Noise and Sound Services

Railway Noise and Vibration Assessment

At:-
84 Cox Avenue
Penrith
NSW 2750

August 2020

Report No. nss23240 – Final

Prepared for:-

PreTech Pty Ltd
Level 1, Suite 9
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Prepared by: -

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C O N T E N T S

1. INTRODUCTION

Noise and Sound Services was requested by PreTech of Level 1, Suite 9, 86 Henry Street, Penrith, NSW 2750, on behalf of Mr. Michael Harriden to carry out a rail traffic noise and vibration assessment. This is required for the proposed four townhouses on the site at 84 Cox Avenue, Penrith, NSW 2750.

In view of the close proximity of the dwellings to the railway line, a noise and vibration assessment is required by Council to meet the State Environmental Planning Policy (Infrastructure) 2007, Clause 87, Impact of rail noise or vibration on non-rail development.

2. SITE AND DEVELOPMENT DESCRIPTION

2.1 Site Description

The proposed new townhouses at 84 Cox Avenue, Penrith are approximately 70 metres west of Parker Street (Highway 9) and approximately 15 metres north from the Blue Mountains, North Shore and Western Railway line. Cox Avenue is a residential road with little road traffic, hence only rail noise is likely to be adversely affected for this development.

2.2 Development Description

The proposed development at 84 Cox Avenue, Penrith, NSW 2750 consists of four new two storey townhouses. All of the townhouses consist of an open plan kitchen, family, living room on the ground floor and three bedrooms on the first floor. Full details are given in the *'PreTech'* architectural drawings for drawing number A01 to A05, job number 00391, dated June 2020, issue A.

3 CRITERIA

3.1 Infrastructure SEPP Clause 87 Impact of Rail Noise or Vibration on Non-Rail Development 2007

The State Environmental Planning Policy (Infrastructure) 2007, Clause 87 Impact of rail noise or vibration on non-rail development provides the following:-

(1) This clause applies to development for any of the following purposes that is on land in or adjacent to a rail corridor and that the consent authority considers is likely to be adversely affected by rail noise or vibration:-

(a) a building for residential use,
(b) a place of public worship,
(c) a hospital,
(d) an educational establishment or child care centre.

(2) Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Director-General for the purposes of this clause and published in the Gazette.

(3) If the development is for the purposes of a building for residential use, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following L_{Aeq} levels are not exceeded:-

(a) in any bedroom in the building—35 dB(A) at any time between 10.00 pm and 7.00 am,
(b) anywhere else in the building (other than a garage, kitchen, bathroom or hallway) — 40 dB(A) at any time.

3.2 Rail Infrastructure Corporation / State Rail Authority - Interim Guidelines for Applicants November 2003.

The Rail Infrastructure Corporation/State Rail Authority has produced interim guidelines for applicants and Councils giving consideration to rail noise and vibration at the planning stage (November 2003). This states that new residential buildings should be designed and constructed to comply with the design criteria given in Part C Section 10 of the guidelines (as shown in Table 1 below) in habitable rooms, with external windows and doors closed.

TABLE 1 – RECOMMENDED DESIGN SOUND LEVEL FOR RESIDENTIAL BUILDINGS. FROM RIC INTERIM GUIDELINES FOR APPLICANTS.

Internal Space	Time Period	Railway Noise Level ($L_{Aeq, 1\ hour}$)
Living and Sleeping Areas	Day (7:00 am to 10:00 pm)	40 dBA
	Night (10:00 pm to 7:00 am)	35 dBA

If noise levels with windows or doors open exceed these criteria by more than 10 dBA, the design of the ventilation for these rooms should be such that the occupants can keep the windows closed if they so desire.

Floor vibration levels in habitable rooms should comply with the criteria in the NSW Government's *'Assessing Vibration: A Technical Guideline'* (DEC 2006/43). Whole body vibration is assessed in terms of frequency weighted root-mean quad (r.m.q) acceleration. The frequency weighting is based on the base curve as given in the British Standard (BS 6472:1992) and also the Australian Standard AS 2670 *'Evaluation of human exposure to whole body vibration'* (2001) and, in particular, AS 2670 part 2 (1990). The base value given in the guideline represents an overall frequency-weighted r.m.s acceleration magnitude of 0.005 m/s^2. Criteria for intermittent vibration in residential premises in terms of vibration dose values (VDV) are as shown in Table 2.

TABLE 2 – ACCEPTABLE VIBRATION DOSE VALUES FROM INTERMITTENT VIBRATION ($m/s^{1.75}$). From *'Assessing Vibration'* (DEC 2006/43).

Location	Day Time (7:00 am to 10:00 pm)		Night Time (10:00 pm to 7:00 am)	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Residences	**0.20**	**0.40**	**0.13**	**0.26**

Table 3 below provides equivalent vibration magnitudes to those in Table 2 above, various durations and the peak particle velocity (mm/s).

TABLE 3 – ACCEPTABLE VIBRATION VELOCITY (mm/s) WITH DAILY DURATION.

Peak Particle Velocity (mm/s)	Acceptable	Acceptable with Some Adverse Comment	Unacceptable
0.5	1 hour to16 hours	-	-
1	5 minutes to 1 hour	1 hour to16 hours	-
1.5	1 minute to 15 minutes	15 minutes to 4 hours	Over 4 hours
2	Up to 5 minutes	5 minutes to 1 hour	Over 1 hour
2.5	Up to 2 minutes	2 minutes to 30 minutes	Over 30 minutes
3	Up to 1 minute	1 minute to 15 minutes	Over 15 minutes
3.5	-	Up to 7 min	7 min to 2 hr
4	-	Up to 5 min	5 min to 1 hr

4. NOISE AND VIBRATION MEASUREMENTS

Noise and vibration measurements were carried out close to the site of the proposed development. This section covers the instrumentation used for the acoustical measurements, the measurement procedure, and the results.

