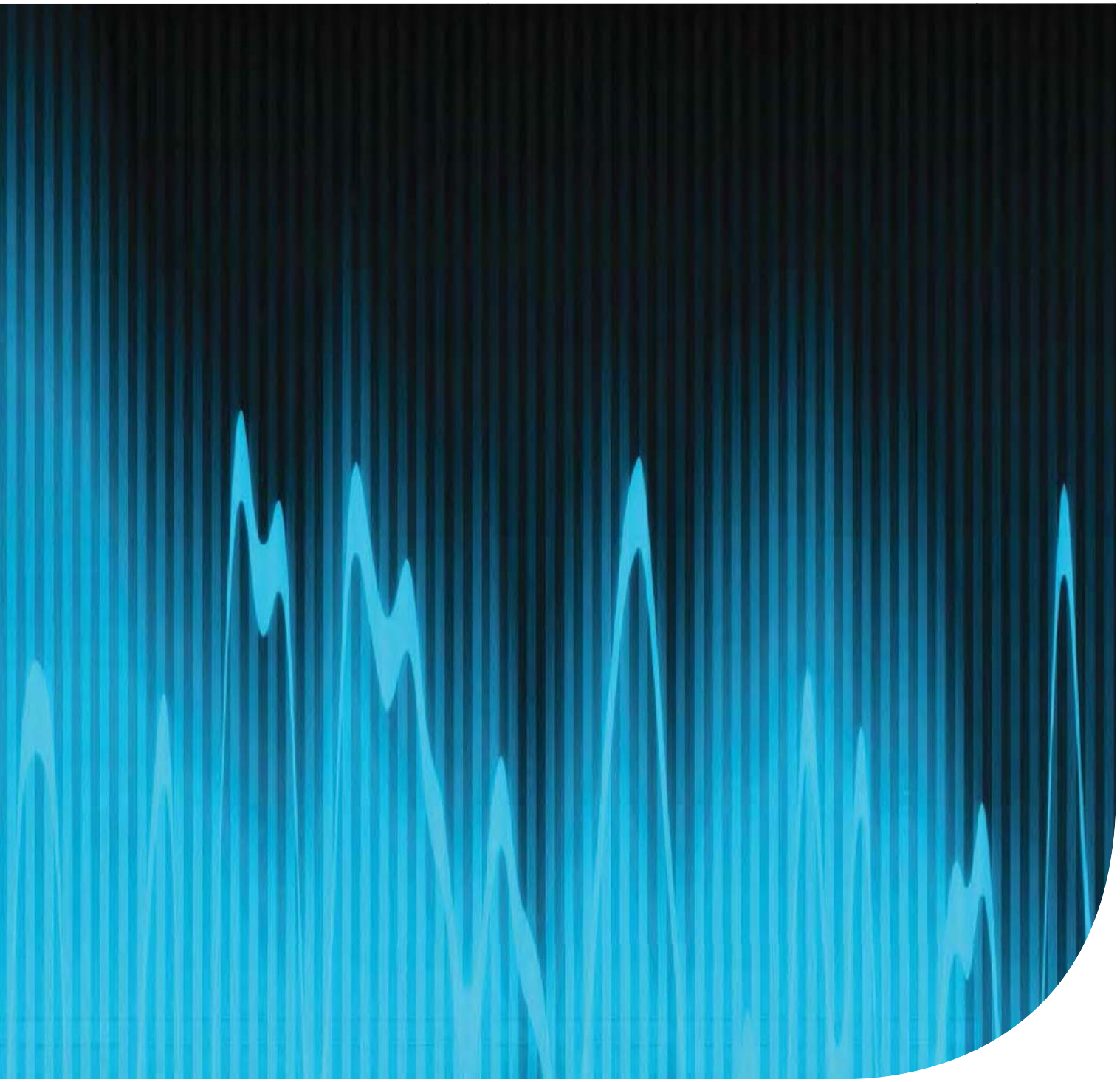
Construction noise and vibration management plan

88 Christie Street, St. Leonards

Prepared for JQZ Pty Ltd | 10 January 2018



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Construction noise and vibration management plan

Final

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Table of contents

Table of contents *(Cont'd)*

Appendices

Tables

Figures

1 Introduction

EMM Consulting Pty Limited (EMM) has been engaged by JQZ Pty Ltd to prepare a construction noise and vibration management plan (CNVMP) to support a development application (DA) for a proposed mixed use development at 88 Christie Street, St Leonards NSW (the project).

