient Noise Monitoring Results

Location	Logging Period	Daytime (7am-6pm)		Evening (6pm-10pm)		Night Time (10pm-7am)	
		RBL (dBA)	L_{Aeq} (dBA)	RBL (dBA)	L_{Aeq} (dBA)	RBL (dBA)	L_{Aeq} (dBA)
Northern Boundary	19-23 March 2014	41	54	42	57	38	54
Clubhouse Deck	19-23 March 2014	42	54	43	57	38	55

Note: Site observations indicated that the L_{Aeq} levels were principally influenced by contributions from passenger and freight train pass bys on the Bankstown line. Other influences on the measured ambient and background noise levels included traffic movements on Canterbury Road, in addition to influences from distant traffic, distant construction works, fauna (birds and insects) and wind disturbed vegetation.

3.3.2 Rail Noise Levels

The L_{Aeq} rail noise levels determined from the unattended monitoring at the northern boundary for the daytime (7.00am-10.00pm) and night time (10.00pm-7.00am) periods are set out in Table 3-1. Daily noise monitoring plots are provided in Appendix A of this report.

Table 3-2: Unattended Rail Noise Monitoring Results

Location	Logging Period	Daytime (7.am-10pm) $L_{Aeq,15Hour}$ (dBA)	Night Time (10pm-7am) $L_{Aeq,9Hour}$ (dBA)
Northern Boundary	19-23 March 2014	55	54

Note: Site observations indicated that the L_{Aeq} levels were principally influenced by contributions from passenger and freight train pass bys on the Bankstown line. Other influences on ambient and background noise levels included traffic, distant construction works, fauna (birds and insects) and wind disturbed vegetation.

3.3.3 Attended Noise Monitoring

For completeness, the measured noise levels determined from the attended monitoring conducted during the site visit during the afternoon of 19 March are set out in Table 3-3. These correlate well with the unattended measurements.

Table 3-3 Attended Noise Monitoring Results

Location	Time	$L_{Aeq,15min}$ (dBA)	$L_{Amax,15min}$ (dBA)	$L_{A90,15min}$ (dBA)	Notes
Clubhouse Deck	12.45pm – 1.00pm	52	66	42	Main influences on L_{A90}: Distant Traffic / Urban Hum / Fauna (Insects/Birds) / Wind Distrubed Vegetation; Main influences on L_{Aeq}: Passenger Trains (up to 57 dBA) / Freight Trains (up to 55 dBA) / Canterbury Road (typically up to 47 dBA) / Distant Construction Noise; Main influences on L_{Amax}: Birds (66 dBA)
Northern Boundary	13.00pm – 13.15pm	58	74	45	Main influences on L_{A90}: Distant Traffic / Urban Hum / Fauna (Insects/Birds) / Wind Distrubed Vegetation; Main influences on L_{Aeq}: Passenger Trains (up to 60 dBA) / Freight Trains (up to 74 dBA) / Canterbury Road (typically up to 48 dBA) / Distant Construction Noise; Main influences on L_{Amax}: Freight Train (74 dBA)
Northern Boundary	13.15pm – 13.30pm	58	80	46	Main influences on L_{A90}: Distant Traffic / Urban Hum / Fauna (Insects/Birds) / Wind Distrubed Vegetation; Main influences on L_{Aeq}: Freight Trains (up to 80 dBA) / Canterbury Road (typically up to 48 dBA) / Distant Construction Noise Main influences on L_{Amax}: Freight Train (80 dBA)
Clubhouse Deck	13.30pm – 13.45pm	56	75	44	Main influences on L_{A90}: Distant Traffic / Urban Hum / Fauna (Insects/Birds) / Wind Distrubed Vegetation; Main influences on L_{Aeq}: Passenger Trains (up to 58 dBA) / Freight Trains (up to 75 dBA) / Canterbury Road (typically up to 47 dBA) / Distant Construction Noise; Main influences on L_{Amax}: Freight Train (75 dBA)

4 ASSESSMENT OF NOISE IMPACTS

4.1 SEPP Noise Criteria

4.1.1 Airborne Noise Criteria

The Infrastructure SEPP sets out the following criteria for internal noise levels from airborne traffic noise:

"For Clauses 87 (Rail) and 102 (Road):

"If the development is for the purpose of a building for residential use, the consent authority must be satisfied that appropriate measures will be taken to ensure that the following L_{Aeq} levels are not exceeded:

> *in any bedroom in the building: 35dB(A) at any time 10pm–7am*
>
> *anywhere else in the building (other than a garage kitchen, bathroom or hallway): 40dB(A) at any time."*

If internal noise levels with windows or doors open exceed the criteria by more than 10dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia

The objectives can be translated to external noise levels by allowing an additional 10 dB for the noise reduction from outside to inside through an opening.

Table 4-1 $L_{Aeq(period)}$ Road Noise Criteria

Room Type	Internal Criteria dBA	External Criteria (open windows) dBA	Level at Which Ventilation is Required dBA
Bedrooms (Night Only)	35	45	55
Any Habitable Room	40	50	60

4.1.2 Ground Borne Noise Criteria

With respect to groundborne noise, the NSW Department of Planning guideline notes the following:

Where buildings are constructed over or adjacent to land over tunnels, groundborne noise may be present without the normal masking effect of airborne noise.

In such cases, residential buildings should be designed so that the 95th percentile of train pass-bys complies with a groundborne L_{Amax} noise limit of 40dBA (daytime) or 35dBA (night time) measured using the "slow" response time setting on a sound level meter.

In some rare instances, groundborne noise may be an issue for noise sensitive locations adjacent to surface or elevated track (ie. not just track in tunnel locations). These instances are uncommon, are not easily predicted, and will need to be assessed and managed on an individual basis, with the assistance of an acoustic consultant.

As a general guide, groundborne noise may be an issue in habitable rooms which are shielded from airborne noise from the railway. Examples are rooms that are not facing the railway, and where cuttings or noise barriers block the line of sight between the receiver room and the rail line. In addition, some structures such as suspended slabs can lend to vibration amplification.

On this site it is considered that groundborne regenerated noise is not an issue and it has not been considered further.

4.2 Rail Noise Modelling Methodology

The measurements and observations showed rail movements to be the main issue with respect to potential noise impacts on the proposed development.

In order to evaluate the future noise exposure from existing rail movements throughout the development, a 3D noise model has been created with the Cadna-A acoustic noise prediction software (Version 4.3.). This program is used and recognised internationally and is also recognised by the EPA as an acceptable computer noise model.

