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Acoustic Noise and Vibration near Railway Lines, Service Station & Road Network

For Proposed Development at

No. 2-6 Pilgrim Ave & No. 11-13 Albert Road, Strathfield

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20/11/2017	Initial Report	Domeniki Tsagaris	Moussa Zaioor
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1.0 SCOPE OF WORK

The aim of this report is to determine the building materials to be used and the construction methods to be adopted such that the proposed development at No. 2-6 Pilgrim Ave & No. 11-13 Albert Road, Strathfield is built to achieve acceptable noise levels as per Strathfield Municipal Council and the NSW Government Planning and Environment Conditions/ Requirements.

Noise intrusion levels are to be within the limits adopted by Clause 87 of the State Environmental Planning Policy – (Infrastructure) 2007, Australian Standards AS 2107 'Acoustics – Recommended Design Sound Levels and Reverberation Times' and the Department of Planning's document titled "Development Near Rail Corridors and Busy Roads – Interim Guidelines", such that all habitable rooms in the proposed development shall be designed to limit internal noise levels.

The proposed development is situated on the corner of Pilgrim Ave and Albert Road in the suburb of Strathfield with the railway corridor located directly north of the site (Figure 1 – Site Location). The architectural plans by Kennedy Associates Architects dated the 21st April, 2017 are for a proposed construction of two buildings (thirteen & sixteen storeys).

This report is also a response to Item (j) in the NSW Government Planning & Environment 'Gateway Determination' letter dated the 6th November, 2017; as the site is in close vicinity to the railway corridor (Figure 2) and Service Station (Figure 3).

2.0 ACOUSTICAL STUDY

The proposed development is to comply with the Department of Planning's document titled "Development Near Rail Corridors and Busy Roads – Interim Guidelines". The noise criteria for residential buildings in Table 2.1 for both road and rail are specified in the Infrastructure SEPP. Other values in Table 2.1 are based on the Environmental Criteria for Road and Traffic Noise (EPA1999).

Table 2.0 - Noise Criteria

Residential Buildings		
Type of occupancy	**Noise Level dBA**	**Applicable time period**
Sleeping areas (bedroom)	35	Night 10 pm to 7 am
Other habitable rooms (excl. garages, kitchens, bathrooms & hallways)	40	At any time

Section 3.6.2 – Ground-borne Noise of the above mentioned standard states that residential buildings should be designed such that the 95th percentile of train pass-bys complies with the rail noise criterion for day and night time periods as below.

- **Daytime** period indoor rail noise levels for sleeping and living areas is an L_{Amax} limit of 40dB(A).
- **Night time** period indoor noise levels for living and sleeping areas is an L_{Amax} limit 35dB(A).

Ground borne noise is calculated as LAmax (slow) which refers to the maximum noise level not exceeded for 95% of rail pass-by events and is measured using the 'slow' response setting on a sound-level meter.

Ground-borne noise from rail operations can be generated when ground-borne vibration produced by a rail vehicle pass-by is re-radiated as noise inside a building by the building structure. The causes of ground-borne noise from rail operations are therefore the same as those of ground-borne vibration.

In our situation ground-borne noise is not normally noticeable as it is at a much lower level than the level of air-borne noise from rail pass-bys. Ground-borne noise may cause annoyance when there is no significant air-borne noise affecting a residence, such as where noise sensitive receivers are located above underground railways or in a mixed-use building integrating rail infrastructure.

In addition floor vibration levels in habitable rooms should comply with the criteria in British standard BS6472-1:2008 Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80 Hz).

Further, when windows and doors are left open, indoor sound levels should not exceed the nominated noise criteria by more than 10 dB(A). If noise levels exceed the nominated rail noise criteria by more than 10 dB(A), then the provision of mechanical ventilation should be incorporated in the design of the building.

2.1 Australian Standard 2107:2000 & Clause 87 of the SEPP

It is usual practice, when we find it necessary to recommend internal sound levels in buildings to refer to Australian/New Zealand Standard AS/NZS 2107:2000 "Acoustics – Recommended Design Sound Levels and Reverberations times for Building Interiors".