4.1 Instrumentation – Noise

4.1.1 Attended Rail Noise Measurements

The instrumentation used during the attended noise survey consisted of a Brüel and Kjær sound level meter model 2250 (serial number 3008564). This meter conforms to Australian Standard AS IEC 61672.1-2004 : '*Electroacoustics - Sound level meters – Specifications*' as a class 1 precision sound level meter and has an accuracy suitable for both field and laboratory use. The calibration of the meter was checked before and after the measurement period with a Brüel and Kjær acoustical calibrator model 4231 (serial number 2445349). No significant system drift occurred over the measurement period.

The sound level meter was checked, adjusted, and aligned to conform to the Brüel and Kjær factory specifications and issued with conformance certificates within the last 24 months as required by the regulations. The internal test equipment used is traceable to the National Measurement Laboratory at C.S.I.R.O., Lindfield, NSW, Australia.

The calibrator was checked, adjusted, and aligned to conform to the Brüel and Kjær factory specifications and issued with conformance certificates within the last 12 months as required by the regulations. The internal test equipment used is traceable to the National Measurement Laboratory at C.S.I.R.O., Lindfield, NSW, Australia.

4.1.2 Unattended Rail Noise Measurements

The instrumentation used during the unattended noise survey consisted of an 'Acoustic Research Laboratories Pty Ltd' - Environmental noise logger sound level meter (serial number 194569). The logger conforms to Australian Standard 1259 "*Acoustics - Sound Level Meters"*, (1990) as a type 2 sound level meter and has an accuracy suitable for both field and laboratory use.

The calibration of the logger was checked before and after the measurement period with a Brüel and Kjær acoustical calibrator model 4231 (serial number 2445349). No significant system drift occurred over the measurement periods.

The logger has been checked, adjusted, and aligned to conform to ARL factory specifications and issued with a conformance certificate within the last two years. The internal test equipment used is traceable to the National Measurement Laboratory at C.S.I.R.O., Lindfield, NSW, Australia.

4.2 Instrumentation – Vibration

The instrumentation used for the vibration survey consisted of a Metra Meß - und Frequenztechnik in Radebeul e.K., Type VM40A vibration meter (serial number 16115). This meter utilises a tri-axial vibration pickup transducer which has a band width of 0.8 Hz to 100 Hz and is suitable for both field and laboratory use. The vibration meter was checked, adjusted, and aligned to conform to the Metra Meß factory specifications.

4.3 Measurement Procedure - Noise

4.3.1 Attended Rail Noise Measurements

The free field outdoor noise measurements were carried out on-site, in Cox Avenue, Penrith, facing the railway line at a distance of 10 metres, in general accordance with Australian Standard AS 1055:2018. The measurements were carried out at a height of approximately 1.5 metres from the ground on Wednesday 8th July 2020. The 'A' frequency weighting and 'fast' time weighting were used exclusively. The weather was cool, fine, and sunny with negligible wind.

The time of the measurements was selected as representing a time when the rail traffic flows are considered to be typical. Noise levels for higher rail traffic flows (i.e. a worst case scenario) have also been calculated.

Night time (from 10:00 pm to 7:00 am) rail movements are taken into account with unattended noise measurements as detailed below.

4.3.2 Unattended Rail Noise Measurements

In addition, to the attended measurements, long-term noise levels were carried out from Wednesday 8th July to Wednesday 15th July 2020. Measurements were carried out in accordance with Australian Standard AS 1055: 2018 - *'Acoustics- Description and measurement of environmental noise'* and taken at a height of approximately 1.5 metres. The 'fast' time weighting and 'A' frequency weighting were used. These measurements were behind a 1.8 metre high *'Colorbond'* fence.

4.4 Measurement Procedure – Vibration

Sample ground borne vibration measurements of the train movements were taken on Wednesday 8th July 2020 at approximately 5 metres from the nearest railway line.

4.5 Attended Measurement Results - Noise

The noise measurement results at approximately 10 metres from the rail track are shown in Table 4:-

TABLE 4 – ATTENDED NOISE MEASUREMENT RESULTS (8th July 2020).

Approx. time	Train Direction	Sound Exposure Level (L_{AE}) dBA	Maximum Noise Level (L_{AFmax}) dBA	Ground Vibration Peak Particle Velocity (mm/s)
12:27	West	82	75	0.8
12:30	East	86	82	1.5
12:31	East	80	75	1.06
12:38	West	95*	87	0.56
12:39	West	79	73	0.79
12:50	East	80	73	0.86
12:59	West	83	78	1.8
13:01	East	99*	92	1.12
13:05	West	83	81	0.64
13:06	East	76	80	0.54
Arithmetic Average		**N/A**	**80**	**0.97**
Total Sound Energy		**101**		
Total Sound Energy/ hour		**104**		

*Notes: All results are rounded to the nearest whole decibel. The passenger trains were Country Link and City rail trains. * Freight trains were also measured. The train speeds were estimated to be 20 km/hr to 40 km/hr.*

4.6 Unattended Measurement Results - Noise

The noise measurement results at approximately 10 metres from the rail track are shown in Table 5 below :-

TABLE 5 – UNATTENDED FREIGHT TRAIN NOISE MEASUREMENT RESULTS (8th to 15th July 2020).