For modelling purposes the Bankstown Rail line has been approximated by a line source defined within the rail corridor. This has been assigned a sound power level by calibration based on the noise levels measured on site (Table 3-2). Additionally, a further 5 dB correction has been applied to the source to conservatively account for modelling tolerance and any future increase in rail movements.

Based on the Master Plan Option 1 site configuration (as discussed in Section 2.1) and taking account of the source and receiver locations and the acoustic shielding provided by the on-site buildings, the daytime ($L_{Aeq,9hour}$) and night time ($L_{Aeq,9hour}$) noise levels have been predicted throughout the site.

The results for the night-time are shown in the following sections. It should be noted that the external noise levels are 1 dB higher in the daytime period, however, the night criterion is 5 dB lower than the day criterion therefore compliance with the night-time objectives also implies compliance with daytime objectives.

4.3 Predicted Rail Noise Levels

The predicted night time noise levels at the future building facades are shown from different perspectives in three dimensional colour plots in Figures 4-1 to 4-5. A review of the plots shows the predicted $L_{Aeq,9hour}$ noise levels exceed 60 dBA at the most exposed building facades, with substantially lower levels predicted at the further and more shielded facades.

A noise reduction of 10 dB would be achieved through a window partially opened for ventilation purposes; therefore, the internal criteria would be expected to be achieved through partially open windows where external facades are exposed to noise levels up to 45 dBA external to bedrooms or 50 dBA external to other habitable rooms.

Compliance with the noise criteria would not be met through open windows where external facades are exposed to noise levels exceeding 45 dBA external to bedrooms or 50 dBA external to other habitable rooms. In these cases, windows would need to be closed and appropriate glazing standards should be specified to ensure that the internal noise criteria are met.

Further to this, mechanical ventilation would be required where external facades are exposed to noise levels exceeding 55 dBA external to bedrooms or 60 dBA external to other habitable rooms.

Figure 4-1: Building Noise Map ($L_{Aeq,9hour}$ dBA) – View from North-West

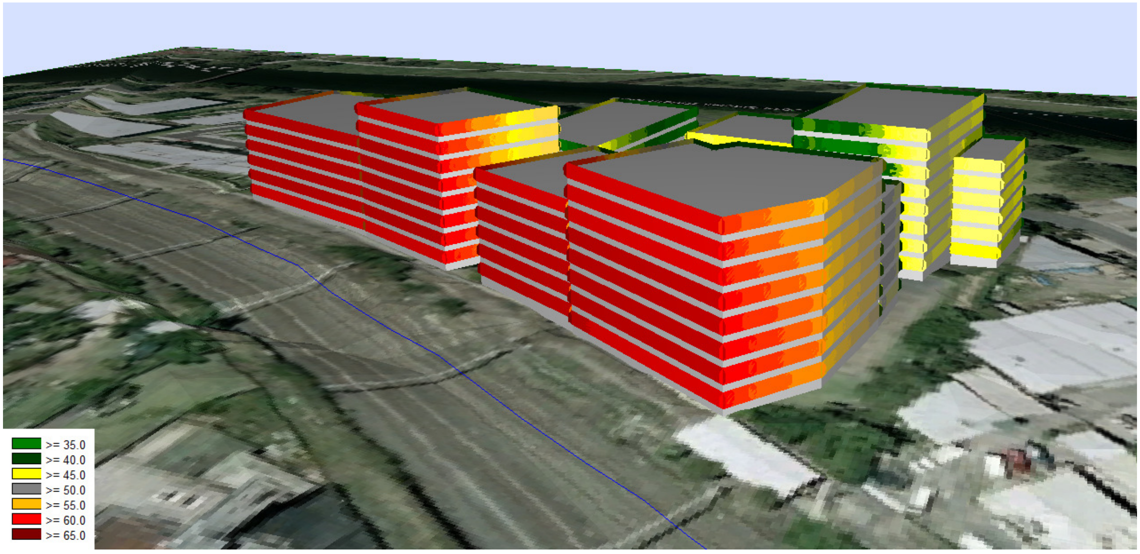


Figure 4-2: Building Noise Map ($L_{Aeq,9hour}$ dBA) – View from West

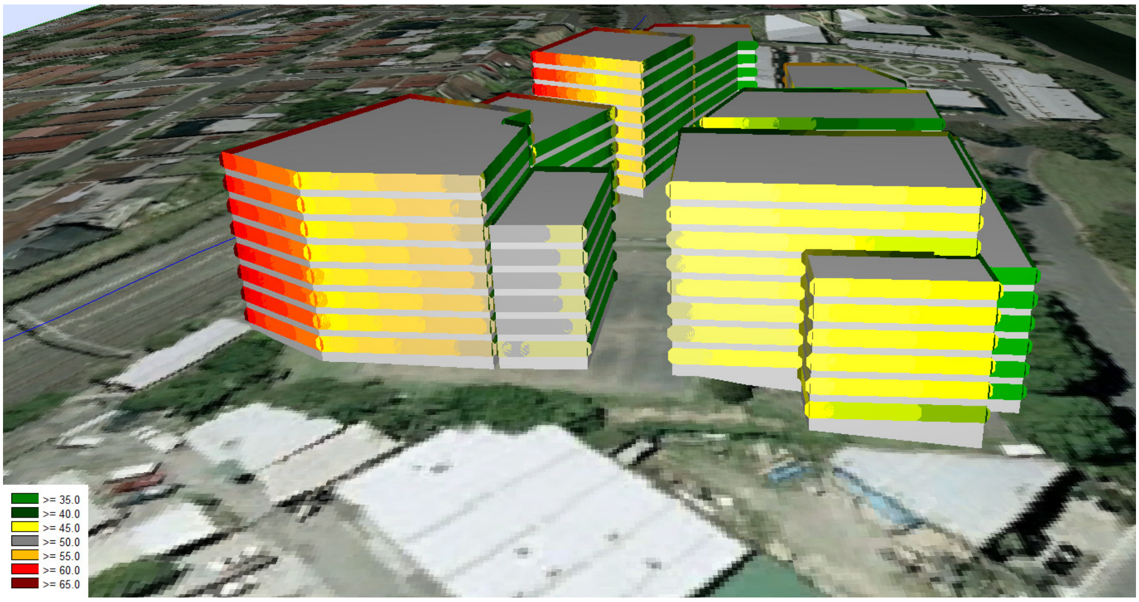


Figure 4-3: Building Noise Map ($L_{Aeq,9hour}$ dBA) – View from North South-West