This standard provides recommended noise levels for steady state such as noise from building services and quasi-steady state sounds, such as traffic and rail noise. The noise levels recommended in AS/NZS 2107:2000 take into account the function of the area and apply to the sound level measured within the space unoccupied although ready for occupancy.

The standard recommends the following noise levels for residential buildings.

AUSTRALIAN STANDARD AS/NZS 2107:2000 RECOMMENDED DESIGN NOISE LEVELS, LAeq

Type of occupancy	Recommended Design Sound Level	
Activity	Satisfactory	Maximum
Houses in areas with negligible transportation		
Sleeping Areas	25	35
Houses and Apartments near minor roads		
Living Areas	30	40
Sleeping Areas	30	35
Work Areas	35	40
Apartment common areas (e.g. foyer, lift lobby)	45	55
Houses and Apartments near major roads		
Living Areas	35	45
Sleeping Areas	30	40
Work Areas	35	45
Apartment common areas (e.g. foyer, lift lobby)	45	55

Similarly, Clause 87 of the SEPP states that where the development is for residential use and is located in or adjacent to a rail corridor, a consent authority must not grant consent unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:

- in any bedroom in the building – 35dB(A) at any time between 10.00p.m. and 7.00a.m.
- anywhere else in the building (other than a garage, kitchen, bathroom or hallway) – 40dB(A) at any time.

3.0 NOISE SURVEY AND INSTRUMENTATION

On the 22nd November, 2017, unattended noise measurements were carried out at Location A (Figure 4 – Noise Reading Locations). The measurements were carried out for a period of seven (7) days to determine the existing acoustic environment and to determine the $L_{(A90,\ 15\ minutes\ [1hr])}$ and $L_{(Aeq,\ 15\ minutes\ [1\ hr])}$ in the vicinity of the proposed development and to carry out noise measurements related to the existing Service Station and the busy road network adjacent to the proposed development.

On the 28th November, we again visited the site to carry out attended noise measurements at Location B (Figure 4 – Noise Reading Locations), near the rear building line of the proposed development) in order to determine the $L_{(Aeq)}$, SEL from train pass-bys.in addition to RMS acceleration.

The measurement procedure and the equipment used for the noise survey are described below. All sound pressure levels are rounded to the nearest whole decibel. All sound level measurements and analysis carried throughout this report are carried with Svantek 957 Noise and vibration level meter which has the following features:

- Type 1 sound level measurements meeting IEC 61672:2002
- General vibration measurements (acceleration, velocity and displacement) and HVM meeting ISO 8041:2005 standard
- Three parallel independent profiles
- 1/1 and 1/3 octave real time analysis
- Acoustic dose meter function
- FFT real time analysis (1920 lines in up to 22.4 kHz band)
- Reverberation Time measurements (RT 60)
- Advanced Data Logger including spectra logging
- USB Memory Stick providing almost unlimited logging capacity
- Time domain signal recording
- Advanced trigger and alarm functions
- USB 1.1 Host & Client interfaces (real time PC "front end" application supported)
- RS 232 and IrDA interfaces
- Modbus protocol

In addition to freight trains, the railway corridor services the T1 North Shore & Northern Line, T1 Northern Line, T1 Western Line, T2 Inner West & Leppington Line, Blue Mountain Line and Central Coast & Newcastle Line. A conservative representation of determining LAeq is to record readings during peak hours, mainly 8:00- 9:00 am / 6:00-7:00 am (Mainly Passengers) & 10:00 p.m - 2:00 a.m (Mainly Freight).

Transient pass-by train events were recorded during those measurements. Typical Sound Exposure Levels (SELs) for commuter and freight trains are shown in the table below.

Table 3.0 – Measured SEL for typical train pass-by

Description	Measured Noise Level dB(A) at Octave Band Centre Frequencies (Hz)									
	dB(A)	31.5	63	125	250	500	1k	2k	4k	8k
Freight Train	**94**	58	65	69	81	91	89	87	82	69
Commuter Train	**73**	40	57	59	67	69	70	67	60	46

Another method is to carry readings for pass-by trains recording the duration, and LAeq of each pass–by. To calculate the $L_{Aeq,T}$ for a period based on measurements of all pass-bys during that period then the following equation is used:

$$L_{Aeq,T} = 10 \times log_{10}\left(\frac{\sum p_i \times 10^{0.1 \times L_i}}{T_P}\right)$$