Date (July 2020)	Approx. time	Energy Average ($L_{Aeq, 15\ minute}$) dBA	Maximum Noise Level (L_{AFmax}) dBA
8tth	13:00	66	90
	16:00	59	84
	20:30	67	91
	21:30	63	86
	23:00	65	88
9tth	0:00	68	94
	1:00	66	90
	2:00	62	85
	2:30	64	89
	4:15	59	83
	5:30	61	85
	12:00	68	93
	20:00	65	83
	21:00	64	87
	22:15	67	89
	23:45	62	84
10th	0:15	62	86
	1:15	54	83
	2:00	64	83
	2:30	61	82
	3:00	66	90
	20:00	61	84
	23:30	68	91
11th	1:00	68	91
	1:30	60	84
	5:30	63	89
	11:15	65	89
	13:30	68	91
	20:00	61	83
	22:30	67	90
	23:45	61	80
12th	5:45	60	84
	11:45	67	91
	13:15	67	90
13th	0:15	62	86
	11:00	68	90
	11:45	69	92
	22:00	67	91
14th	4:30	69	95
	11:00	68	91
	12:00	72	95
	13:00	67	91
	21:30	63	87
	22:00	65	88
	0:15	67	90
	2:30	66	88
15th	11:00	67	91
	13:00	71	94
Logarithmic Average		**66**	**90**

See Appendix A, below for full logger results.

4.7 Measurement Results - Vibration

The vibration magnitudes from rail traffic at the proposed site were between 0.54 mm/s and 1.8 mm/s. Taking an adjustment for distance, 5 metres (measurement location) to 15 metres (railway line to nearest building facade) the vibration magnitude would not exceed 0.4 mm/s. This is below the level of perception (0.5 mm/s) for whole body vibration. Therefore, no further action is required for rail traffic vibration.

5. DISCUSSION AND CALCULATIONS

This section of the report discusses the measurement results and predicts noise levels at the proposed development. The external railway noise levels can be used to give predictions of the internal noise levels for the proposed development.

5.1 External Noise Levels

The free field external rail traffic sound exposure level (L_{AE}) at the subject site was found to be 104 dBA at the measurement location of approximately 10 metres from the railway line. The façade of the nearest proposed dwellings to be facing the railway line is at a distance of approximately 15 metres. The distances of other rooms of the development from the measurement position have been taken into account. The average of the maximum freight train noise levels (L_{AFmax}) at the nearest ground floor façade was measured at 90 dBA. The sound exposure level (L_{AE}) in one hour from train movements was found to be 104 dBA at approximately 10 metres from the nearest railway line. The noise level at the nearest façade facing the railway line at 15 metres is calculated to be **102 dBA** (from 104 - 10 $\log_{10}$ (15/10)) and **104 dBA** at the first floor front façade due to a 2 dB increase in upper storey levels found from previous measurements. Calculations are therefore based on the maximum number of freight trains in any one hour.

This can be used to calculate the hourly energy average $L_{Aeq,\ 1\ hour}$ (3600 seconds) using the formula:-

$$\begin{aligned} L_{Aeq,\ 1\ hour} &= L_{AE} - 10 \log_{10} (3600) \\ &= 104 - 35 \\ &= \mathbf{69\ dBA.} \end{aligned}$$

5.2 Internal Noise Levels - Glazing Closed

The internal noise level (L_{p2}) with windows closed is found from the formula:

$$\mathbf{L_{p2} = L_{p1} - R_w + 10\ Log_{10}\ (S/A) - K + 6\ dBA}$$

Where: L_{p1} is the external noise level ($L_{Aeq,\ 1\ hour}$);
R_w is the weighted sound reduction index of the partition;
S is the area of the partition (window or glazed door);
A is the room acoustic absorption;
K is a façade, barrier and angle of view correction.

By applying this formula, the selection of the weighted sound reduction index (R_w) for the windows and glazed doors of the proposed development for the façades can be found. The glazed areas are assumed to be the weakest acoustic partition in the façades for this project. Sheet metal roofs with sarking, ceiling insulation to R3.5 thermal rating and plasterboard ceilings will have a R_w of at least 45 dB and hence will be suitable for the roof / ceiling application. External brick veneer or cladding/plasterboard walls with wall insulation to R2.0 thermal rating will have a R_w of at least 45 dB and hence will be suitable for this application.

6. RECOMMENDATIONS

This section of the report gives recommendations, specifically on window glazing construction, to enable the proposed development to meet the noise criteria.

6.1 Minimum Glazing Thickness and R_w Rating – Glazing Closed

To meet the internal design goals as given in Table 1 above, the required glazing for the various rooms is listed in Table 6A and 6B below. For all other habitable rooms in this development 4 mm thick float glazing with a R_w of at least 24 dB is recommended. Units 1 and 2 are at a greater distance from the railway line and also shielded by units 3 and 4. Therefore, only units 3 and 4 require additional sound attenuation due to railway traffic noise as shown below.

TABLE 6A - MINIMUM GLAZING THICKNESS AND R_W RATINGS.

Room	Approximate Size of Glazing (mm)	Recommended Glazing Minimum Thickness	Required Minimum R_w or STC (dB)
Unit 3			
Bedroom 1	1200 x 1800	8.38 mm Laminated	32
En-suite	1000 x 900	6.38 mm Laminated	25
Stairs	1000 x 800	6.38 mm Laminated	23
Bedroom 2	1200 x 1800 1200 x 1800	6.38 mm Laminated	33
Bedroom 3	1200 x 1800 600 x 1800	6.38 mm Laminated	31
Bath	1000 x 900	4 mm float	24

TABLE 6B - MINIMUM GLAZING THICKNESS AND R_W RATINGS.