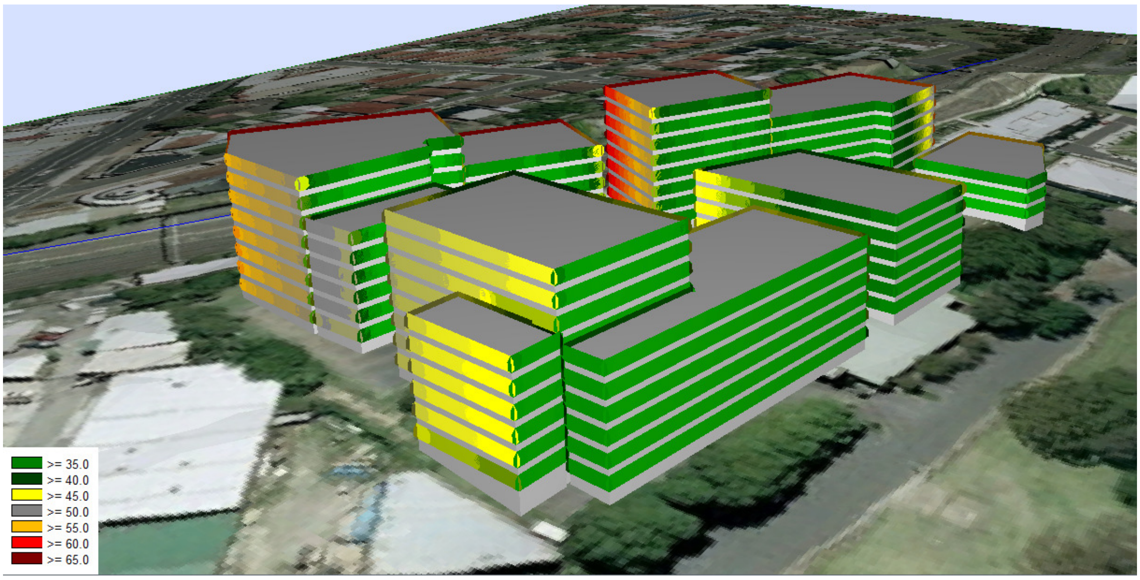


Figure 4-4: Building Noise Map ($L_{Aeq,9hour}$ dBA) – View from South-East

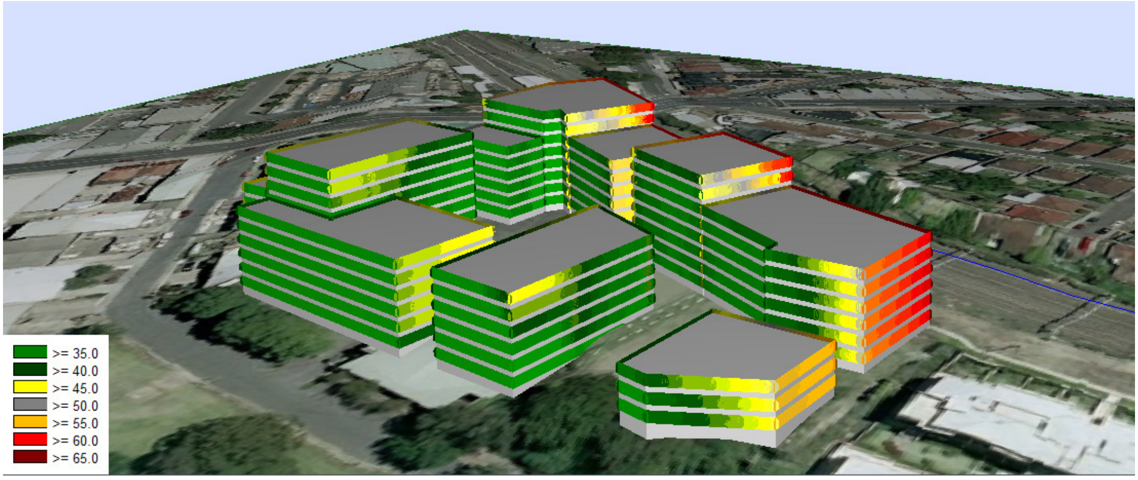
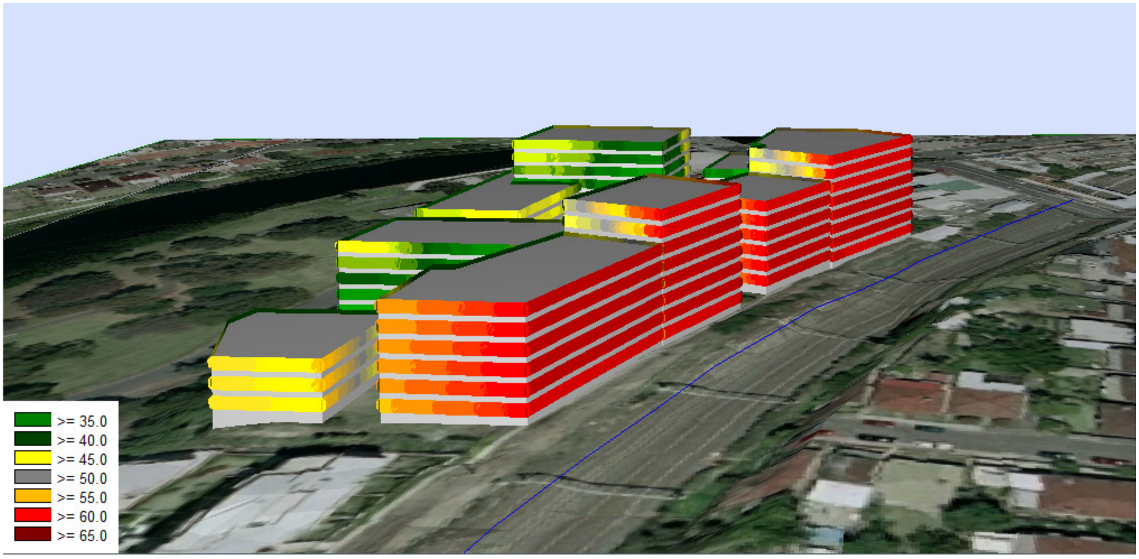


Figure 4-5: Building Noise Map ($L_{Aeq,9hour}$ dBA) – View from North-East



In reference to the predicted levels shown in Figures 4-1 to 4-5, indicative glazing and mechanical ventilation requirements for achieving the SEPP criteria are provided in Section 4.4.