Where:

- p_i is the duration of each pass-by, in seconds
- L_i is the L_{Aeq} noise level of the pass-by over that duration
- T_p is the duration of the total assessment period (T) in seconds

Above method is also an acceptable method of determining the Noise levels from train passbys and more accurate as it eliminates any sudden unrelated environmental noise that may occur during the unattended acoustic monitoring period. To adopt this method Section 3.4 of the "Development Near Rail Corridors and Busy Roads – Interim Guideline" requires an increase of 2dB(A) which is equivalent to increasing the number of passbys by 60 percent, or reducing the distance between the railway and receptor by 40 percent (eg: from 25 meters to 15 meters {in a straight line}).

3.1 NOISE SURVEY RESULTS

The results of the noise survey carried out adjacent to the existing service station (Figure 4 – Location A) are presented in Figure 5 - Noise Survey. Noise levels measured at the proposed rear building line (Figure 4 - Location B) between 8.00am and 9.00am to determine a conservative sample of the LAeq, (daytime) and between 10:00pm and 2:00am to determine a conservative sample of the LAeq, (nighttime). According to Sydney Trains timetable there were 136 predominately commuter train pass-by movements during the daily hour and approximately 169 during the night hours from 10:00pm and 2:00am. Each train pass-by was generally audible for up to 24 seconds.

A Summary of those readings is presented in the tables below:

Table 3.1.1- Summary of Noise Readings 22nd November, 2017 – 29th November, 2017

At Location A	**$L_{(Aeq, 15\ minutes)}$**	**$L_{(A90, 15\ minutes)}$**
Day & Evening Time – 7:00am-10:00pm	68 dB(A)	53 dB(A)
Night & Early Morning Time – 10:00pm-7:00am	63 dB(A)	46 dB(A)

Table 3.1.2 - Rail Noise Survey Results, Noise Criteria and Noise Reduction Required

At Location B					
LAeq dB(A), 7:00am – 10:00pm (Conservative Sample)			**LAeq dB(A), 10:00pm – 7:00am (Conservative Sample)**		
Outdoor Rail Noise	**Noise Criteria**	**Noise Reduction**	**Outdoor Rail Noise**	**Noise Criteria**	**Noise Reduction**
63	**40.0**	**23**	**55**	**35.0**	**20**

3.2 RAIL VIBRATION SURVEY

3.2.1 Rail Vibration Criteria

The floor vibration levels in habitable rooms should comply with the criteria in British Standard BS 6472-1:2008 Evaluation of Human Exposure to Vibration in Buildings (1 to 8 Hertz) or the Australian Standard AS2670.2:1990 Vibration and shock - Guide to the evaluation of human exposure to whole body vibration.

The building line of the proposed development is approximately 10 metres away from the centerline of the railway corridor.

BS 6472-1:2008 considers the eVDV levels for daytime and night time. The probability of adverse effects will be low when the eVDV is less than 0.4 during the daytime and less than 0.13 for the night time periods.

Table 3.2.1 – Probability of Adverse Effects for Different Vibration Levels ($m/s^{1.75}$) for Residential Buildings

Place	**Low Probability of adverse effects**	**Possibility adverse effects**	**Probable adverse effects**
Residential buildings 16hr day (Daytime)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8hr night (Night time)	0.13	0.26	0.51

3.2.2 Rail Vibration Measurement

Vibration measurements were carried out at Location B using a Vibrock V9000. Typical vibration levels by various train pass-by events were found to be as follows:

Table 1.2.2 – Measured Rail Pass-by Vibration Levels at Location B

Description	RMS Acceleration Direction X, m/s^2	RMS Acceleration Direction Y, m/s^2	RMS Acceleration Direction Z, m/s^2	Whole Body Vibration X-Y-Z, m/s^2	Event Duration, seconds
Freight Train	0.00042	0.00058	0.00081	0.0011	82
Commuter Train	0.00055	0.00069	0.00082	0.0012	29

The vibration dose, eVDV, for each train pass-by is estimated using the following formula:

eVDV = eVDV = $1.4 \times a_{rms} \times t^{0.25}$

where a_{rms} = weighted rms acceleration of train (m/s^2); and

t = time taken for the train pass-by

While the total vibration for the train pass-by is eVDV (total) = $[N(V_e)^4]^{0.25}$ where N = the number of identical events.