Room	Approximate Size of Glazing (mm)	Recommended Glazing Minimum Thickness	Required Minimum R_w or STC (dB)
Unit 4			
Family / Kitchen / Living	1200 x 1800 600 x 2400 800 x 1800 2100 x 1800 1200 x 1800 1200 x 800 500 x 600	6.38 mm Laminated	31
Bedroom 1	1200 x 1800	8.38 mm Laminated	34
	600 x 900	6.38 mm Laminated	31
En-suite	1000 x 900	6.38 mm Laminated	27
Stairs	1000 x 800	6.38 mm Laminated	25
Bedroom 2	1200 x 1800 1200 x 1800	10.38 mm Laminated	35
Bedroom 3	1200 x 1800 600 x 1800	10.38 mm Laminated	35
Bath	1000 x 900	6.38 mm Laminated	31

Notes:-

- *All glazing, given in Tables 6A and 6B above, should be fitted in well sealed frames including window frame to the brickwork;*
- *R_w = Weighted Sound Reduction Index, covers a frequency range from 100 Hz to 3.15 kHz;*
- *STC = Sound Transmission Class, is similar to R_w but covers a frequency range from 120 Hz to 4 kHz;*
- *Glazing systems recommended are minimum requirements for acoustic purposes. In some cases, thicker glass may be preferred or required for safety or other reasons.*

6.1.1 Glazing Manufacturers

Glazing manufacturers, as listed in Appendix A below, have provided attenuation data for their windows and will meet the requirements given in this report. Should other suppliers be used, laboratory test data to support the window system ratings should be provided before the glazing is fitted.

6.2 Internal Noise Levels - Glazing Open

With windows, or external glazed doors, opened sufficiently to provide adequate ventilation, i.e. at least 5% of the floor area of the room, a 10 dB reduction from the outside to the inside is usually assumed; see for example the NSW

Environmental Criteria for Road Traffic Noise (May 1999) page 14. This gives an internal level ($L_{Aeq,\ 1\ hour}$) for unit 4, with open glazing during the day time hours of 59 dBA (i.e. 69 dBA – 10 dB). This exceeds the day time criterion of 50 dBA (i.e. 40 dBA + 10 dB) as given in the Rail Infrastructure Corporation/State Rail Authority interim guidelines for applicants and Councils. Hence, ventilation is required as detailed in section 6.3 below.

The open window night time criterion of 45 dBA (i.e. 35 dBA + 10 dB) is also likely to be exceeded. However, ventilation is recommended to enable windows to be kept closed if required during hot weather conditions (see Section 6.3 below).

6.3 Ventilation

An acoustically insulated building must be kept virtually airtight to exclude external noise. Therefore, the required R_w ratings are only achieved if the glazing is closed. Hence there is a requirement for mechanical ventilation or air-conditioning to provide fresh air to control odours. Specific ventilation requirements are outside of our scope of expertise, however requirements for indoor-air quality are given in Australian Standard AS 1668.2 -2012, *"The use of ventilation and air-conditioning in buildings - Ventilation design for indoor air contaminant control"*. Internal noise levels from mechanical ventilation or air-conditioning should not exceed 35 dBA for bedroom areas and 40 dBA for all other habitable areas. External noise levels from mechanical ventilation or air-conditioning should not exceed 5 dB over the lowest existing background noise level (L_{AF90}) when in day time use and when measured at the neighbouring boundary. Night time noise levels must meet the requirements of the Protection of the Environment Operations (Noise Control) Regulation 2017.

7. SUMMARY AND CONCLUSIONS

Noise and vibration from railway train movements has been measured close to the site of the proposed new townhouses at 84 Cox Avenue, Penrith, NSW 2750. The measurements have been used to predict internal noise levels for the proposed four unit development.

The predictions have been compared to criteria given in the State Environmental Planning Policy (Infrastructure) 2007 Clause 87, Impact of rail noise or vibration on non-rail development and the Rail Infrastructure Corporation/State Rail Authority interim guidelines for Applicants 2003.

No noise exceedences are predicted provided the recommendations given in section 6 above are adhered to. No vibration exceedances are predicted.

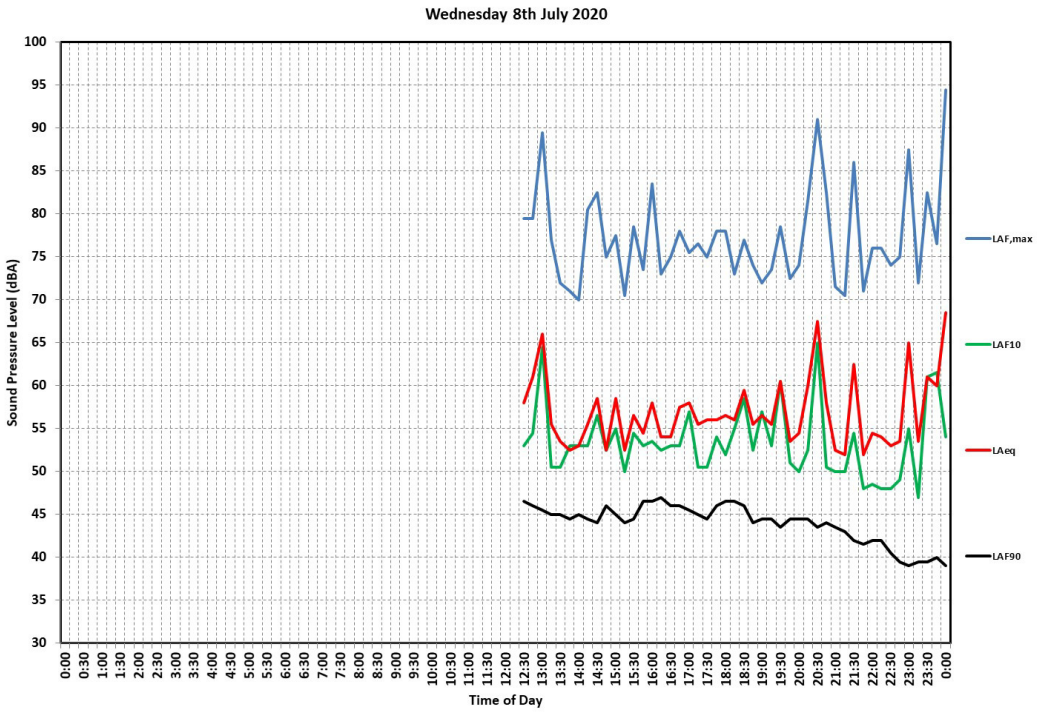
Date	Prepared by:	Status
28th July 2020	Mark Scannell BA MAAS	Draft
Date	**Checked by:**	**Status**
31st July 2020	Ken Scannell MSc MAAS	Draft
Date	**Issued by:**	**Status**
4th August 2020	Ken Scannell MSc MAAS	Final

