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1 Crescent St Holroyd

Acoustic Report
Feasibility Study

Prepared for:	Prepared by:
Tiberius Parramatta Pty. Ltd.	**Marc Guitart** Project No. 27139-SYD-N \\WGE.FILES\PROJECTS\27839\PROJECT DOCUMENTATION\REPORTS\N_RE_004.DOCX
Date: 11 May 2015	Level 6, Building B, 207 Pacific Highway, St Leonards NSW 2065 **T:** (02) 8484 7000 **F:** (02) 8484 7100 **E:** sydney@wge.com.au **W:** www.wge.com.au

WOOD & GRIEVE ENGINEERS

Revision

REVISION	DATE	COMMENT	APPROVED BY
4	11/05/2015	Comments added	**ORFG**
3	30/04/2015	Comments added	**ORFG**
2	28/04/2015	Comments added	**ORFG**
1	17/04/2015	Initial issue	**ORFG**

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1. Executive Summary

As part of the early works documentation process, Wood & Grieve Engineers has been engaged by Tiberius Parramatta Pty. Ltd. to provide an acoustic assessment for the proposed mixed use development located at 1 Crescent St, Holroyd.

The current use of the existing site is industrial and the aim of this report is to study if a potential change of use from industrial to residential is feasible in terms of noise and vibrations.

This report will be part of the Planning Proposal documentation to be submitted to Holroyd Council in order to support the rezoning of the site.

The proposed development will consist of:

- Approximately 3.9 hectares
- New 7 mixed use towers with building heights ranging from 8 storeys to 35 storeys maximum

This assessment discusses the likely noise impact of the development on the potentially nearest most-affected receivers surrounding the site but also the impact of the existing environment surrounding the site in terms of noise and vibration on the potential residential and mixed use development.

This assessment has been prepared considering the following documents:

- Residential Controls; Holroyd Development Control Plan (DCP) 2013.
- NSW OEH Industrial Noise Policy (INP).
- NSW Department of Planning – Development Near Rail Corridors and Busy Roads – Interim Guideline
- AS/NZS 2107:2000 – Acoustics - Recommended Design Sound Levels and Reverberation Times for Building Interiors.
- AS/NZS 3671:1989 – Acoustics – Road Traffic Noise Intrusion – Building Siting and Construction.
- Department of Environment and Conservation NSW – Assessing Vibration: a Technical Guideline

This report provides:

- A statement of compliance with the Holroyd City Council requirements for the proposed mixed-use development within the vicinity of the nearest potentially most affected residential receivers.
- Recommendations and advice for noise mitigation measures for the proposed development in order to meet the relevant criteria.

This noise assessment is based on noise data collected by a combination of attended noise and vibration measurements and unattended noise loggers at representative locations around the site over 7 days.

The overall conclusion includes the following:

- The Glazing façade for all buildings fitted with standard glazing thickness will achieve internal noise levels criteria;
- Future mechanical noise generated by the development will achieve noise criteria using typical noise mitigations measures;
- No negative traffic noise impact or sleep disturbance on the surrounding sensitive receivers is expected from the development;
- Existing noise and vibrations impact from the railway corridor are complying with the minimum acceptable levels.

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This preliminary acoustic study has been prepared and taken into account existing site conditions in terms of traffic and railway noise and vibrations. Consultations with the transport authorities are necessary in order to understand future conditions that could vary existing ones.

A 3D acoustic modelling study to accurately predict the traffic noise impact from the nearby roads through all the facades is strongly recommended at the relevant DA stage. This will provide accurate results which will provide a good level of amenity for the residents of the proposed mixed use development.

This report is based on our understanding of the proposed project, application of the relevant state guidelines and professional experience within the acoustic field. Therefore this report shall not be relied upon as providing any warranties or guarantees.

2. Background

2.1 Information Sources

The following documentation has been used for the preparation of this report:

- Site drawings presenting the location of the proposed development in relation to the nearest receivers:
  - 070807 – 1 Crescent St Site Plan MD Rev 3
- Holroyd Inception Meeting presentation from Mckenzie Group dated 19 March 2015

  Site drawings presenting the location of the proposed development in relation to the nearest receivers:
  - 070807 – 1 Crescent St Site Plan MD Rev 3
- Architectural presentation to Holroyd Councillors from Architectus, which include:
  - Masterplan 11.05.2015

3. Project Overview

3.1 Site description

The site is located at 1 Crescent Street, Holroyd and is bound by Western Motorway and Holroyd Sportsground to the North, Woodville Rd to the East, an existing industrial area to the West and Crescent St and the railway corridor to the South.

The existing site is currently occupied by an industrial warehouse dedicated to sell and repair heavy machinery.

The nearest noise sensitive residential receivers is the house located at 1 Blane Street (labeled as R1), and 25 Union Street (R2), Holroyd. The surrounding industrial receivers to the West are also considered as receivers.

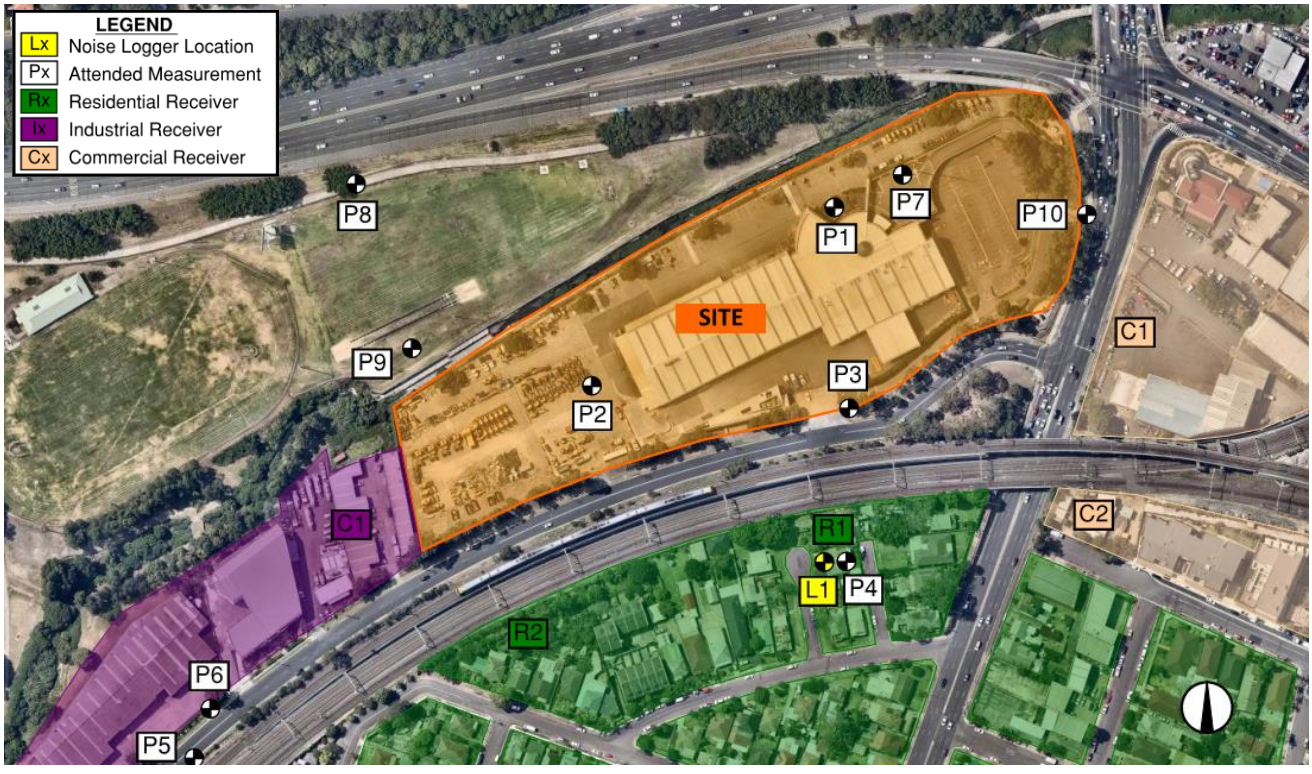
The site location, measurement positions and surrounding commercial and residential receivers are shown in Figure 1.