4.4 Glazing Requirements

Based on the modelled facade noise levels illustrated in Figures 4-1 to 4-5, indicative glazing requirements to achieve the internal noise objectives of the Infrastructure SEPP have been determined.

Table 4-2 sets out the minimum glazing requirements that would be expected to allow the SEPP noise criteria to be met considering the contributions from rail movements and road traffic on Canterbury Road. Whilst noise from the industrial area to the west is not considered to be significant, the identified glazing would also be expected to provide appropriate control for any intermittent noise emanating from this area.

It should be noted that the identified glazing standards have been based on achieving the SEPP criteria, which is aimed at achieving a level of acoustic amenity that most people would find satisfactory. The intent is not to render the external noise inaudible internally.

Additionally, it should be noted that the identified glazing standards are to be regarded as indicative only for planning purposes. Exact details should be established at the detailed design stage of each project.

4.5 Mechanical Ventilation Requirements

Where a noise reduction of greater than 10 dB is required to achieve the internal noise criteria, windows would need to be closed. This in turn necessitates the requirement for mechanical ventilation.

With reference to the predicted façade noise levels and requirements for mechanical ventilation set out in Table 4-1, Table 4-2 also indicatively identifies mechanical ventilation requirements.

Where mechanical ventilation is required this may be achieved using an in-wall acoustic noise absorbing ventilator, for example the Aeropac Ventilator from Acoustica. These ventilators provide fan-forced ventilation of the room while reducing noise intrusion from the exterior by incorporation of acoustic absorption into the ventilator.

Whilst the recommendations provided herein are indicative only, calculations confirm that subject to appropriate building façade / glazing design and appropriate provision of mechanical ventilation, the proposed development may be established without undue risk of noise impacts.

Table 4-2: Recommended Glazing Types (Indicative Only)

Site	Building ID	Building Use	Facade							
			North		East		South		West	
			Bedrooms	Other Habitable Rooms	Bedrooms	Other Habitable Rooms	Bedrooms	Other Habitable Rooms	Bedrooms	Other Habitable Rooms
1	1a	Community	Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard
2	2a	Commercial Ground Floor & Residential Upper Floors	Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard
	2b	Residential	6.38 mm Laminate	Standard	6.38 mm Laminate	Standard	Standard	Standard	6.38 mm Laminate	Standard
	2c	Residential	6.38 mm Laminate	Standard	6.38 mm Laminate	Standard	Standard	Standard	n/a	n/a
3	3a	Residential	Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard
	3b	Residential	Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard
	3c	Residential	Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard
	3d	Residential	6.38 mm Laminate	Standard	6.38 mm Laminate	Standard	Standard	Standard	West Façade: 6.38 mm Laminate North-West Façade: 6.38 mm Laminate	West Façade: Standard North-West Façade: Standard
	3e	Residential	6.38 mm Laminate	Standard	6.38 mm Laminate	Standard	Standard	Standard	6.38 mm Laminate	Standard

- Recommended minimum glazing standards are presented. Higher levels of internal noise amenity may be achieved by specifying higher glazing standards;
- If operable windows should be fitted with acoustic seals capable of achieving an airtight closure – These can be provided by suppliers including Raven and Schlegel;
- Shaded cells indicate the requirement for provision of mechanical ventilation. These mechanical ventilation systems should be selected/located to ensure that they do not materially contribute to internal noise levels;
- All details to be confirmed during detailed design.

5 SLEEP DISTURBANCE ASSESSMENT

5.1 Sleep Disturbance Criteria

Based on the current research into the effects of noise on sleep disturbance, the EPA recognises the requirement to undertake a detailed assessment of maximum noise levels in cases where $L_{A1,(1min)}$ levels are found to exceed the $L_{A90,(15min)}$ by more than 15 dB during the night time.

In the case of the site night time background noise levels have been determined to be 38 dBA at both monitoring locations therefore an external sleep disturbance screening criterion of 53 dBA is considered applicable for any future residences on the site.

The EPA recognises that the detailed analysis should address the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night time period.

The $L_{A1,(1 min)}$ descriptor is meant to represent a maximum noise level measured under 'fast' time response. However, the EPA accepts analysis based on either $L_{A1,(1min)}$ or $L_{A(max)}$.

Based on the current research it is generally accepted that:

- Maximum internal noise levels below 50–55 dBA are unlikely to cause awakening reactions; and
- One or two noise events per night, with maximum internal noise levels of 65–70 dBA, are not likely to affect health and wellbeing significantly.

The "sleep disturbance" criterion is only applicable to night time (10.00pm to 7.00am) operations.

5.2 Maximum Night-Time Rail Noise Levels

Review of the Ngara monitoring data (in conjunction with the recorded audio files) identified that that rail movements during the night time period generated maximum noise levels typically no higher than $L_{A1,1min}$ 75-80 dBA. A few isolated rail pass by events did, however, generate maximum levels exceeding 80 dBA. The measured $L_{A1,1min}$ levels associated with these events are compared with the $L_{Aeq,15min}$ and $L_{A90,15min}$ levels in Table 5-1.

Table 5-1: Maximum Rail Noise Levels ($L_{A1,1min}$) exceeding 80 dBA

Date	Time	$L_{A1,1min}$	$L_{Aeq,15min}$	$L_{A90,15min}$	Source
20 March 2014	3.22am	82	63	41	Rail Squeal
21 March 2014	2.06am	88	63	39	Rail Squeal
24 March 2014	2.11am	81	61	40	Rail Squeal
24 March 2014	3.47am	81	60	39	Rail Squeal

5.3 Maximum Night Time Rail Noise Assessment

By comparing the levels in Table 5-1, it can be seen that for these events the $L_{A1,1min}$ noise levels emerged above the L_{Aeq} noise level by some 19-25 dB and above the background noise level by some 41-49 dB. This level of emergence above the ambient / background levels indicates a high level of intrusiveness and this can be heard on the audio recordings.

Notwithstanding this, with regard to the guidance concerning sleep disturbance discussed above, as these events have only been noted to seldom occur during the night-time period, the typical maximum noise level of L_{A1} 80 dBA is principally considered by this assessment.