Using the formulas above the eVDV (total) for day was found to be less than 0.05 $m/s^{1.75}$ and much lower for the night time which complies with the criteria presented in the table from BS 6472-1:2008 as shown above.

3.2.3 Rail Vibration Assessment

The proposed development will comply with the vibration criteria without any additional vibration treatments being installed.

4.0 Mechanical Plant & Equipment Noise Assessment

There are no plans at this stage showing the basements layout and the mechanical plans servicing the building. Car park levels servicing the proposed development will be located below ground level and therefore natural ventilation becomes an issue. The mechanical ventilation system needs to achieve six air changes per hour for exhaust fume extract and ten air changes per hour for smoke clearance.

The noise from the mechanical ventilation and other mechanical plants at the above address is governed under Section 2.1 of the NSW Industrial Noise policy. Noise intrusion from the mechanical ventilation plant is generally considered acceptable if the weighted level of noise from the source measured over a 15 minutes interval does not exceed the background noise level by more than 5dB.

$$L_{Aeq,15\ minutes} < \text{background levels} + 5$$

Therefore the noise emission criterion is **53 + 5 = 58 dB(A) during the Day**
46 + 5 = 51 dB(A) during the Night

Section 3.1 of the above policy defines the background level as $L_{A90,15\ minutes}$ which is the Noise exceeded 90% percent of a time period over which annoyance reactions may occur (taken to be in 15 minute periods).

In order to achieve this, a full acoustic design will be taken place later in the CC stage. Quiet plants and equipment, enclosed fan shafts with silencers or lining the fan box with 50mm thick insulation blankets (e.g. 50mm rigid grade fibre glass) are typical ways of achieving that. A qualified acoustical consultant may be required to progressively inspect the installation of various suppression components and certify to council that it meets installation.

5.0 RECOMMENDATIONS

5.1 WINDOWS/SLIDERS, DOORS, EXTERNAL WALLS & ROOF

Building Component	Rw Rating Achieved
Sliding Windows, Sliding Doors & Skylights in Living/Dining/Kitchen Area & Bedroom *facing the railway line* are to be 10mm laminated with full perimeter Schlegel Q-Lon acoustic seals (Ph: 8707-2000).	33-36
Sliding Windows, Sliding Doors & Skylights in Living/Dining/Kitchen Area & Bedroom *facing Alfred Rd & the Service Station* are to be 10mm/12mm laminated with full perimeter Schlegel Q-Lon acoustic seals (Ph: 8707-2000).	35-39
Windows in all other Areas (Bathrooms/Laundries/Storage Areas etc) are unrestricted and to be in accordance with AS 2047 (Windows in Buildings). (1).	-
External Doors to be Solid Core 42mm thick, soft plastic gasket around sides, top & drop seal at base or any other combination having an STC of minimum 30.	30-33
External Walls are to be Double skin cavity brick walls minimum 270/250 mm double brick/brick veneer construction or any other method of wall construction with an Rw of 44. (2).	40-44
Roof is to be Galvanised Steel Roofing (0.5mm) on 10mm gypsum plaster board ceiling with 75mm thick, 11kg/m³ mineral wool batts between ceiling joists.(2).	36-40

NB: This report is to be read in conjunction with the BASIX certificate and any other related building specification. (1). All gaps between window & door frames and the masonry walls are to be sealed using acoustic foam Hilti CP620 or similar. Glass wool batts can be applied prior to the application of the foam to seal larger gaps. Full

(2) Acoustic design to take place upon DA/CC.

(3). All gaps are to be acoustically sealed.

6.0 DISCUSSION AND CONCLUSION

The proposed development at No. 2-6 Pilgrim Ave & No. 11-13 Albert Road, Strathfield if carried out as recommended in plans and specifications and including the acoustic recommendations in this report, will meet the required noise reduction levels as required by Clause 87 of the State Environmental Planning Policy – (Infrastructure) 2007, NSW Department of Planning's 'Development near Rail Corridors and Busy Roads – Interim Guideline', NSW Government Planning & Environment and Strathfield Municipal Council Conditions/Requirements.