3.1.1 Acoustic Issues

The acoustic issues relating to the development are as follows:

- Noise intrusion to the proposed development from vehicle movements on M4 Western Motorway and Woodville Rd;
- Noise and vibration intrusion from trains pass-by on Southern Railway corridor;
- Noise intrusion from surrounding industrial noise from existing industrial sites;
- Noise emissions from mechanical plant for the commercial and residential sites;
- Traffic noise generation from vehicle movements accessing / exiting the proposed development.

Figure 1: Overview of the Site and Measurement Locations



Source: nearmap.com

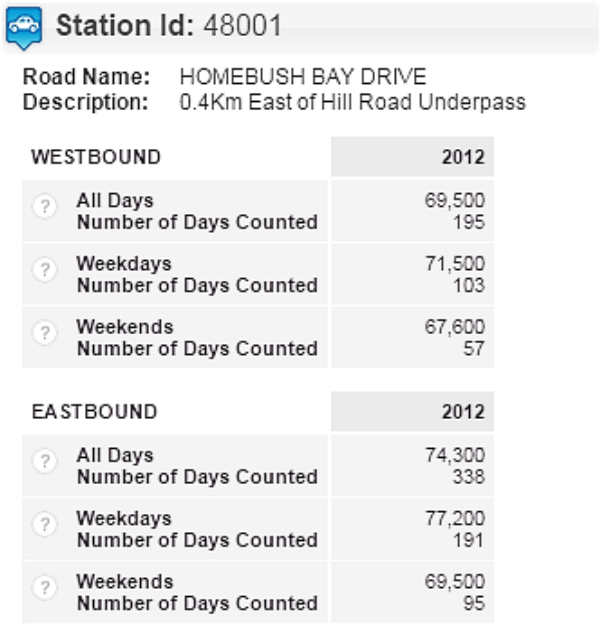
3.1.2 M4 Western Motorway

M4 Western Motorway is located within 50-140 metres from the boundary of the proposed development.

The motorway has 4 lines plus merging lines in each direction.

Exiting traffic volume according to www.rms.nsw.gov.au at the nearest station Id: 48001 (Homebush Bay Drive) is shown in Figure 2.

Figure 2: RMS - Average Daily Traffic Volume



Station Id: 48001

Road Name: HOMEBUSH BAY DRIVE
Description: 0.4Km East of Hill Road Underpass

WESTBOUND	2012
All Days Number of Days Counted	69,500 195
Weekdays Number of Days Counted	71,500 103
Weekends Number of Days Counted	67,600 57

EASTBOUND	2012
All Days Number of Days Counted	74,300 338
Weekdays Number of Days Counted	77,200 191
Weekends Number of Days Counted	69,500 95

3.1.3 Southern Railway Corridor

The existing southern railway corridor, located between (30-40metres) from the development boundary, has four different train lines with Granville, Merrylands and Harris Park as the closest stations.

The speed of the trains passing by the site vary from each line although most of them are in a slow speed mode and / or stop just in front of the proposed development waiting for instructions to start again and carry on with their journeys. This low speed and frequent train stops situation helps reduce the amount of noise and vibrations that trains produce.

The railway track is curved therefore some potential squeal noise from wheel rail contact could be audible. The railway gradient is in moderate slope.

The train lines within the corridor are at different levels, the closest line is elevated (8-10m from ground level). This situation helps shielding the direct noise from the other lines and also reduces vibration transmission towards the proposed development.

Most of the trains are for passengers only although some freight trains circulate during the day and night time on that line.

4. Noise and Vibrations Survey

4.1 Instrumentation

The equipment used for the noise survey was the following:

- ARL Environmental Noise Logger ARL EL-215 S/N 194560
- Hand-held sound spectrum analyzer B&K 2250, S/N 2709742
- Sound Calibrator B&K Type 4231, S/N 2709826
- Hand-held sound and vibration spectrum analyzer SVANTEK 958, S/N 15153
- Sound Calibrator SVANTEK SV30A, S/N 17556

All equipment was calibrated before and after the measurements and no significant drift was found. All equipment carries current traceable calibration certificates that can be provided upon request.

4.2 Attended Noise Survey Results

Attended short-term noise measurements of 5 and 15-minute duration were conducted around the site to characterise the acoustic environment for noise intrusion into the development, and to determine the background noise environment at the surrounding residential receivers for establishing the noise criteria and conducting a noise impact assessment. The measurement positions are shown in Figure 1, and a summary of the attended noise measurements taken on site are presented in Table 1.