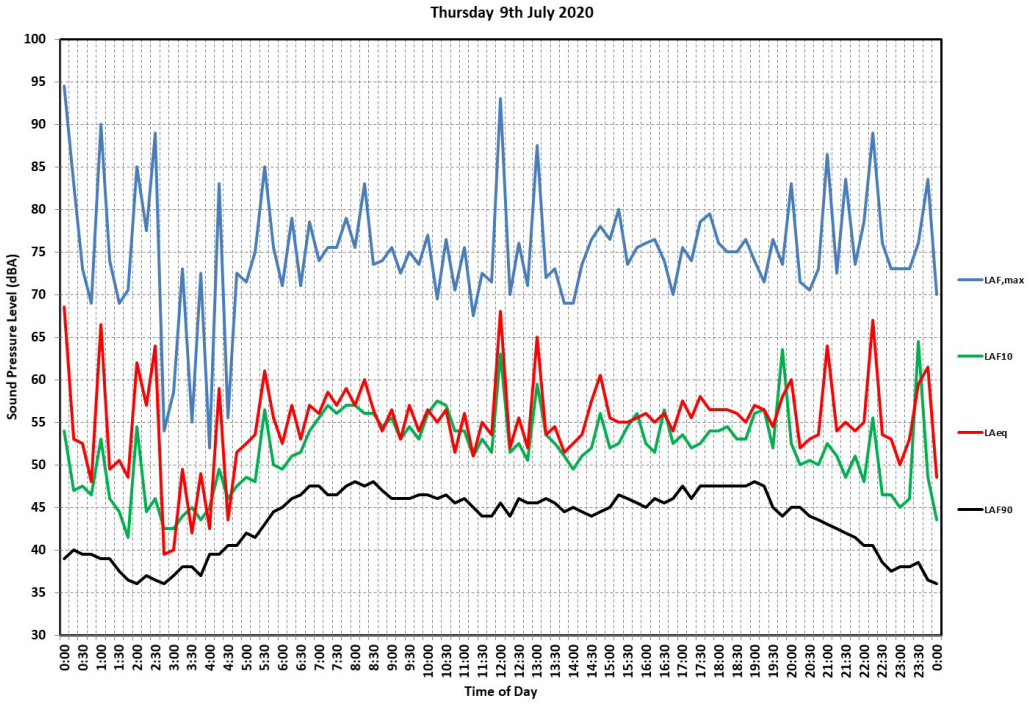
Important Note. *All products and materials suggested by 'Noise and Sound Services' are selected for their acoustical properties only. All other properties such as airflow, aesthetics, chemical, corrosion, combustion, construction details, decomposition, expansion, fire rating, grout or tile cracking, loading, shrinkage, smoke, ventilation, etc are outside of 'Noise and Sound Services' field of expertise and* ***must be*** *checked with the supplier or suitably qualified specialist before purchase.*