This report presents an assessment of potential noise and vibration impacts from the proposed construction works on the surrounding community and provides recommended management measures. The assessment has been developed and guided by the following:

- NSW Department of Environment and Climate Change (DECC) 2009, *Interim Construction Noise Guideline* (ICNG);
- NSW Environment Protection Authority (EPA) 2017, *Noise Policy for Industry* (NPI);
- NSW Department of Environment Climate Change and Water (DECCW) 2011, *Road Noise Policy* (RNP);
- NSW Department of Environment and Conservation (DEC) 2006, *Assessing Vibration: a technical guideline*;
- NSW Department of Planning (DoP) 2008, *Development near Rail Corridors and Busy Roads – Interim Guideline*;
- Transport for NSW (TfNSW) 2015, *External Developments (T HR CI 12080 ST)*
- Standards Australia – AS 1055.1-1997 *Acoustics - Description and measurement of environmental noise - General procedures*;
- Australian Standard AS 2436-2010 *Guide to Noise Control on Construction, Maintenance and Demolition Sites*; and
- State Environmental Planning Policy (Infrastructure) 2007.

Several technical terms are required for the discussion of noise and vibration. These are explained in Appendix A.

2 Project and site description

2.1 Project description

The proposed development is to be located at 88 Christie Street, St Leonards and will comprise one commercial building fronting the Pacific Highway, two residential tower buildings set back from the Pacific Highway (behind the commercial building), common open communal space, retail space and basement parking. The proposed works will include demolition, excavation and construction activity associated with the mixed use development. The broad construction methods and schedule are summarised in Table 2.1.

Table 2.1 Broad construction methods and schedule

Project timing	Likely activities
3 months approx.	Demolition of existing structures
6 months approx.	Piling and bulk excavation (heavy machinery and truck movements)
	Rock cutting and hammering for foundation piles and footings
18 months approx	Structural works including formwork, reinforcement and concrete pouring.
	Façade treatments consisting of aluminum and glass panels, face brick work, precast concrete panels.
	Concrete pumping and placing, grinding/cutting
12 months approx.	Internal fit-out - dry wall construction, services and various fit-out trades
6 months approx.	Civil works such as roads, pavement and landscaping

Notes: Please note that the above project timing is indicative only and may vary depending on approval, regulation, weather, etc.