Assuming the glazing schedule provided in Table 4-2 were to be adopted, based on the external level of L_{A1} 80 dBA, with windows closed typical maximum internal noise levels of up to approximately L_{A1} 50 dBA could be expected to arise within any of the most exposed future bedrooms (i.e. bedrooms with north facing external facades within Buildings 2b, 2c, 3d and 3e). This is an acceptable typical maximum noise level for bedrooms.

With respect to the loudest rail noise events identified in Table 5-1 (i.e. up to L_{A1} 88 dBA), maximum internal noise levels of up to approximately L_{A1} 58 dBA may be expected to arise within the most exposed bedrooms. For infrequent events this is also considered an acceptable level.

With predicted internal maximum noise levels of 50 dBA (typical) and up to 58 dBA (for no more than one or two noise events per night), it has been determined that the identified recommendations for glazing and mechanical services would provide sufficient control of maximum noise levels.

If a greater level of noise amenity is however desired, providing the most exposed bedroom windows of Buildings 2b, 2c, 3d and 3e with 12.27 mm laminate glass would be expected to result in a further reduction to internal noise levels by approximately 5 dB.

6 ASSESSMENT OF VIBRATION IMPACTS VIBRATION CRITERIA

With respect to vibration, the NSW Department of Planning guideline *Development Near Rail Corridors and Busy Roads – Interim Guideline* notes the following:

- *Vibration levels such as the intermittent vibration emitted by trains should comply with the criteria in Assessing Vibration: A Technical Guideline (DECC 2006); and*
- The standards used for assessing the risk of vibration damage to structures are German Standard DIN 4150 Part 3 1999 and British Standard BS 7385 Part 2 1993.

6.1.1 Human Exposure to Vibration

Assessing Vibration: A Technical Guideline provides guidance for assessing human exposure to vibration. The publication is based on British Standard BS 6472:1992.

The guideline notes that intermittent vibration (such as the nature of vibration that occurs with train pass bys) is best assessed by calculation of the Vibration Dose Value (VDV) which is based on the *weighted* root mean quartic (rmq) acceleration. However, for simplicity of assessment and monitoring, a RMS particle velocity goal is preferred.

Table 6-1 sets out RMS velocity values for continuous vibration as specified by *Assessing Vibration: A Technical Guideline.* These criteria are more onerous than the vibration dose values for intermittent vibration recommended by the guideline. Compliance with the criteria in Table 6-1 would therefore imply compliance with the intermittent criteria.

Table 6-1: Human Comfort Vibration Goals – RMS Velocity (mm/s)

Place	Day (7.00am-10.00pm)		Night (10.00pm-7.00am)	
	Preferred	Maximum	Preferred	Maximum
Residences	0.20	0.40	0.14	0.28
Offices	0.40	0.80	0.40	0.80

6.1.2 Building Damage from Vibration

British Standard BS 7385:1993 and German Standard DIN 4150:1999 both provide goal levels, below which vibration is considered insufficient to cause building damage. Of these, DIN 4150 is the more stringent. Table 6-2 summarises the goal levels specified in DIN 4150.

Table 6-2: Guideline Values for Vibration Velocity to be used when Evaluating the Effects of Short-Term Vibration on Structures (DIN4150-3:1999)

Type of Structure	Guideline Values for Velocity – PPV (mm/s)		
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz
Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20
Structures that, because of their particular sensitivity to vibration, cannot be classified under either of the other classifications and of great intrinsic value	3	3 to 8	8 to 10

With regard to these levels DIN4150 states, *"experience has shown that if these values are complied with, damage that reduces the serviceability of the building will not occur. If damage nevertheless occurs, it is to be assumed that other causes are responsible. Exceeding these values does not necessarily lead to damage; should they be significantly exceeded, however, further investigations are necessary."*

6.2 Vibration Measurement Methodology

For the purpose of determining the existing vibration levels on-site, a Texcel ETM vibration logger (serial number: 7073) was installed as shown in Figure 3-1. The logger has a current and valid calibration certificate.

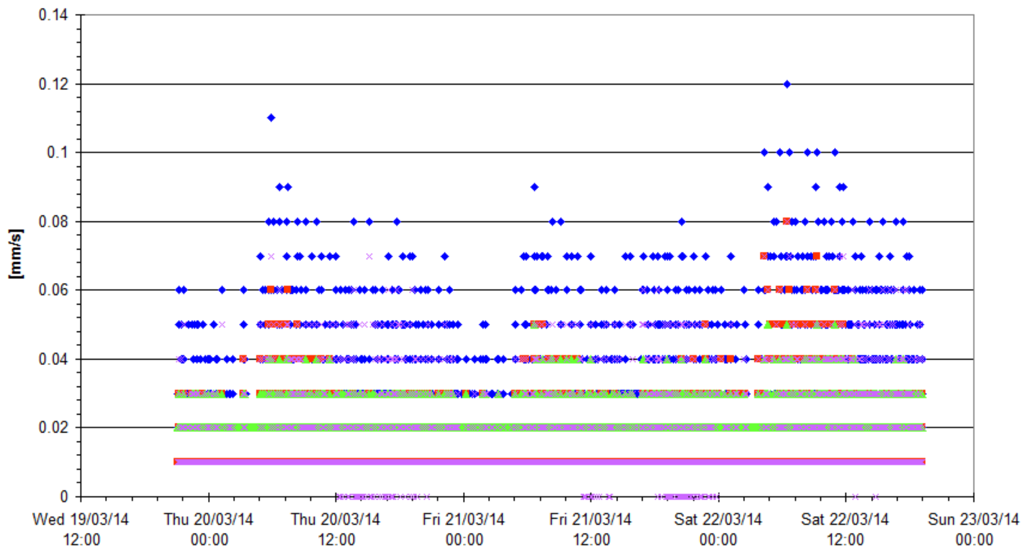
The logger was located at approximately 5 m from the northern boundary of the site and at approximately 20 m from the nearside rail line. The transducer was fixed a concrete footing using an epoxy resin. This location was considered to be representative of the site's highest rail vibration exposure.

The instrument was configured to measure vibration velocity (in mm/s) continuously over 10 second measurement intervals in 3 orthogonal axes. Vibration levels were recorded between 9.00pm on 19 March and 12.30pm on 22 March.

6.3 Measured Vibration Levels and Assessment

The RMS vibration velocity component levels and vector sum levels measured between 9.00pm on 19 March and 12.30pm on 22 March are plotted in Figure 6-1.

Figure 6-1: RMS Vibration Velocity Measured at 20 m from Rail Corridor



Note: Pink, Green & Red: Orthogonal RMS velocity components; Blue: Vector sum of the three orthogonal components.