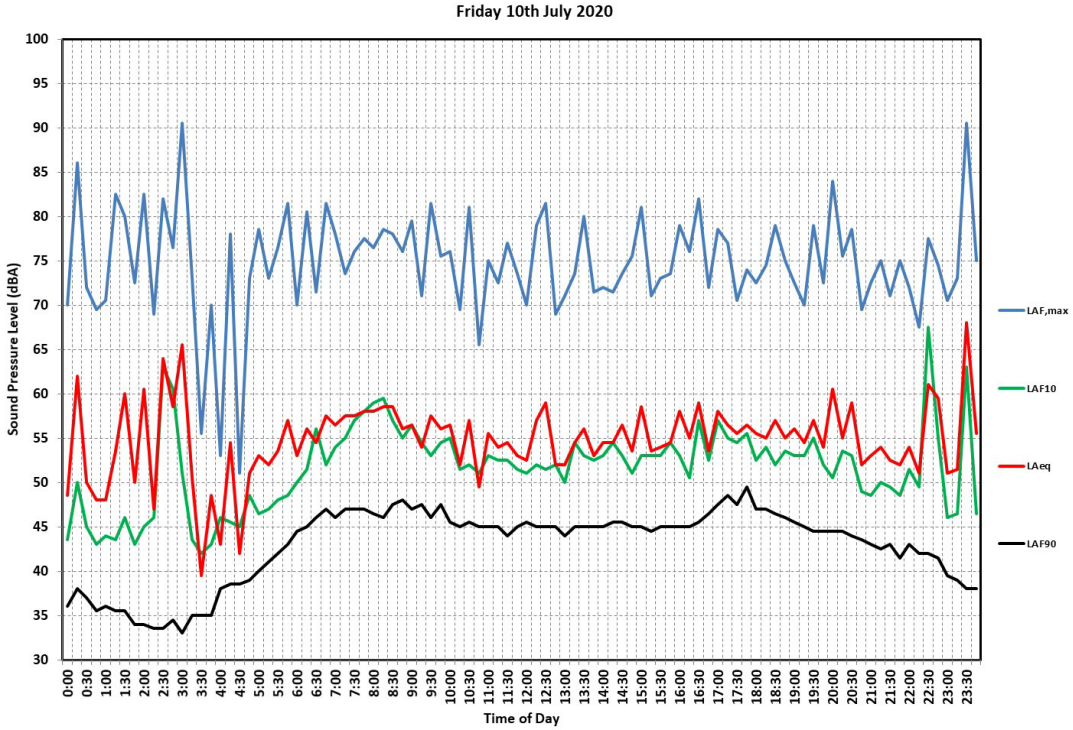
APPENDIX A – MEASURED AMBIENT AND BACKGROUND NOISE LEVELS

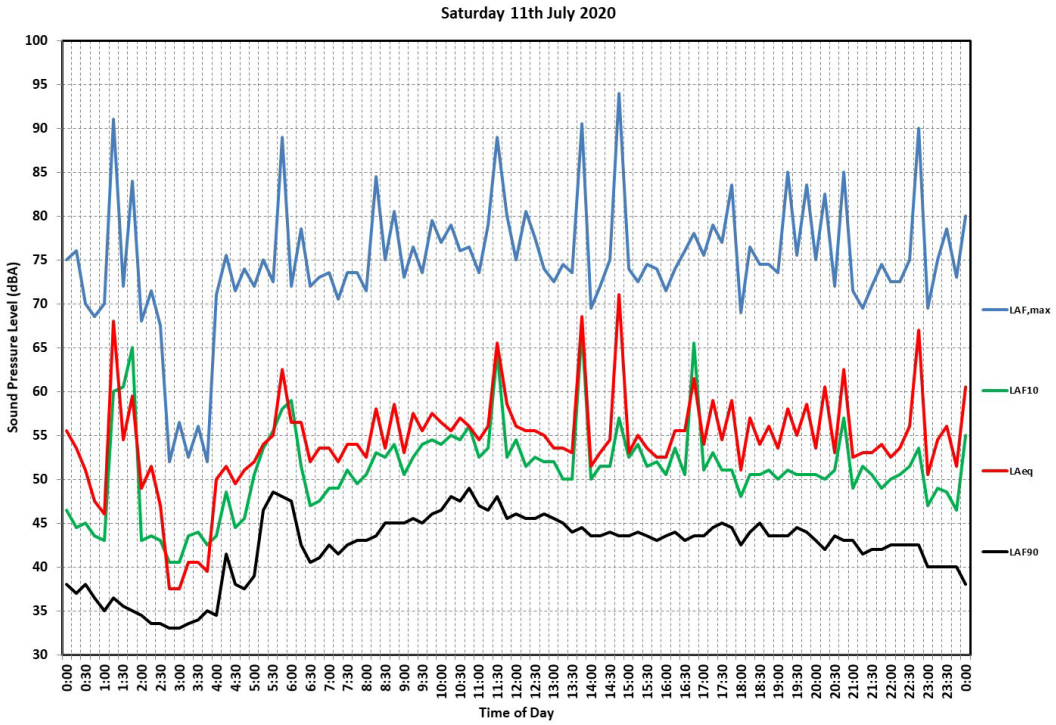
Environmental noise levels can vary considerably with time; therefore, it is not adequate to use a single number to fully describe the acoustic environment. The preferred, and now generally accepted, method of recording and presenting noise measurements is based upon a statistical approach. For example, the L_{AF10} noise level is the level exceeded for 10% of the time and is approximately the average maximum noise level. The L_{AF90} level is the level that is exceeded for 90% of the time and is considered to be approximately the average of the minimum noise level recorded. This level is often referred to as the 'background' noise level. The L_{Aeq} level represents the average noise energy during the measurement period. This level is often referred to as the 'ambient' noise level. The high maximin ($L_{AF,\,max}$) are indications of freight train movements.