Table 1: Attended Noise Measurements (at 1,5m height above ground otherwise indicated)

Measurement Location	Measurement Date, Time - Duration	L_{Aeq} - dB(A)	L_{A90} – dB(A)	Comments
P1	26/03/15 – 14:39pm (5 min)	67.5	65.8	Traffic noise from M4 only
	26/03/15 – 14:45pm (5 min)	68.0	66.4	
P2	26/03/15 – 14:58pm (5 min)	68.6	63.4	Traffic noise from M4, Crescent St and existing industry normal operation
P3	26/03/15 – 15:29pm (5 min)	64.0	60.1	Traffic noise from Crescent St, railway and existing industry normal operation
	07/04/15 – 12:06pm (5 min)	65.3	60.9	
P5	26/03/15 – 16:36pm (5 min)	64.7	53.5	Railway noise and existing industrial noise
P7	26/03/15 – 15:48pm (5 min)	64.0	66.2	Traffic noise from M4 merging line mostly (4.5m above ground)
P8	26/03/15 – 17:01pm (5 min)	74.6	72.4	Traffic noise from M4 only (aprox. 20m distance)
P9	26/03/15 – 17:12pm (5 min)	66.7	65.5	Traffic noise from M4 only (aprox. 85m distance)
	07/04/15 – 13:34pm (15 min)	66.9	64.9	
P10	07/04/15 – 12:40pm (15 min)	71.2	64.5	Traffic noise from Woodville Rd only (aprox. 12m distance)

As a summary of external noise sources the primary source of noise is traffic from the nearby road rather than railway noise therefore only traffic noise is taken into consideration for the façade noise calculations.

4.3 Unattended Noise Survey Results

The NSW OE&H Industrial Noise Policy defines background and ambient noise for the daytime, evening and night time periods as follows:

Day: is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.

Evening: is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.

Night: is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.

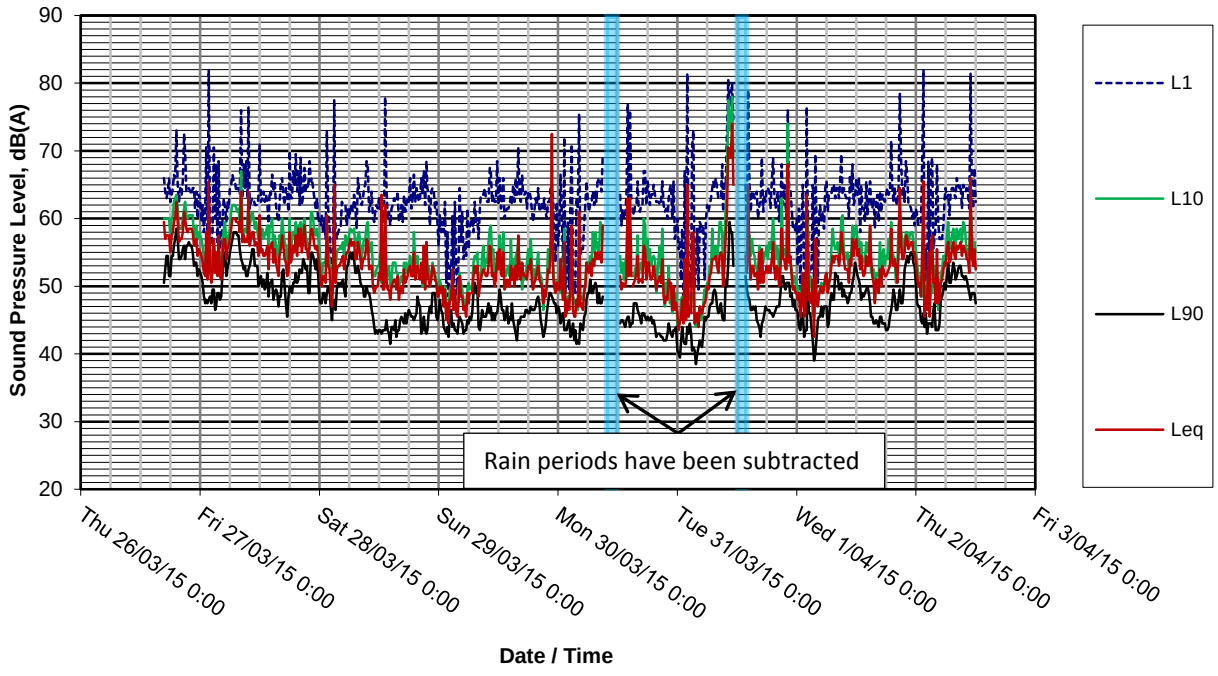
Long-term measurements were conducted using a noise logger located at position L1 as shown in Figure 1 representative of the ambient and background noise of the nearest most affected residential receiver. The results of the unattended noise survey are shown in Table 2. These noise measurements are the baseline to establish the noise criteria for this area.

Table 2: Unattended Noise Measurements

Location	Equivalent Continuous Noise Level $L_{Aeq,period}$ - dB(A)			Background Noise Level RBL- dB(A)		
	Day	Evening	Night	Day	Evening	Night
L1	57	55	55	44	45	43

Refer to Figure 3 for the noise data of logger L1 at the nearest residential receiver.

Figure 3: Unattended Noise Monitor data for L1



4.4 Attended Vibration Survey Results

Vibration measurements were conducted when trains were passing by in front of the site to characterise the existing vibration level intrusion into the development. The measurement positions are shown in Figure 1, and a summary of the attended vibration measurements taken on site are presented in Table 3.

Table 3 presents intermittent vibration measured results as per Department of Environment and Conservation NSW – Assessing Vibration: a Technical Guideline using vibration dose value (VDV) that is recommended to characterise vibration levels for train pass-bys for day and night time period.

The VDV values are calculated considering the following:

- 8 and 4 trains pass by per hour during the day and night time period respectively;
- An average of 30 seconds has been assumed for each train pass by;
- A minimum of 3 passenger trains pass by have been considered for each VDV calculation;
- No freight train vibrations was measured;
- Vertical vibration values (z axis) assessed as a worst case scenario.

Table 3: Attended Vibration Measurements

Measurement Location	Date and Measurement Time	VDV day [$m/s^{1.75}$]	VDV night [$m/s^{1.75}$]	Approximate Distance from the Railway
P1	26/03/15 – 14:42pm	0.0139	0.0103	130m
P2	26/03/15 – 14:55pm	0.0102	0.0075	65m
P3	26/03/15 – 1:00pm	0.1128	0.0835	34m
	07/04/15 – 12:11pm	0.0186	0.0138	
P4	26/03/15 – 16:05pm	0.0295	0.0219	33m (at the southern side of the railway) 3 Blane St.
P5	26/03/15 – 16:35pm	0.0369	0.0273	10m (not within the development site)
	07/04/15 – 11:25pm	0.1991	0.1474	

5. Noise and Vibration Criteria

5.1 Site noise emission

The following section presents the criteria applicable for noise emissions from the development.