2.2 Site description

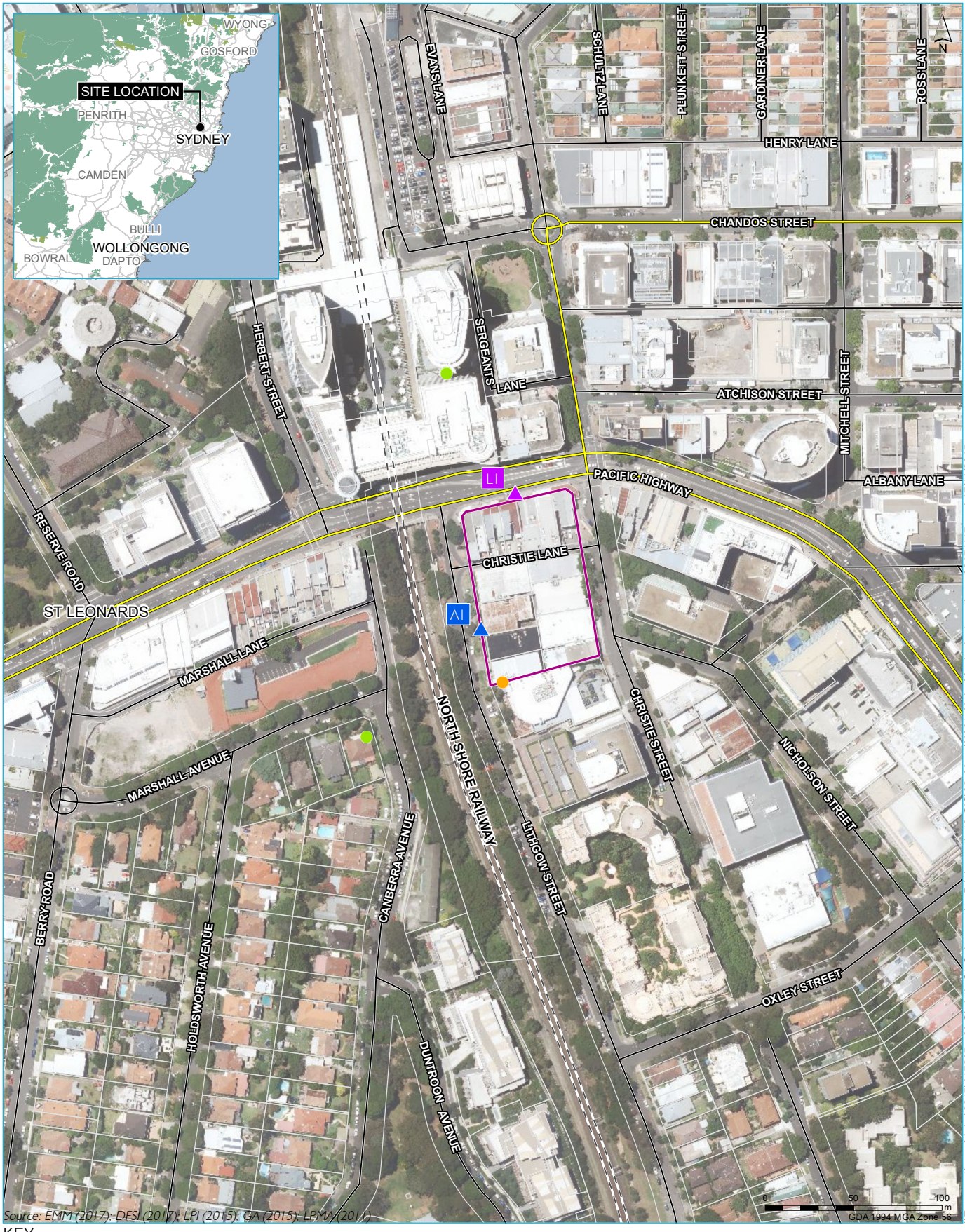
The proposed development site is bounded by the Pacific Highway to the north, Lithgow Street to the west and Christie Street to the east with commercial properties bounding the site to the south. Figure 2.1 shows the boundary of the proposed development and surrounding land uses.

The nearest noise-sensitive receptors potentially affected by noise from the subject site are residences on Marshall and Canberra Avenues (located to the west of the project site) and adjacent commercial businesses. The nearest residences are located approximately 70 m from the western boundary of the subject site while the nearest commercial properties are approximately 5-10 m from the southern boundary of the site.

2.3 Construction hours

Construction works are proposed during the following hours:

- 7:00 am – 6:00 pm, Monday to Friday;
- 7:00 am – 5:00 pm, Saturday; and
- No works to be undertaken on Sundays or public holidays.



KEY

- Site boundary
- Cadastral boundary
- Rail line
- Main road
- Local road
- Nearest commercial receiver
- Nearest residential receiver
- Attended noise monitoring location
- Unattended noise monitoring location
- NPWS reserve
- State forest

Project site and noise monitoring locations

88 Christie Street, St Leonards
Construction noise & vibration management plan
Figure 2.1

EMM

2.4 Existing ambient noise environment

Unattended noise monitoring was conducted to establish the existing ambient noise environment and road traffic noise levels at the proposed development site. An unattended noise logger (L1) was placed near the site's north-west boundary to represent the sites proposed facade. The unattended noise monitoring location can be seen in Figure 2.1.

The location of L1 was selected to record background and ambient noise levels representing potential receptors that are most exposed to road traffic noise from the Pacific Highway (eg apartments of the Forum residential towers at St Leonards station). The location of A1 was selected to capture noise levels representing the closest residences to the proposed construction site (ie residences to the west). This area is affected by noise from train passbys on the Sydney Trains T1 North shore, Northern and Western rail line.