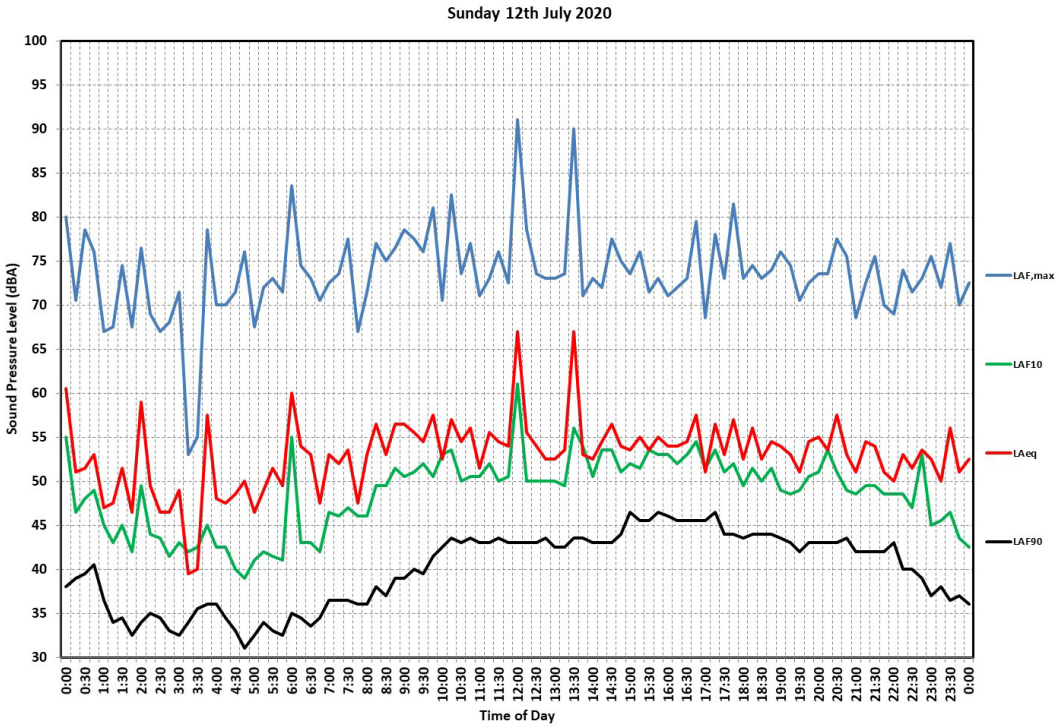
The following graphs show the noise logger results at the rear location of the subject site which represents a worst-case acoustic climate for the surrounding areas.