The highest of the measured levels are materially lower than the most onerous human comfort vibration criterion of 0.14 mm/s that would apply to residences at night. The risk of disturbance of human comfort due to rail pass by events and / or vibration effects from Canterbury Road is therefore considered to be minimal.

Additionally, the measured vibration levels are far below the building damage criteria.

On this basis, it is considered that the proposed development may be established without material risk of adverse vibration impacts.

7 NOISE GENERATED ON THE SUBJECT SITE

Future development on the site will include mechanical plant which will generate noise emissions to the surrounding area and other buildings on the site. Therefore noise may need to be mitigated to protect the acoustic amenity of existing and future receivers.

Appropriate site specific noise criteria bas been determined based on the stipulations of the NSW *Industrial Noise Policy (INP)*.

There are two noise criteria which should be satisfied under the *INP*. The first being the "intrusiveness" criterion which assesses the likelihood of noise being intrusive above the ambient noise level. The intrusiveness criterion applies for residential receivers only.

The second noise criterion, known as the "amenity" criterion ensures the total industrial noise from all sources in the area does not rise above a maximum acceptable level.

The *INP* stipulates that intrusiveness and amenity criteria are determined for the daytime (7.00am 6.00pm), evening (6.00pm 10.00pm) and night time (10.00pm 7.00am) periods, as relevant. The determined criteria apply at the most affected point on or within the receiver property boundary.

The intrusiveness criterion requires that the L_{Aeq} noise level from the source being assessed, when measured over 15 minutes, should not exceed the Rating Background Noise Level (RBL) by more than 5 dB.

The amenity criteria set limits on the total noise level from all industrial noise sources affecting a receiver. Different amenity criteria apply for different types of receiver (e.g. residential, commercial, industrial – or for areas specifically reserved for passive recreation) and different areas (e.g. urban, suburban, rural).

Table 7-1 sets out the site specific criteria, determined in accordance with *INP*. These criteria would apply at the most affected point on or within the receiver property boundary. Criteria applicable at the boundaries of passive recreation sites apply only when those sites are in use.

Table 7-1 *INP* Noise Criteria

Receiver	Intrusiveness Criterion ($L_{Aeq,15min}$ dBA)			Amenity Criterion ($L_{Aeq,Period}$ dBA)		
	Day	Evening	Night	Day	Evening	Night
Residential	46	47	43	60	50	45
Commercial	n/a	n/a	n/a	65	n/a	n/a
Passive Recreation Area	n/a	n/a	n/a	50	50	50

Note: The determined criteria apply at the most affected point on or within the receiver property boundary. Criteria applicable at the boundaries of passive recreation sites apply only when those sites are in use.

These criteria should be considered during the specification of mechanical services that may be installed on the site. As a general guide, to ensure compliance, it would be recommended that all plant be specified and located to ensure that cumulative operational noise from the site does not exceed the most onerous night time criterion of L_{Aeq} 43 dBA at the site boundaries. During detailed design, noise emission allowances for each building could be calculated to ensure compliance with the criteria identified in Table 7-1.

The adoption of standard engineering noise controls, such as silencers, barriers and lined ducts, can be adopted to mitigate any future noise emissions associated with services It is recommended that above criteria be applied to any future development applications for the site.

8 CONCLUSION

Canterbury City Council is considering the reclassification and rezoning of the existing Public Recreation (RE1) zoned site, located at 15 Close Street, Canterbury to provide for residential and / or community uses.

Wilkinson Murray has undertaken an assessment of potential noise and vibration effects that may arise due to the site's proximity to the existing Bankstown rail corridor and Canterbury Road.

Based on the results of on-site monitoring, assessment of potential noise and vibration impacts on the proposed development has been undertaken in reference to the relevant assessment criteria set out in the NSW Infrastructure SEPP which is supplemented by the Department of Planning's document *Development* in *Rail Corridors and Busy Roads – Interim Guideline*.

Additionally an assessment of on-site maximum noise levels arising from rail movements has been undertaken in reference to the sleep disturbance criteria recognised by the EPA.

The following findings have been made:

- Appropriately specified glazing standards would be required for the proposed buildings located on the northern boundary in order to meet the internal noise criteria recommended by the Infrastructure SEPP. A schedule of indicative glazing requirements has been prepared to indicate the measures necessary to achieve satisfactory internal noise levels. The identified glazing would also be expected to control maximum noise levels arising from rail movements to acceptable levels.

- The internal noise criteria would not be met within the most exposed rooms with windows open and therefore mechanical ventilation would be required to ensure that satisfactory ventilation can be achieved with windows closed. Indicative requirements for provision of mechanical ventilation have also been provided.

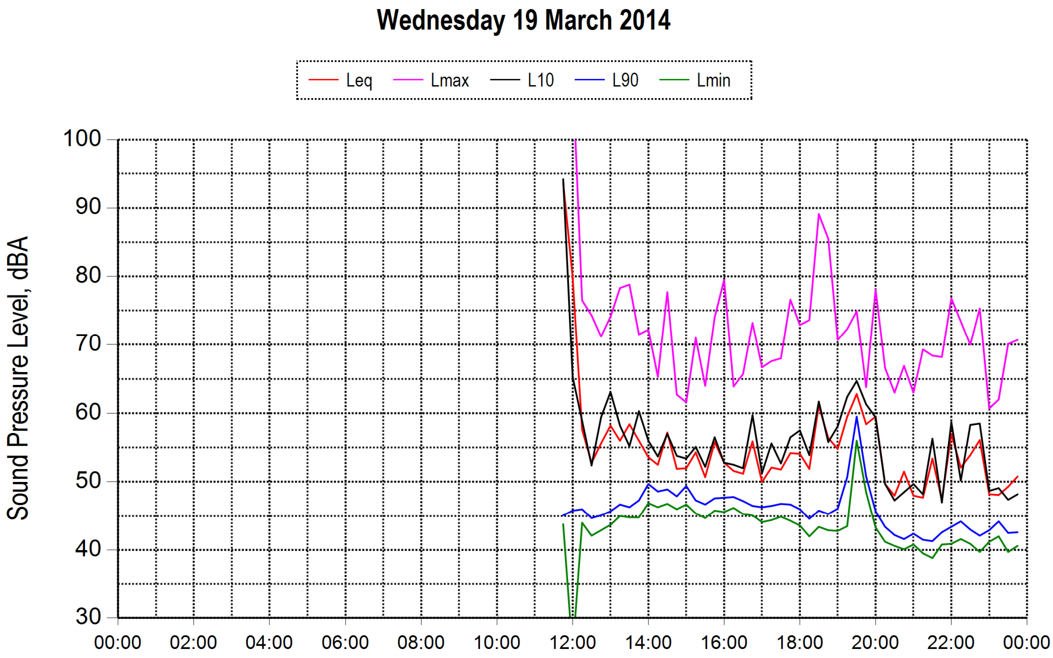
- It is considered that provided the identified glazing standards and mechanical ventilation recommendations are adopted, the proposed development may be established without undue risk of noise impacts.