5.1.1 Holroyd City Council DCP

In regards to noise emissions associated with the non-residential components of the development, the 2013 Holroyd City Council DCP states the following:

"C15. Air conditioners, swimming pool pumps and the like are not to exceed 5dba above background noise levels and should not be audible from habitable rooms of neighbouring dwellings.

Note: Air conditioners, swimming pool pumps and the like shall comply with the protection of the environment operations act and noise regulation.

NOISE

C24. Any potential noise- generating motor, equipment or machinery system must be located so as to not cause a noise nuisance for neighbours. These items must be capable of being operated in accordance with the noise requirements of the Protection of the Environment Operations Act.1997.

C25. Should the noise generating item be deemed to be causing a nuisance to neighbours then the items may have to be acoustically treated to reduce noise levels to an acceptable level."

The Holroyd City Council recognises and accepts the NSW Office of Environment & Heritage (OEH) Industrial Noise Policy (INP) as the guideline to follow in order to assess impact noise of new development.

5.1.2 New South Wales (NSW) Office of Environment & Heritage (OEH) Industrial Noise Policy (INP)

Holroyd City Council recognises and accepts the NSW OEH INP as a guideline, therefore the state policy will be used to assess noise associated with the operation of the new mechanical plant installed for the proposed residential redevelopment.

The environmental noise criteria or project-specific noise level is calculated following the NSW OEH INP guidelines.

The calculation is based on the results of the ambient and background noise unattended monitoring, addressing two components:

- Controlling intrusive noise into nearby residences (Intrusiveness Criteria);
- Maintaining noise level amenity for particular land uses (Amenity Criteria).

Once both criteria are established the most stringent for each considered assessment period (day, evening, night) is adopted as the project-specific noise level (PSNL).

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Intrusiveness Criteria

The NSW OEH INP states the following:

> *"The intrusiveness of an industrial noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the LAeq descriptor), measured over a 15-minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB(A)."*

The intrusiveness criterion can be summarised as L_{Aeq}, 15 minute ≤ RBL background noise level plus 5 dB(A).

Table 4: OEH INP intrusiveness criteria

Period	Noise Descriptor – dB(A)	Noise Criteria – dB(A)
Daytime 7am – 6pm	$L_{Aeq,15min} \leq$ RBL + 5	49
Evening 6pm – 10pm	$L_{Aeq,15min} \leq$ RBL + 5	50
Night 10pm – 7am	$L_{Aeq,15min} \leq$ RBL + 5	48

Amenity Criteria

The NSW INP states the following:

> *"To limit continuing increases in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.1 of the INP. Meeting the acceptable noise levels in table 2.1 will protect against noise impacts such as speech interference, community annoyance and to some extent sleep disturbance. These levels represent best practice for assessing industrial noise sources, based on research and a review of assessment practices used overseas and within Australia."*

The applicable parts of Table 2.1: Recommended L_{Aeq} Noise Levels from Industrial Noise Sources - dB(A) which are relevant to the project are reproduced below:

Table 5: Amenity Criteria for External Noise Levels

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level, dB(A)	
			Acceptable	Recommended Maximum
Residential (Urban)	All	Day	60	65
	All	Evening	50	55
	All	Night	45	50
Commercial	All	When in use	65	70
Industrial	All	When in use	70	75

*Urban area as defined in EPA INP 2.2.1.4.

'Modifying Factor' Adjustments

Table 2.21 of chapter 2.2 *"modification to acceptable noise level (ANL) (recommended acceptable L_{Aeq} noise level for the specific receiver, area and time of day from Table 2.1"* when exiting L_{Aeq} has industrial noise contribution.

Table 6: Modification to Acceptable Noise Level (ANL)

Total exiting L_{Aeq} noise level from industrial sources, dB(A)	Maximum L_{Aeq} noise level for noise from new sources alone, dB(A)
≥ Acceptable noise level plus 2	If exiting noise is *likely to decrease* in future: Acceptable noise level minus 10 If exiting noise is *unlikely to decrease* in future: Existing level minus 10
Acceptable noise level plus 1	Acceptable noise level minus 8
Acceptable noise level	Acceptable noise level minus 8
Acceptable noise level minus 1	Acceptable noise level minus 6
Acceptable noise level minus 2	Acceptable noise level minus 4
Acceptable noise level minus 3	Acceptable noise level minus 3
Acceptable noise level minus 4	Acceptable noise level minus 2
Acceptable noise level minus 5	Acceptable noise level minus 2
Acceptable noise level minus 6	Acceptable noise level minus 1
< Acceptable noise level minus 6	Acceptable noise level

The NSW INP also states:

> *"Where a noise source contains certain characteristics, such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level."*

In order to take into account the potential annoying character of the noise an adjustment of 5 dB(A) for each annoying character aspect and cumulative of up to a total of 10 dB(A), is to be added to the measured value to penalise the noise for its potentially greater annoyance aspect.

Table 4.1 of Chapter 4 of the NSW OEH INP (see Table 7 below) provides procedures for determining whether an adjustment should be applied for greater annoyance aspect.

Table 7: Table 4.1 NSW DECCW INP – Modifying Factor Corrections

Factor	Assessment / Measurement	When to Apply	Correction[1]	Comments
Tonal Noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: - **5 dB** or more if the centre frequency of the band containing the tone is above 400 Hz - **8 dB** or more if the centre frequency band containing the tone is 160 to 400 Hz	5 dB[2]	Narrow-band frequency analysis may be required to precisely detect occurrence.

		inclusive - **15 dB** or more if the centre frequency of the band containing the tone is below 160 Hz		
Low Frequency Noise	Measurement of C-weighted and A-weighted level	Measure / assesses C- and A-weighted levels over same time period. Correction to be applied if the difference between the two levels is 15 dB or more	5 dB[2]	C-weighting is designed to be more responsive to low-frequency noise, especially at higher overall levels
Impulsive Noise	A-weighted fast response and impulsive response	If difference in A-weighted maximum noise levels between fast response and impulse response is greater than 2 dB	Apply difference in measured levels as the correction, up to a maximum of 5 dB.	Characterised by a short rise time of 35 milliseconds (ms) and decay time of 1.5 s.
Intermittent Noise	Subjectively assessed	Level varies by more than 5 dB	5 dB	Adjustment to be applied for **night-time only.**
Duration	Single-event noise duration may range from 1.5 min to 2.5 h	On event in any 24-hour period	0 to – 20 dB(A)	The acceptable noise level may be increased by an adjustment depending on duration of noise.
Maximum Adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated	Maximum correction of 10dB(A)[2] (excluding duration correction)	

Notes:

1. Corrections to be added to the measured or predicted levels.
2. Where a source emits tonal and low-frequency noise, only one 5 dB correction should be applied if the tone is in the low-frequency range.