The location of the noise logger was selected after inspection of the proposed development site, giving due consideration to other noise sources which may influence the readings (eg mechanical plant on site), the proximity of neighbouring sensitive locations to the proposed site, and security issues for the noise monitoring device.

The unattended measurements were carried out using an Acoustic Research Laboratories EL316 environmental noise logger (serial number 16-207-005). The noise logger was in place from 27 October to 9 November 2017 (14 days).

The noise logger was programmed to record statistical noise level indices continuously in 15 minute intervals in accordance with the requirements of the NPI, including the L_{Amax}, L_{A1}, L_{A10}, L_{A50}, L_{A90}, L_{A99}, L_{Amin} and the L_{Aeq}. Calibration of all instrumentation was checked prior to and following measurements. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

Weather data for the survey period was obtained from the Bureau of Meteorology automatic weather stations (AWS) at Fort Denison (AWS ID 066022) and Observatory Hill (AWS ID 066062), approximately 4.5 km south-east and 4 km south-south-east of the site, respectively. The wind speed (from Fort Denison) and the rainfall data (from Observatory Hill) was used to exclude noise data during periods of any rainfall and/or wind speed in excess of 5 m/s (approximately 9 knots) at the microphone height in accordance with NPI methods.

A summary of the existing background and ambient noise levels is provided in Table 2.2. Daily results and charts from the unattended noise logger are provided in Appendix B.

Table 2.2 Ambient noise monitoring results summary

Monitoring location	Period[1]	$L_{Aeq,period}$ (dB)	RBL (dB)
L1 (adjacent to Pacific Highway)	Day	73	62
	Evening	71	55
	Night	67	46
A1 (adjacent to Lithgow Street and rail line)[4]	Day	69	53
	Evening	-	46
	Night	-	37

Notes. *1. The daytime is 7 am to 6 pm; evening 6 pm to 10 pm; night-time 10 pm to 7 am. On Sundays and Public Holidays, the daytime is 8 am to 6 pm; evening 6 pm to 10 pm; night-time 10 pm to 8 am.*

2. The RBL is an NPI term and is used represent the background noise level.

3. L_{Aeq} is the energy averaged noise level over the measurement period and representative of general ambient noise. It is used for day (7 am to 10 pm) and night (10 pm to 7 am).

4. The daytime RBL for A1 has been calculated using short-term attended measurements cross correlated with the noise monitoring data from L1. The evening and night RBLs for A1 reflect the relationships between the RBLs at L1.

For the purpose of establishing relevant construction noise criteria at the western residential areas, the daytime RBL determined at monitoring location A1 has been utilised. Background noise levels at this location are the lowest of the two monitoring locations and most representative of the closest residential properties.

3 Construction noise guidelines

The ICNG provides guidelines for the assessment and management of noise from construction works.

The ICNG suggests the following time restriction for construction activities where the noise is audible at residential premises:

- Monday to Friday 7.00 am–6.00 pm;
- Saturday 8.00 am–1.00 pm; and
- No construction work is to take place on Sundays or public holidays.

Table 3.1 is an extract from the ICNG and provides noise management levels for residential receivers for both recommended standard construction hours and outside of these periods. These time restrictions are the primary management tool of the ICNG.

Table 3.1 ICNG residential criteria

Time of day	Management level $L_{Aeq,15\ minute}$	How to apply
Recommended standard hours: Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq,15\ minute}$ 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 residents 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	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, taking into account: i) 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; and ii) 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 + 5 dB	• 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.

In summary, the ICNG noise level goals for activities during standard construction hours are 10 dB above the existing background levels. Table 3.2 is an extract from the ICNG and provides noise management levels for other land uses.

Table 3.2 ICNG noise levels at other land uses

Land use	Management level, $L_{Aeq,15\ minute}$
Industrial premises	External noise level 75 dB (when in use)
Offices, retail outlets	External noise level 70 dB (when in use)
Classrooms at schools and other educational institutions	Internal noise level 45 dB (when in use)
Hospital wards and operating theatres	Internal noise level 45 dB (when in use)
Places of worship	Internal noise level 45 dB (when in use)
Active recreation areas	External noise level 65 dB (when in use)
Passive recreation areas	External noise level 60 dB (when in use)

Source: ICNG (DECC, 2009).