Although adjacent to the railway line and service station, the proposed development at above address is suitable for redevelopment provided all building components comply with Section 5.1 of this report.

Should you require further explanations, please do not hesitate to contact us.

Yours Sincerely,

M. Zaioor
M.S. Eng'g Sci. (UNSW).
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7.0 APPENDIX

Figure 1 - Site Location

Figure 2 - Railway Line

Figure 3 - Service Station

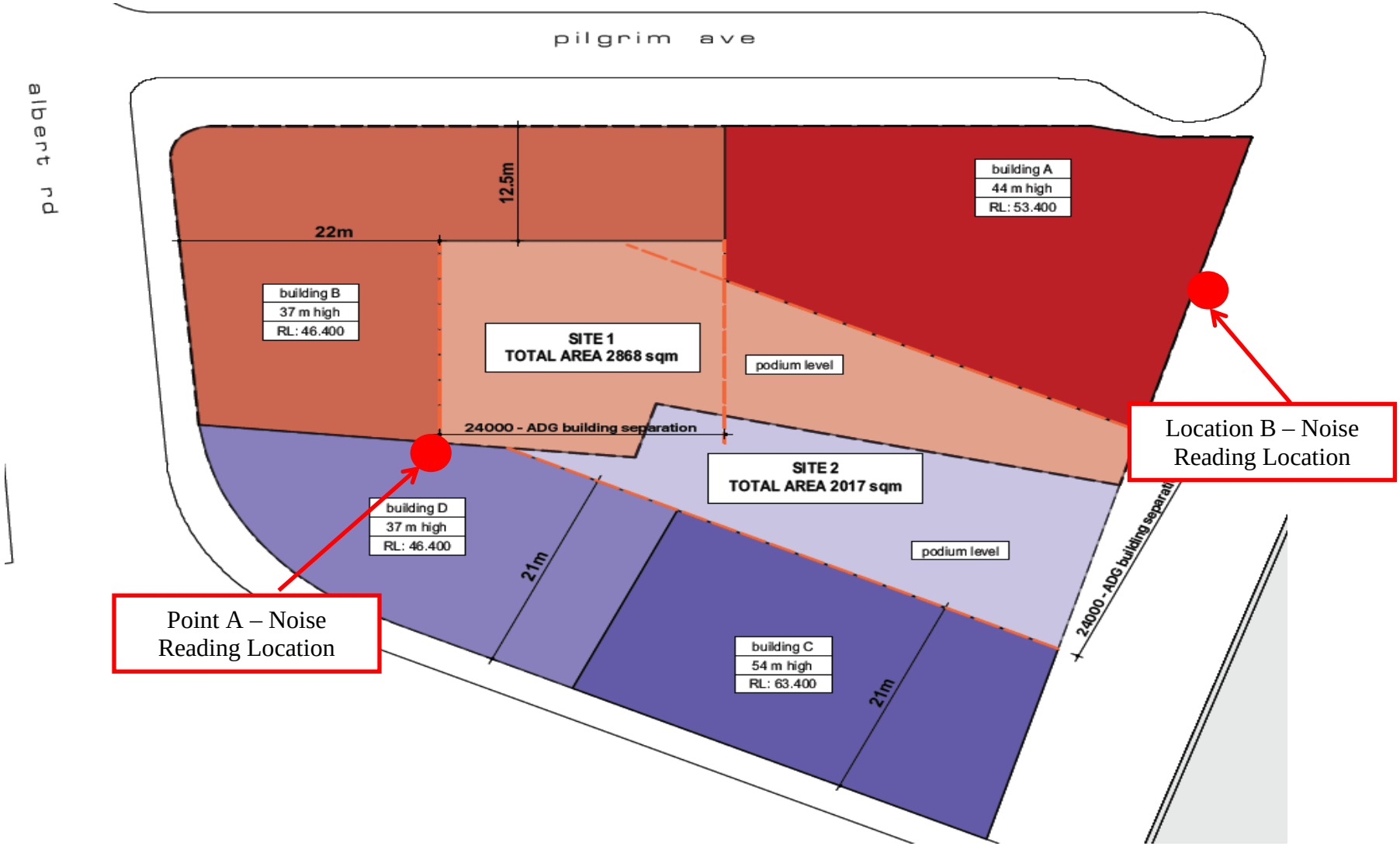

Figure 4 - Noise Reading Locations

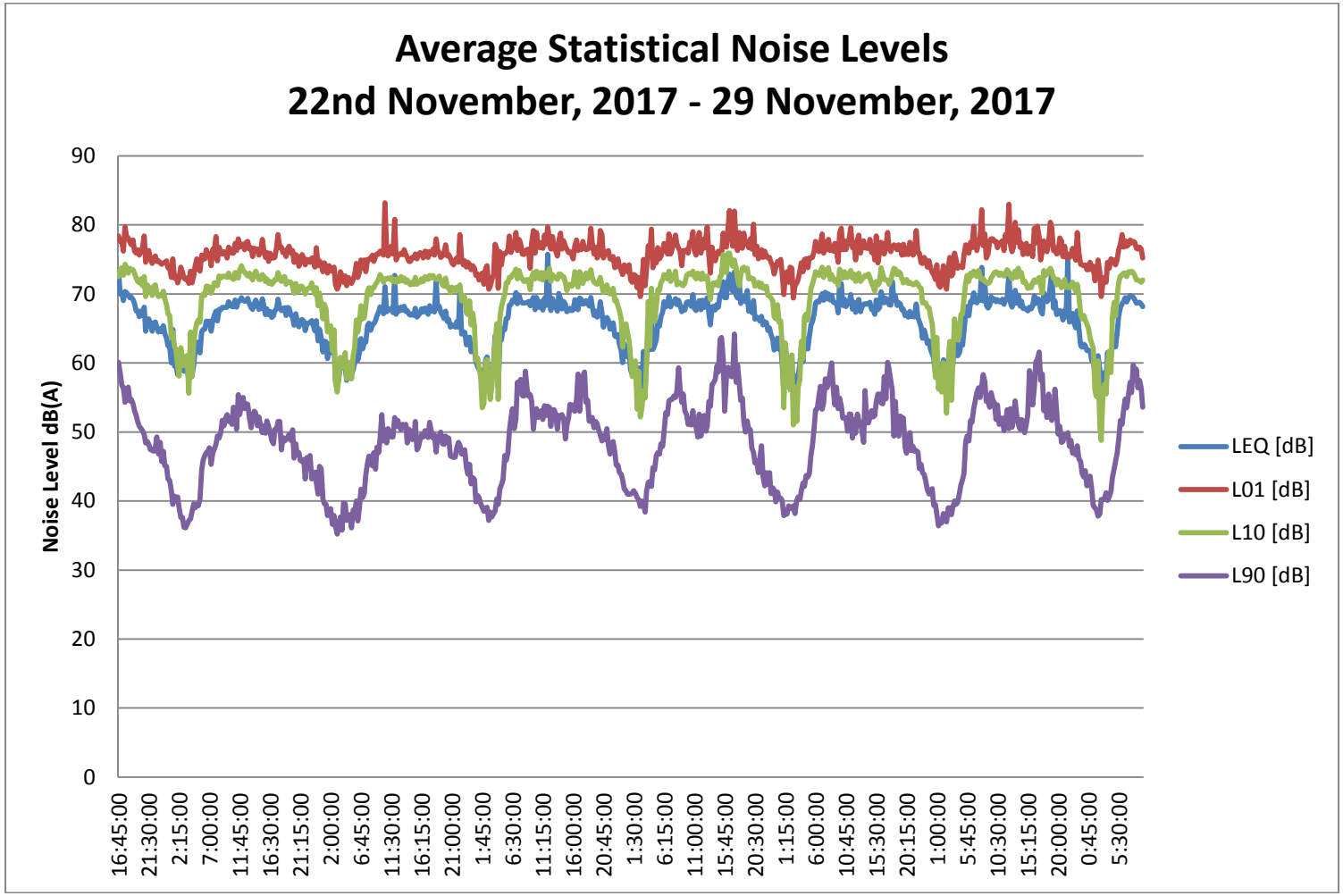

Figure 5 - Noise Survey