As the site has a strong component of industrial noise, modifying factors included in Table 6 have been applied. Modified Amenity Criteria levels are shown in Table 8.

Table 8: Amenity Modified Acceptance Noise Levels According to Table 6

Period	Noise Descriptor – dB(A)	Noise Criteria – All commercial receivers
Daytime 7am – 6pm	Table 6 modification to acceptable noise level (ANL)	57
Evening 6pm – 10pm		45
Night 10pm – 7am		45

5.2 Project-Specific Noise Levels (PSNL)

Table 9 below displays the project-specific noise levels PSNL for the project. Any operational or mechanical noise emissions from the development must comply with the PSNL provided at the surrounding receivers.

Table 9: Project Specific Noise Levels, LAeq

Period	Descriptor	PSNL dB(A)
Residential Areas		
Day (7:00am to 6:00pm)	$L_{Aeq,15min}$	**57**
Evening (6:00pm to 10:00pm)	$L_{Aeq,Evening}$	**45**
Night (10:00pm to 7:00am)	$L_{Aeq,Night}$	**45**
Commercial		
When in use	$L_{Aeq,Day,Evening}$	**65**
Industrial		
When in use	$L_{Aeq,Day,Evening}$	**70**

Note: The PSNL for the project was established using the noise data collected at logger location L1 as it is the most representative location of ambient noise level for the surrounding potentially most affected receivers.

The most stringent noise criterion to meet at the boundary of the nearest potentially affected receiver is the residential evening and night time criterion of 45dB(A).

Where necessary, noise mitigation measures will be incorporated in the design to ensure that noise levels comply with the recommended noise emission criteria noted above.

5.3 Internal Noise Levels

This section details the criteria used to define the internal noise target for spaces within the proposed residential development.

5.3.1 Holroyd City Council DCP

The 2013 Holroyd City Council DCP Part B states as following:

"C11. Where a property is adjacent to a railway or arterial road, an acoustic report conducted by a suitably qualified acoustic consultant is required to be submitted to Council. The acoustic report shall provide measurements of noise impacts upon proposed dwellings and make specific recommendations for the attenuation of noise to currently recognised levels conductive to reasonable residential amenity. Compliance with the maximum design sound levels recommended by the revelant Australian Standard. Recommended design sound levels and reverberation times for building interiors, as follows:

- *Recreation areas- 40dB(A)*
- *Sleeping areas- 35dB(A)*
- *Other habitable rooms- 40dB(A)*

Note: Additional information and/ or reports may be required for development adjoining a railway line. Applicants are advised to contact State Rail or the Rail Infrastructure Corporation for further information on their requirements.

C12. Where dwellings or dwelling additions are proposed within close proximity to busy roads and rail corridors, entries, halls, storage rooms, bathrooms and laundries should be located on the noise affected side of each dwelling and should be able to be sealed off by doors from living areas and bedrooms where practicable, whilst maintaining good housing design and building appearance.

C13. Where dwellings are proposed within close proximity to busy roads and rail corridors, appropriate materials with acoustic properties should be incorporated such as solid core doors with seal vents and insulation, suitably treated glazing and enclosed balconies.

C14. Communal courtyards and paved areas (e.g. vehicle driveways) shall be designed to minimise reflected noise.

Note: These conditions will be applied at DA stage.

AS/NZS2107:2000 will be used to assign internal noise level criteria to other spaces within the proposed development where Holroyd City Council DCP doesn't nominate a noise target.

The 2013 Holroyd City Council DCP Part B also states general recommendations as follow:

C16. Terraces, townhouses, villas and apartments shall be arranged within a development to minimise noise transition between dwellings by:

- *Locating busy, noisy areas next to each other and quieter areas next to other quiet areas (i.e. living rooms with living rooms, bedrooms with bedrooms).*
- *Using storage or circulation zones within an apartment to buffer noise from adjacent apartments, mechanical services or corridors and lobby areas.*
- *Minimising the amount of party (shared) walls with other dwellings/apartments.*

C17. Internal apartment layout shall be designed to separate noisier spaces from quieter spaces by grouping uses within an apartment (i.e. bedrooms with bedrooms and service areas like kitchen, bathroom, and laundries together).

C18. Conflicts between noise, outlook and views shall be resolved by using design measures including:

- *Double glazing;*
- *Operable screened balconies;*
- *Continuous walls to ground level courtyards where they do not conflict with streetscape or other amenity requirements.*

C20. Reduce noise transmission from common corridors or outside the building by providing seals at entry doors. *"*

Note: These conditions will be applied at DA stage.

5.3.2 AS/NZS2107:2000 Recommended Design Sound Levels

Australian Standard (AS/NZS) 2107:2000 – *'Acoustics- Recommended design sound levels and reverberation times for building interiors'* specifies target noise levels for internal spaces and values corresponding to the relevant types of spaces that are expected to be at the proposed development, as summarised below Table 10.

Table 10: Recommended Noise Levels according to AS/NZS 2107:2000

Type of occupancy / activity	Recommended Design Sound Level, L_{Aeq}, dB(A)	
	Satisfactory	Maximum
Residential Buildings – Houses and apartments near major roads		
Living Areas	35	45
Sleeping Areas	30	40
Common Areas (Foyer, Lift lobby, etc.)	45	55
Washrooms and Toilets	45	55
Enclosed Car Parks	55	65
Commercial		
Small Retail Stores (general)	45	50
Shopping malls	45	55

5.4 Sleep Disturbance Criteria

The NSW OEH's INP does not address the issue of sleep arousal. The NSW EPA's "Environmental Noise Control Manual" (ENCM) however, makes the general observation that a person's sleep can be significantly disrupted by noise. Scientific research has established that short duration or intermittent noise is more disturbing to sleep than continuous noise of similar acoustic energy.

Chapter 19 of the ENCM provides guidelines for assessing sleep disturbance resulting from short-duration high-level noises which occur at night (10:00pm to 7:00am according to the OEH) as follows:

"Noise control should be applied with the general intent to protect people from sleep arousal. To achieve this, the L_1 level of any specific noise source should not exceed the background noise level (L_{90}) by more than 15 dB(A) when measured outside the bedroom window."

The following Table 11 summarises the sleep arousal criteria that are applied to the surrounding residential premises based on data from L1.