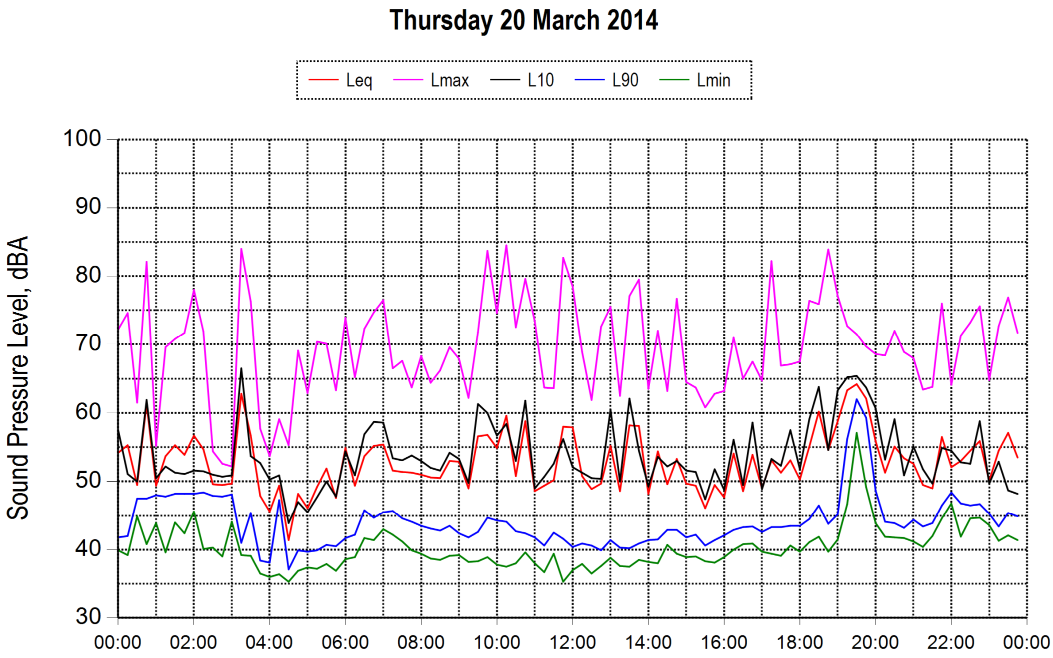
- Measured on-site vibration levels indicate a minimal risk of disturbance to human comfort due to rail pass-by events and/or vibration effects from Canterbury Road. On this basis, it is considered that the proposed development may be established without undue risk of vibration impacts.

- Based on the background noise levels measured on-site, recommended noise criteria for the management of noise generated within the subject site have been determined. It is recommended that these noise criteria be applied at Development Application stage and during detailed design of mechanical services that may be installed on the site in the future.