The construction noise management levels (NMLs) for this assessment presented in Table 3.3 have been developed using the noise monitoring data provided in Section 2.4 and in accordance with the ICNG.

Table 3.3 Construction noise management levels

Receiver	Period	Representative RBL, dB(A)	NML[1], $L_{Aeq,15\ minute}$, dB
Residential - west (nearest potentially affected)	Recommended standard hours	53	63
	Outside recommended standard hours	53	58
Residential - north	Recommended standard hours	62	72 75 (highly noise affected)
	Outside recommended standard hours	62	67
Offices, retail outlets	When in use	N/A	70
Neighbouring industrial premises	When in use	N/A	75
Classrooms	When in use	N/A	45 (Internal)/55 (External)
Hospital wards and operating theatres	When in use	N/A	45 (Internal)/55 (External)
Places of worship	When in use	N/A	45 (Internal)/55 (External)
Active recreation areas	When in use	N/A	65
Passive recreation areas	When in use	N/A	60

Notes: N/A = not applicable.

1. External noise levels, except where noted.

4 Construction vibration guidelines

4.1 Human comfort – Assessing vibration a technical guideline

Environmental Noise Management – Assessing Vibration: a technical guideline (DEC, 2006) is based on guidelines contained in *BS 6472 – 2008, Evaluation of human exposure to vibration in buildings (1-80Hz).*

The guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. At vibration values below the preferred values, there is a low probability of adverse comment or disturbance to building occupants. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, it is recommended the operator negotiate directly with the affected community.

The guideline defines three vibration types and provides direction for assessing and evaluating the applicable criteria. Table 2.1 of the guideline provides examples of the three vibration types and has been reproduced in Table 4.1.

Table 4.1 Examples of types of vibration (from Table 2.1 of the guideline)

Continuous Vibration	Impulsive Vibration	Intermittent Vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZECC (1990).	Trains, intermittent nearby construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer these would be assessed against impulsive vibration criteria.

4.1.1 Continuous vibration

Appendix C of the guideline outlines acceptable criteria for human exposure to continuous vibration (1-80Hz). The criteria are dependent on both the time of activity (usually daytime or night-time) and the occupied place being assessed. Table 4.2 reproduces the preferred and maximum criteria relating to measured peak velocity.

Table 4.2 Criteria for exposure to continuous vibration

Place	Time	Peak velocity (mm/s)	
		Preferred	Maximum
Critical working Areas (e.g. hospital operating theatres, precision laboratories)	Day or night-time	0.14	0.28
Residences	Daytime	0.28	0.56
	Night-time	0.20	0.40
Offices	Day or night-time	0.56	1.1
Workshops	Day or night-time	1.1	2.2

Notes: 1. RMS velocity (mm/s) and vibration velocity value (dB re 10^{-9} mm/s).

2. Values given for most critical frequency >8 Hz assuming sinusoidal motion.

4.1.2 Intermittent vibration

Intermittent vibration (as defined in Section 2.1 of the guideline) is assessed using the vibration dose concept which relates to vibration magnitude and exposure time.

Intermittent vibration is representative of activities such as impact hammering, rolling or general excavation work (such as an excavator tracking).

Section 2.4 of the Guideline provides acceptable values for intermittent vibration in terms of vibration dose values (VDV) which requires the measurement of the overall weighted RMS (root mean square) acceleration levels over the frequency range 1 Hz to 80 Hz. To calculate VDV the following formula (refer *section 2.4.1* of the guideline) was used:

$$VDV = \left[\int_0^T a^4(t)dt\right]^{0.25}$$

Where VDV is the vibration dose value in $m/s^{1.75}$, *a (t)* is the frequency-weighted rms of acceleration in m/s^2 and *T* is the total period of the day (in seconds) during which vibration may occur.