These noise levels can be assessed (outdoor) at the facade of the premises.

Table 11: Sleep Arousal Criteria

Location	Night-time L_{A90}	L_{A1} Criteria – dB(A)
All	43	58

The Application notes regarding the INP published by the OEH suggest that the OEH recognises that the current sleep disturbance criterion of an $L_{A1,1min}$ not exceeding the $L_{A90,15min}$ by more than 15 dB(A) is not ideal. Nevertheless as there is insufficient evidence to determine what should replace it, the OEH will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely to occur, but where it is not met, a more detailed analysis is required.

The detailed analysis should cover the maximum noise level $L_{A1,\ 1min}$ that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the appendices to the *NSW Environmental Criteria for Road Traffic Noise* (ECRTN, Environment Protection Authority 1999). Other factors that may be important in assessing the extent of impacts on sleep include:

- How often high noise levels will occur.
- Time of day (normally between 10pm and 7am).
- Whether there are times of the day when there is a clear change in the noise environment (such as early morning shoulder periods).

The $L_{A1, 1min}$ descriptor represents a maximum noise level measured under fast time response. OEH will accept analysis based on either $L_{A1, 1min}$ or L_{Amax}.

5.5 Traffic Noise Generation Criteria

The L_{Aeq} noise level or the "equivalent continuous noise level" correlates best with the human perception of annoyance associated with traffic noise.

Road traffic noise impact is assessed in accordance with the newly introduced NSW Road Noise Policy (Office of Environment and Heritage July 2011) (which supersedes the *NSW Environmental Criteria for Road Traffic Noise* (ECRTN, Department of Environment Climate Change and Water 1999).

The criterion (Table 3 – Road Traffic Noise Assessment Criteria for Residential Land Uses) divides land use developments into different categories and lists the respective criteria for each case. The category that is relevant to the proposed use of the site is shown below:

Table 12: NSW Road Noise Policy – Traffic Noise Assessment Criteria

Road Category	Type of project/land use	Assessment Criteria – dB(A)	
		Day (7am – 10pm)	Night (10pm – 7am)
Freeway/arterial/Sub-arterial roads	Existing Residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use developments	$L_{Aeq,15\ hour}$ 60 (external)	$L_{Aeq,9\ hour}$ 55 (external)

In the event that the traffic noise at the site is already in excess of the criteria noted above, the NSW RNP states that the primary objective is to reduce the existing level through feasible and reasonable measures to meet the criteria above.

If this is not achievable, Section 3.4.1 Process for applying the criteria – Step 4 states that for existing residences affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise should be limited to 2dB above that of the corresponding 'no build option'.

5.6 Construction Noise Criteria

Noise criteria for construction sites are established in accordance with the Interim Construction Noise Guideline (*ICNG July 2009*) by the NSW Office of Environment &Heritage (NSW OE&H). It is important to note that the recommended criteria are for planning purposes only. Numerous other factors need to be considered when assessing potential noise impacts from construction works.

However, in undertaking the assessment of potential noise intrusion associated with the proposed construction activities, Chapter 4 of the NSW OE&H ICNG (July 2009) were specifically referenced. The noise limits are presented in Table 13, and are applicable to the development.

Table 13: NSW DECCW ICNG Construction Noise Criteria

Time of Day	Management Level $L_{Aeq,15min}$ *	How to Apply
Recommended Standard Hours: Mon – Fri (7am – 6pm) Sat (8am – 1pm) No work on Sunday & Public Holidays	Noise Affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq,15min}$ 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 residences of the nature of works to be carried out, the expected noise levels 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 in, taking into account: • 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) • 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 + 5dB	• 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.

Note: 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 30m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Source: Chapter 4 (Table 2 Sec 4.1.1) of NSW OE&H ICNG.

5.7 Human Comfort and Construction Vibration Criteria

The Office of Environment and Heritage (OEH) developed a document, "Assessing vibration: a technical Guideline" in February 2006 to assist in preventing people from exposure to excessive vibration levels within buildings. The guideline does not however address vibration induced damage to structures or structure-borne noise effects. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent.

5.7.1 Human Comfort – Continuous and Impulsive Vibration Criteria

Structural vibration in buildings can be detected by occupants and can affect them in many ways including reducing their quality of life and also their working efficiency. Complaint levels from occupants of buildings subject to vibration depend upon their use of the building and the time of the day.

Maximum allowable magnitudes of building vibration with respect to human response are shown in Table 14. It should be noted that the human comfort for vibration are more stringent than the building damage criteria.

Table 14: Preferred and maximum weighted RMS values for continuous and impulsive vibration acceleration (m/s2) 1-80Hz

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration					
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and place of worship	Day or night time	0.020	0.014	0.040	0.028
Impulsive vibration					
Residences	Daytime	0.30	0.21	0.60	0.42
	Night time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and place of worship	Day or night time	0.64	0.46	1.28	0.92

5.7.2 Human Comfort – Intermittent Vibration Criteria

Disturbance caused by vibration will depend on its duration and its magnitude. This methodology of assessing intermittent vibration levels involves the calculation of a parameter called the Vibration Dose Value (VDV) which is used to evaluate the cumulative effects of intermittent vibration. Various studies support the fact that VDV assessment methods are far more accurate in assessing the level of disturbance than methods which is only based on the vibration magnitude.

Table 15: Acceptable Vibration Dose Values for Intermittent Vibration (m/s1.75)

Location	Daytime (7:00am to 10:00pm)		Night-time (10:00pm to 7:00am)	
	Preferred value	Maximum value	Preferred value	Maximum value
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and place of worship	0.40	0.80	0.40	0.80

5.7.3 Structural Damage – Vibration Criteria

Ground vibration criteria are defined in terms of levels of vibration emission from the construction activities which will avoid the risk of damaging surrounding buildings or structures. It should be noted that human comfort criteria are normally expressed in terms of acceleration whereas structural damage criteria are normally expressed in terms of velocity.

Most commonly specified structural vibration levels are defined to minimize the risk of cosmetic surface cracks and are set below the levels that have the potential to cause damage to the main structure. Structural damage criteria are presented in German Standard DIN4150-Part 3 “Structural vibration in buildings – Effects on structures” and British Standard BS7385-Part 2: 1993 “Evaluation and Measurement for Vibration in Buildings”. Table 16 indicates the vibration limits presented in DIN4150-Part 3 to ensure structural damage doesn’t occur.