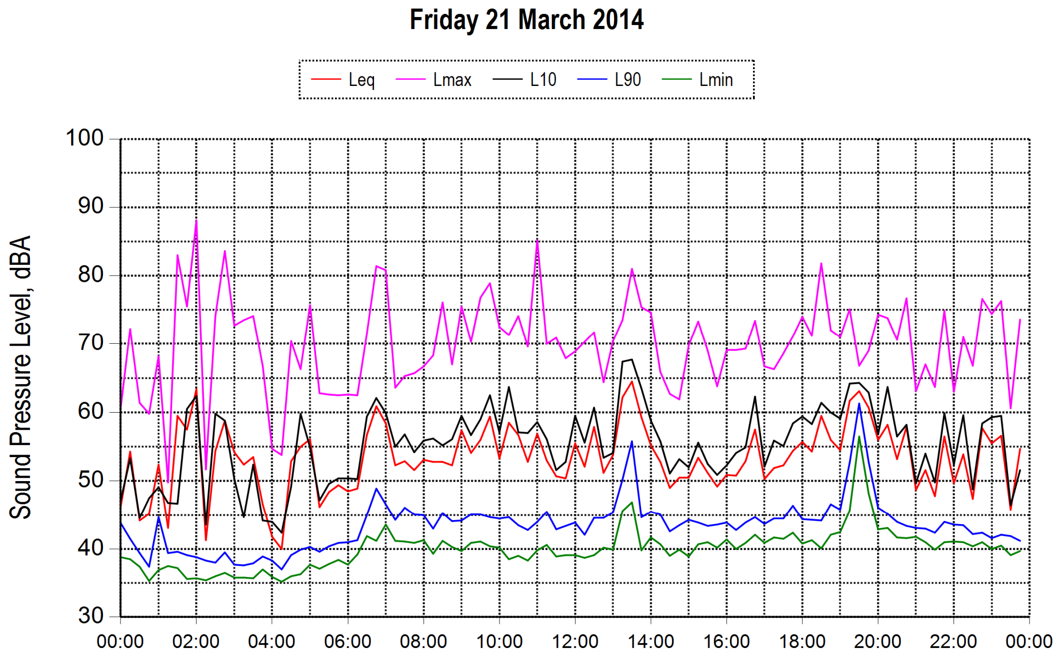
APPENDIX A

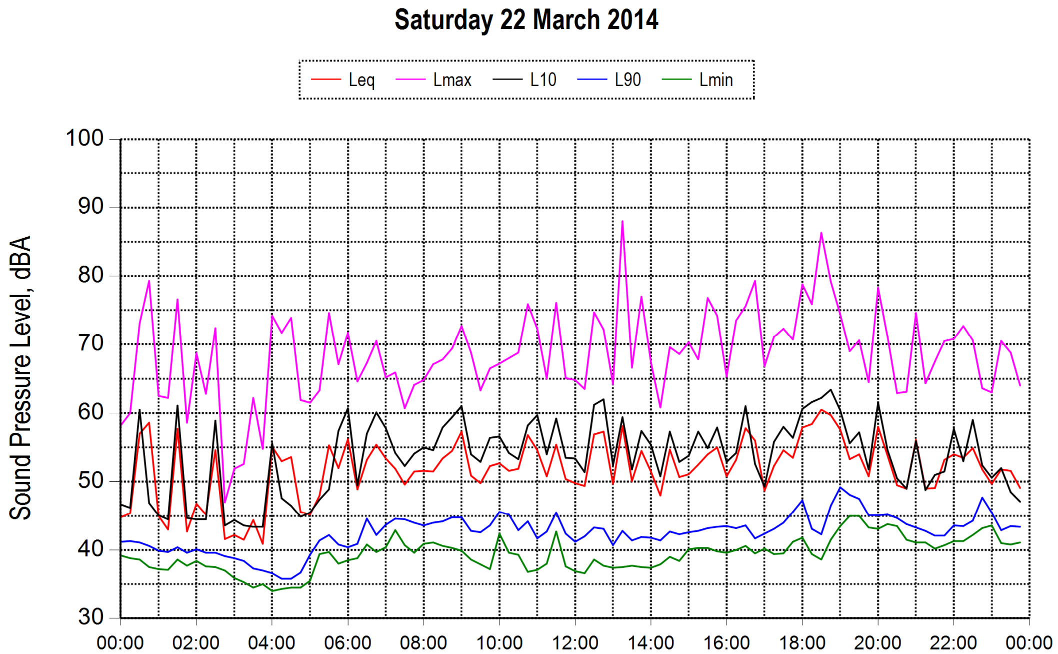
NOISE MEASUREMENT RESULTS



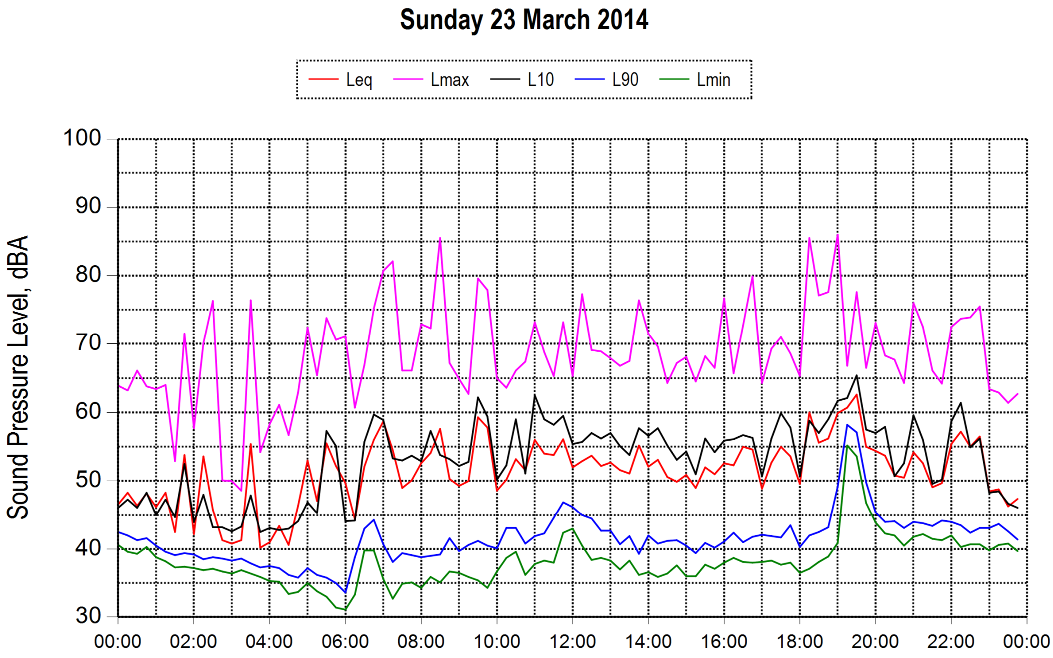


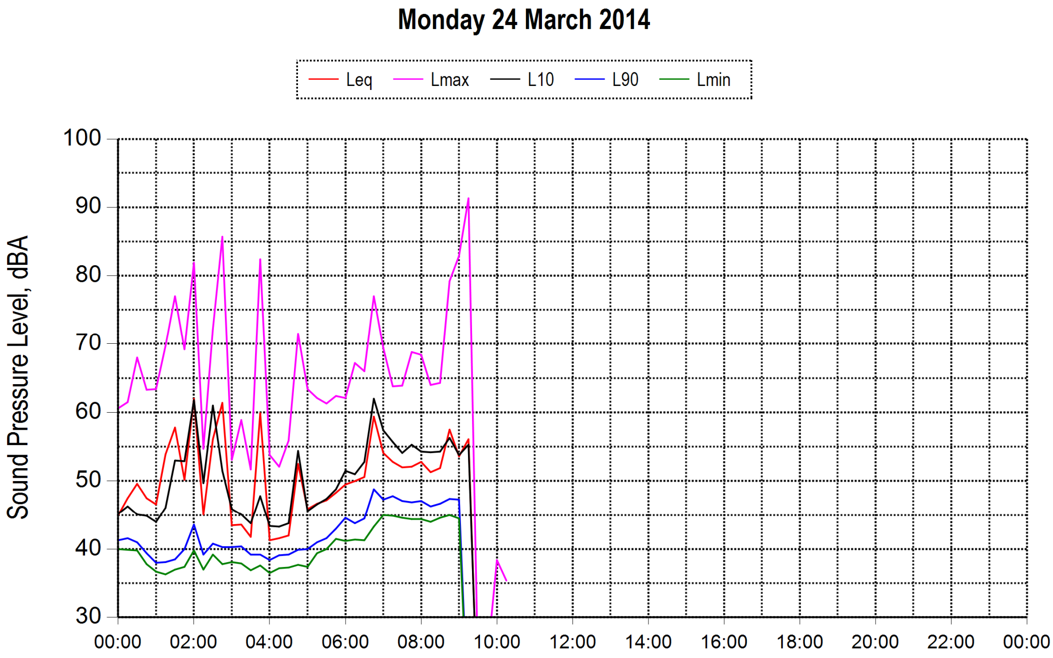
Noise levels measured by ARL Ngara at 5 m from the northern site boundary and 20 m from rail corridor.





Noise levels measured by ARL Ngara at 5 m from the northern site boundary and 20 m from rail corridor.





Noise levels measured by ARL Ngara at 5 m from the northern site boundary and 20 m from rail corridor.