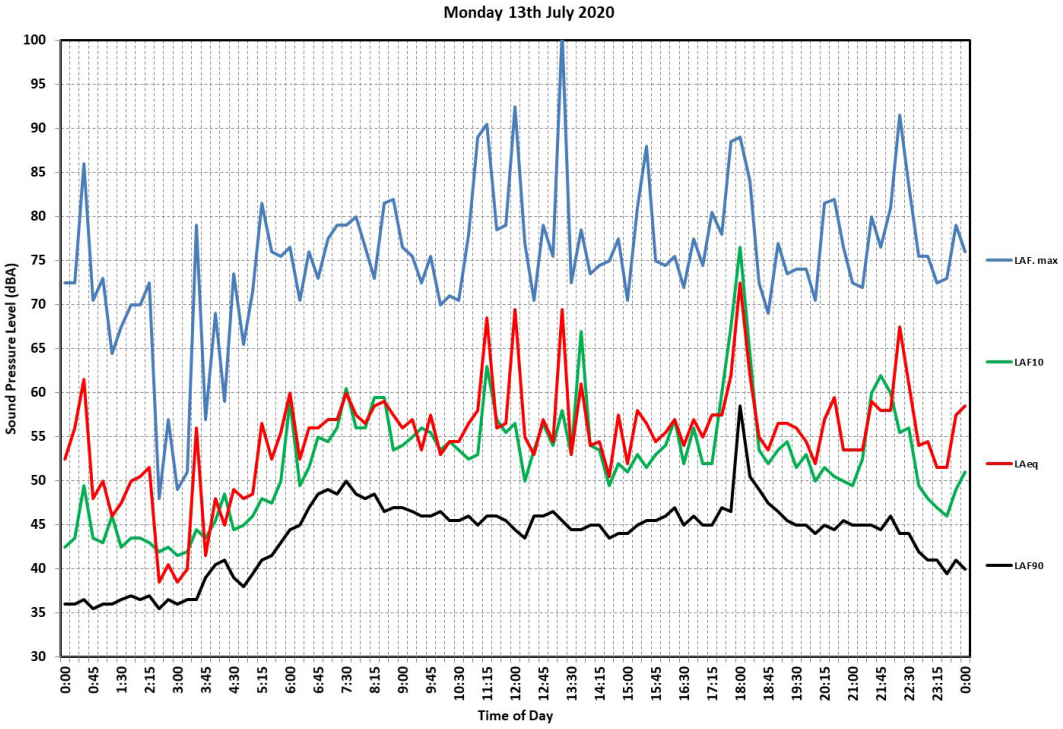


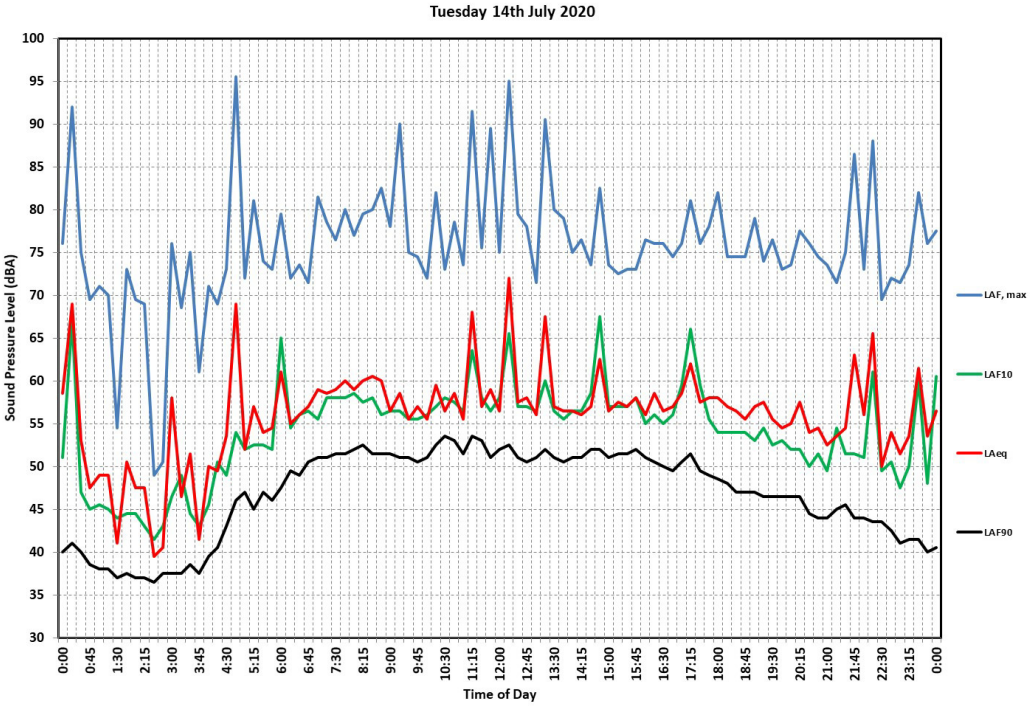

Thursday 9th July 2020
Sound Pressure Level (dBA)
Time of Day
LAF,max
LAF10
LAeq
LAF90

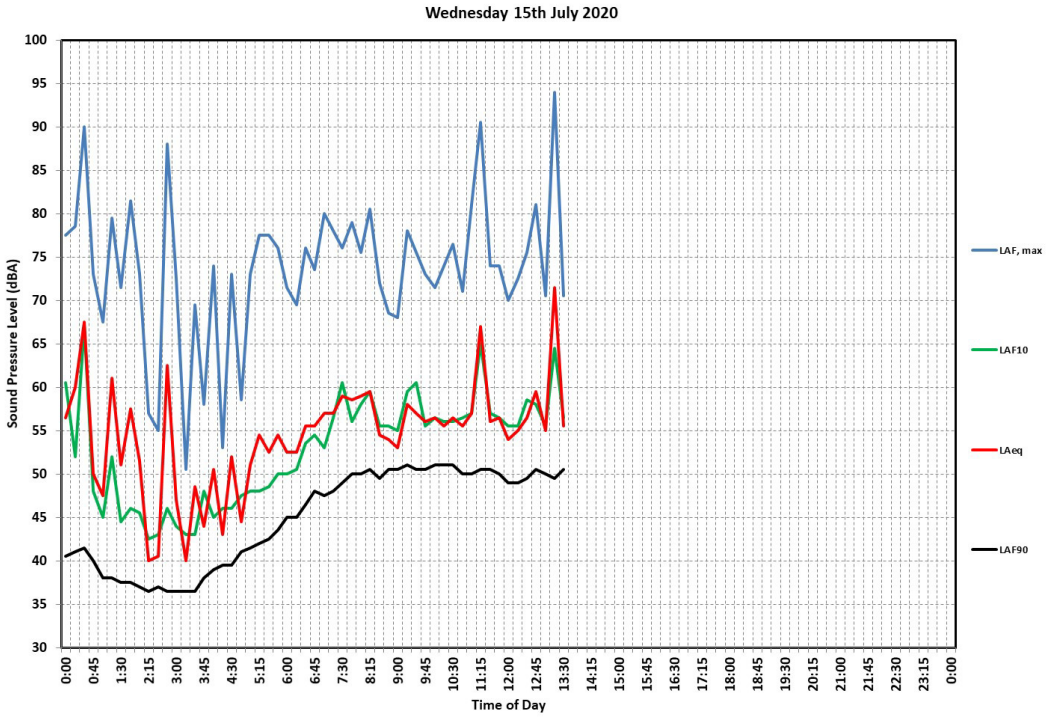

Friday 10th July 2020
Sound Pressure Level (dBA)
Time of Day
LAF,max
LAF10
LAeq
LAF90


Saturday 11th July 2020
Sound Pressure Level (dBA)
Time of Day
LAF,max
LAF10
LAeq
LAF90


Sunday 12th July 2020
Sound Pressure Level (dBA)
Time of Day
LAF,max
LAF10
LAeq
LAF90


Monday 13th July 2020
Sound Pressure Level (dBA)
Time of Day
LAF, max
LAF10
LAeq
LAF90


Tuesday 14th July 2020
Sound Pressure Level (dBA)
Time of Day
LAF, max
LAF10
LAeq
LAF90


Wednesday 15th July 2020
Sound Pressure Level (dBA)
Time of Day
LAF, max
LAF10
LAeq
LAF90

APPENDIX B - EXAMPLE MATERIAL SUPPLIERS

Acoustic Glazing Suppliers

Windows

'Trend Windows & Doors Pty Ltd' telephone (02) 9840 2000.
www.trendwindows.com.au
'Wideline Pty Ltd' telephone (02) 8304 6400.
www.windowline.com.au
'Vantage Windows' telephone 1300 026 189
http://www.awsaustralia.com.au
'Christoffel Pty Ltd' telephone (02) 9627 4811
www.christoffel.com.au/contact.htm
'Sound Barrier Systems Pty. Ltd' telephone (02) 9540 4333
www.soundbarrier.com.au
'Velux Australia Pty Ltd'
www.velux.com.au

Acoustic Absorbent Material

Pyrotek - telephone 13 17 44. www.pyroteknc.com
Tontine Website: www.spec-net.com.au/tontine/acoustic/acousorb.htm

Internal Wall-Mounted Air Ventilators

Acoustica – telephone 1300 722 825 www.acoustica.com.au
Sonair – telephone 1300 858 674 www.edmonds.com.au

Passive:
Silenceair® – telephone **02 9555 7215 www.silenceair.com.**