Table 16: Guideline value of vibration velocity, vi, for evaluating the effects of short-term vibration

Line	Type of Structure	Vibration velocity, vi, in mm/s			
		Foundation			Plane of floor of uppermost full storey
		At a frequency of			
		Less than 10Hz	10 to 50Hz	50 to 100*Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that, because of their particular sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8
*For frequencies above 100Hz, at least the values specified in this column shall be applied					

Table 17 presents guide values for building vibration, based on the lowest vibration levels above which cosmetic damage has been demonstrated as per BS7385-Part 2:1993.

Table 17: Transient vibration guide values for cosmetic damage

Type of Building	Peak Particle Velocity in frequency range of predominant pulse (PPV)	
Residential or light commercial type buildings	4 Hz to 15 Hz	15 Hz and above
	15mm/s at 4Hz increasing to 20mm/s at 15Hz	20mm/s at 15Hz increasing to 50mm/s at 40Hz and above

5.7.4 Construction Vibration Objectives

Table 18 indicates the construction vibration criteria applicable to the residential and commercial properties located adjacent to the development site.

Table 18: Construction vibration criteria summary

Location	Period	Human Comfort Vibration Objectives			Building damage Objectives – Velocity (mm/s)
		Continuous mm/s^2 (RMS)		Intermittent $mm/s^{1.75}$ (VDV)	
		z-axis	x- and y-axis		
Residential	Daytime	10-20	7-14	0.2-0.4	5
	Night time	7-14	5-10	0.13-0.26	5
Commercial	Day or night	20-40	14-28	0.4-0.8	20

6. Preliminary Assessment and Acoustic Recommendations

The following sections detail all the acoustic requirements that proposed development should achieve in order to comply with noise and vibrations criteria specified in Section 5 of this report.

Each section has conclusions that complement the noise and vibration specified targets and also defines the level of complexity in achieving these targets.

6.1 Noise and Vibration Survey Results

As stated in Section 4 the site is exposed to a noisy environment due to the major roads and railway line nearby and it could be potentially affected by vibrations from the railway corridor.

At this point in time we only have assessed the existing situation regarding the nearby roads and railway corridor.

At a later stage it will be worth consulting NSW Transport and Maritime Services for any upgrade or extension of existing road or rail infrastructure and also consider future projected conditions of traffic for motor vehicles but also for trains. At the concept design stage, a 3D modelling will be completed as it represents the best option to predict the future noise impact from surrounding transport infrastructure on the proposed development.

6.1.1 Conclusions regarding mechanical noise

The measured noise levels around the site due to the traffic and train pass-by are relatively high but consistent with similar major road and railway corridors. We are of the opinion that with the implementation of acoustic recommendations during the design stages, the site will be suitable for the proposed mixed use development.

Although all the measured vibration levels within the development site are not exceeding the acceptable vibration dose values (VDV) shown in Table 15 a longer vibration survey, using vibration noise loggers, is recommended to be conducted during the detailed design stage of the project. This study will determine if vibrations impacting on site are high enough to take any mitigation measure within the building structure.

We are of the opinion that taking in account the minimum distance between the site and the railway corridor and how the track is built (elevated through a retention wall) no negative vibration impact is expected on the proposed development should the exiting railway conditions being unchanged.

6.2 External Glazing

The general limiting factor of the performance of a building façade in terms of noise attenuation is the glazing. In the case of the proposed development, the surrounding railway and traffic noise form M4 Western Motorway and Woodville Rd will provide most of the external noise sources driving the design of the building façades and its acoustic performance.

In order to achieve the internal noise levels specified within the Holroyd City Council DCP and AS/NZS 2107:2000, the minimum recommended glazing selection for the façades of the proposed development is presented in Table 21.

The data presented in this table is based on the worst case scenario of external noise obtained from attended and unattended noise measurements. As at this stage of the project there is no architectural layouts generated yet, standard window openings and room sizes have been assumed as per Table 19. The glazing thicknesses presented below should be considered as the minimum thicknesses to achieve acoustical ratings. Greater glazing thicknesses may be required for structural loading, wind loading or to comply with other requirements.

1 Crescent St Holroyd

Building orientation (angle of façade noise incidence) and the distance from the noise source are critical when assessing façade performance and specifically glazing. Figure 4 shows how the proposed Materplan layout.

Figure 4: Proposed Masterplan Showing the Buildings Location and Orientation

Table 19: Assumed Standard Window and Room Dimensions

Room type	Window Dimensions	Room Volume
Bedroom	1.6 x 2.6 = 4.2m^2	5 x 3 x 2.7 = 40.5m^3
Living	2.5 x 2.6 = 6.5m^2	9.5 x 3.7 x 2.7 = 94.9m^3

Taking into account the attended noise survey the facades have been grouped according to their noise exposure. Two different facade groups are presented in Table 20 with measured/predicted L_{eq} noise levels exposure.

Table 20: Façade Noise Groups according Noise Exposure

Façade Group	Measured/predicted Leq [dB(A)]
VN - Very Noisy	68
N - Noisy	65

Window openings and room dimensions play a critical role when assessing acoustic glazing performance within a building. Any changes on Table 19 values will cause changes on the results presented in Table 21.

Table 21: Recommended Acoustic Performance of Glazing System

Façade Category	Occupancy	Glass System	Required Acoustic Rating of Glazing Assembly, Rw[1]	Predicted Internal Noise Level dB(A)
VN	Bedroom	12.38mm lam glass	37	35
	Living	10.38mm lam glass	35	35
N	Bedroom	10.38mm lam glass	35	33
	Living	6.38mm lam glass	34	35

NOTES:

The Required Acoustic Rating of Glazing Assembly, refers to the acoustic performance of the glazing once installed on site (including the frame)

6.2.1 Conclusions regarding glazing

All the predicted internal noise levels due to external traffic noise and rail noise are within the recommended levels shown in Section 5.3 of this report.

During the detailed design stage of the project the acoustic performance of the glazing facade should be reviewed considering the combined noise from external sources and mechanical services when the latest is more accurately defined and could result in internal noise level exceeding the recommended design sound level ($L_{Aeq,T}$ dB(A)) specified in the AS/NZS 2107:2000.

Due to the complexity of the development in terms of different facades orientation and position regarding external noise sources 3D noise modelling will be conducted during the design stages of the proposed development.

Completing 3D modelling is the most accurate way to understand the noise exposure of the façade at each level of the building. This 3D modelling is very useful in order to achieve glazing budget.