The Acceptable Vibration Dose Values (VDV) for intermittent vibration are reproduced in Table 4.3.

Table 4.3 Acceptable vibration dose values (VDV) for intermittent vibration (m/s $^{1.75}$)

Location	Daytime		Night-time	
	Preferred value, m/s$^{1.75}$	Maximum value, m/s$^{1.75}$	Preferred value, m/s$^{1.75}$	Maximum value, m/s$^{1.75}$
Critical Areas	0.10	0.20	0.10	0.20
Residences	0.20	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes: *1. Daytime is 7 am to 10 pm and night-time is 10 pm to 7 am.*

2. These criteria are indicative only, and there may be a need to assess intermittent values against continuous or impulsive criteria for critical areas.

There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values. The Guideline states that activities should be designed to meet the preferred values where an area is not already exposed to vibration.

4.2 Structural vibration criteria

Most commonly specified "safe" structural vibration limits are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have potential to cause damage to the main structure.

In terms of the most recent relevant vibration damage criteria, Australian Standard AS 2187.2 - 2006 "*Explosives* - Storage *and Use* - *Use of Explosives*" recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 *"Evaluation and measurement for vibration in buildings Part 2*" be used as they are "applicable to Australian conditions".

The standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration that are considered in the standard include demolition, blasting (carried out during mineral extraction or construction excavation), piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 4.4 and graphically in Figure 4.1.

Table 4.4 Transient vibration guide values - minimal risk of cosmetic damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

The standard states that the guide values in Table 4.4 relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings.

Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 4.4 may need to be reduced by up to 50%.

Sheet piling activities (for example) are considered to have the potential to cause dynamic loading in some structures (eg residences) and it may therefore be appropriate to reduce the transient values by 50%.

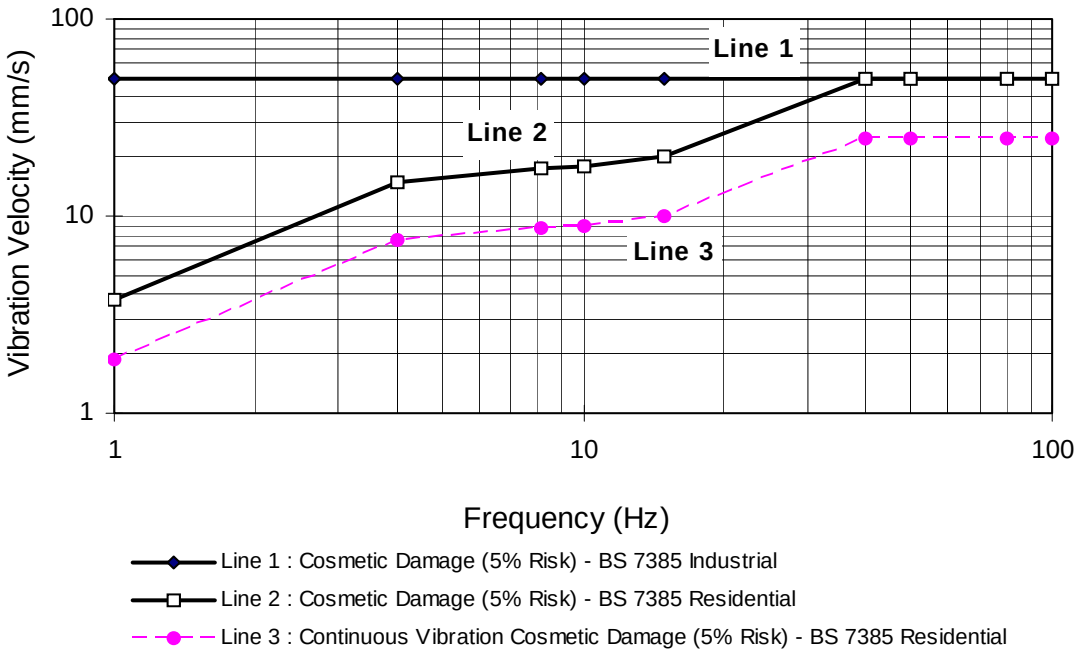


Figure 4.1 Graph of transient vibration guide values for cosmetic damage

In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for building types corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz. The standard goes on to state that minor damage is possible at

vibration magnitudes which are greater than twice those given in Table 4.4, and major damage to a building structure may occur at values greater than four (4) times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in Table 4.4 should not be reduced for fatigue considerations.