6.3 Noise Emission from Future Mechanical Plants

During the detailed design stage of the project the noise emission from mechanical plants will need to be checked and noise levels will require to be predicted at the boundary of the most affected receivers. Noise mitigation measures may be needed in order to comply with Section 5.2 noise criteria summarised in Table 22.

Table 22 displays the project-specific noise levels PSNL for the project. Any noise associated with the operation of mechanical services or building services from the development must comply with the PSNL provided at the surrounding receivers.

[1] See Appendix 1 for Rw definition

Table 22: Project Specific Noise Levels, LAeq

Period	Descriptor	PSNL dB(A)
Residential Areas		
Day (7:00am to 6:00pm)	$L_{Aeq,15min}$	**57**
Evening (6:00pm to 10:00pm)	$L_{Aeq,Evening}$	**45**
Night (10:00pm to 7:00am)	$L_{Aeq,Night}$	**45**
Commercial		
When in use	$L_{Aeq,Day,Evening}$	**65**
Industrial		
When in use	$L_{Aeq,Day,Evening}$	**70**

6.3.1 Conclusions regarding mechanical noise

The nearest potentially affected residential receivers are located on the southern side of the rail corridor about 55m away from the proposed development and are only 1 or 2 storeys high.

This will assist in order to minimise acoustic mitigation measures needed in order to comply with the PSNL noise criteria.

The PSNL noise criteria shown in Table 22 is not very stringent therefore the amount of mitigation measures expected are not significant.

Therefore it is our opinion that there will not be significant difficulties in achieving the PSNL at the boundary of the nearest sensitive receivers for the proposed development.

6.4 Traffic Noise Impact Assessment

During the detailed design stage of the project a traffic consultant should be engaged to assess the future traffic generation due to the proposed development. This traffic data will be used to calculate the impact of the traffic generated by the development on the nearest residential receivers and make sure it is achieving Section 5.5 criteria.

6.4.1 Conclusions regarding mechanical noise

Taking into account the current traffic noise level on Crescent St and the fact that it is already relatively high we are of the opinion that it will not be difficult to comply with the traffic noise criteria.

If the access to the proposed development is split between Crescent St and Woodville Rd the traffic noise generated would be split and it will provide a strategy in order to meet the traffic noise criteria.

7. Conclusion

An acoustic feasibility study for the proposed development at 1 Crescent St, Holroyd has been conducted. This report will be part of the Planning Proposal documentation to be submitted to Holroyd Council in order to assess the potential for the rezoning of the site from Industrial to Residential and Mixed use.

This report has provided noise and vibration criteria, in-principle treatment, design requirements and advice in regards to the possibility and ease of achieving the statutory criteria discussed in Section 5 of this report.

In terms of noise and vibration criteria we have provided the following:

- Noise criteria for emissions from the development to receivers in accordance with the Holroyd DCP and the NSW OEH INP provided in Section 5.1.
- Vibration criteria in accordance with Department of Environment and Conservation NSW – Assessing Vibration: a Technical Guideline provided in Section 5.7.
- Noise criteria for internal noise levels according to the Holroyd DCP and AS/NZS2107, provided in Section 5.3.
- Sleep Disturbance criteria provided in Section 5.4.
- Traffic Noise Generation criteria provided in Section 5.5.
- Construction noise criteria provided in Section 5.6.

Section 6 explains in detail the conclusions regarding the noise and vibration criteria that need to be achieved and the preliminary comments given at this stage of the project.

The overall conclusion includes the following:

- The Glazing façade for all buildings fitted with standard glazing thickness will achieve internal noise levels criteria;
- Future mechanical noise generated by the development will achieve noise criteria using typical noise mitigations measures;
- No negative traffic noise impact or sleep disturbance on the surrounding sensitive receivers is expected from the development;
- Existing noise and vibrations impact from the railway corridor are complying with the minimum acceptable levels.

This preliminary acoustic study has been prepared and taken into account existing site conditions in terms of traffic and railway noise and vibrations. Consultations with the transport authorities are necessary in order to understand future conditions that could vary existing ones.

A 3D acoustic modelling study to accurately predict the traffic noise impact from the nearby roads through all the facades is strongly recommended at the relevant DA stage. This will provide accurate results which will provide a good level of amenity for the residents of the proposed mixed use development.

Based on our analysis and the conclusions presented in this report it is our opinion that the re-zoning of the site from Industrial to Residential and Mixed use should not be refused on the basis of noise and / or vibration exposure.

Appendix

Appendix 1 - Glossary of Acoustic Terms

NOISE	
Acceptable Noise Level:	The acceptable LAeq noise level from industrial sources, recommended by the EPA (Table 2.1, INP). Note that this noise level refers to all industrial sources at the receiver location, and not only noise due to a specific project under consideration.
Adverse Weather:	Weather conditions that affect noise (wind and temperature inversions) that occur at a particular site for a significant period of time. The previous conditions are for wind occurring more than 30% of the time in any assessment period in any season and/or for temperature inversions occurring more than 30% of the nights in winter).
Acoustic Barrier:	Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc. used to reduce noise.
Ambient Noise:	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment Period:	The period in a day over which assessments are made.
Assessment Location	The position at which noise measurements are undertaken or estimated.
Background Noise:	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level.
Decibel [dB]:	The units of sound pressure level.
dB(A):	A-weighted decibels. Noise measured using the A filter.
Extraneous Noise:	Noise resulting from activities that are not typical of the area. Atypical activities include construction, and traffic generated by holidays period and by special events such as concert or sporting events. Normal daily traffic is not considered to be extraneous.
Free Field:	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground
Frequency:	Frequency is synonymous to pitch. Frequency or pitch can be measured on a scale in units of Hertz (Hz).

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Impulsive Noise:	Noise having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent Noise:	Level that drops to the background noise level several times during the period of observation.
LAmax	The maximum A-weighted sound pressure level measured over a period.
LAmin	The minimum A-weighted sound pressure level measured over a period.
LA1	The A-weighted sound pressure level that is exceeded for 1% of the time for which the sound is measured.
LA10	The A-weighted sound pressure level that is exceeded for 10% of the time for which the sound is measured.
LA90	The A-weighted level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
LAeq	The A-weighted "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
LAeqT	The constant A-weighted sound which has the same energy as the fluctuating sound of the traffic, averaged over time T.
Reflection:	Sound wave changed in direction of propagation due to a solid object met on its path.
R-w:	The Sound Insulation Rating R-w is a measure of the noise reduction performance of the partition.
SEL:	Sound Exposure Level is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound Absorption:	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter:	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level:	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.

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Sound Power Level:	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise:	Containing a prominent frequency and characterised by a definite pitch.