In order to assess the likelihood of cosmetic damage due to vibration, AS2187 specifies that vibration measurements should be undertaken at the base of the building and the highest of the orthogonal vibration components (transverse, longitudinal and vertical directions) should be compared with the criteria curves presented in Table 4.4.

It is noteworthy that extra to the guide values nominated in Table 4.4, the standard states that:

> "Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."

Also that:

> "A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive."

5 TfNSW and RMS requirements

Condition 6.4 of the TfNSW standard for External Developments (T HR CI 12080 ST) states that:

> The effects of noise and vibration from rail operations shall be considered in the design of the development. The noise from construction and rail operation shall be considered against statutory and project noise vibration limit requirements.

Additionally, Clauses 87 (Rail) and 102 (Road) of SEPP (Infrastructure) 2007 state:

> **Clause 87:** Development for any of the following purposes that is on land that is in or immediately adjacent to a rail corridor and the consent authority considers development is likely to be adversely affected by rail noise or vibration:
>
> - building for residential use
> - a place of public worship
> - a hospital
> - an educational establishment or childcare centre
>
> **Clause 102:** development for any of the following purposes that is on land in or adjacent to a road corridor for a freeway, a tollway or a transit way or any other road with an annual average daily traffic volume of more than 40,000 vehicles (based on the traffic volume data available on the website of the RTA) and that the consent authority considers is likely to be adversely affected by road noise or vibration:
>
> - building for residential use
> - a place of public worship
> - a hospital
> - an educational establishment or childcare centre

If the development, specified in Clauses 87 and 102, is a building for residential use, the consent authority must be satisfied that appropriate measures will be taken to ensure that the following L_{Aeq} levels are not exceeded:

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

EMM's acoustical assessment prepared for the purpose of the development application for the project (refer *Acoustic Assessment, 88 Christie Street, St Leonards* dated 17 November 2017) is considered to address these requirements.

6 Construction noise assessment

6.1 Typical construction equipment

The construction noise impact assessment has adopted equipment noise emission values obtained from the EMM noise database for plant used on similar projects.

Table 6.1 summarises typical equipment items, sound power level and quantities adopted in the noise modelling for each proposed phase of works.

Table 6.1 Typical construction equipment

Equipment	Quantity (worst case per 15-minute period)	Sound power level, $L_{Aeq,15minute}$ (dB)[1]
Demolition and earthworks		
Piling rig	2	116
Excavator including rock-hammer	1	120
Excavator	4	105
825 Compactor	1	106
Dozer	1	108
Roller (up to 20T)	3	107
Truck & Dog	2	104
Structural works		
Concrete trucks	6	108
Concrete pumping	2	110
Crane	2	99
Internal fit-out and civil works		
Concrete trucks	6	108
Crane	2	99
Hand tools	numerous	102
Generator	1	99

Notes: 1. Plant has been assumed to operate continuously in any 15-minute period.

6.2 Construction noise modelling method and results

Construction noise levels have been predicted to the nearest noise-sensitive receivers assuming attenuation due to distance only.

Construction equipment has been modelled at possible locations nearest to and furthest away from the nearest residence to represent the range of noise levels that may be experienced over the relevant periods. Indicative noise predictions are provided in Table 6.2 for each phase of construction activity.

Table 6.2 Construction noise predictions

Representative receiver	Distance	Indicative predicted noise level $L_{Aeq,15\ minute}$	Construction noise goal $L_{Aeq,15\ minute}$
Nearest residences (to west)	70-185 m	Demolition and earthworks 70-79 dB Structural works 65-73 dB Internal fit-out and civil works 63-71 dB	63 dB (Recommended standard hours) 58 dB (Outside recommended standard hours)
Nearest residences (to north)	90-190 m	Demolition and earthworks 70-76 dB Structural works 64-71 dB Internal fit-out and civil works 63-69 dB	72 dB (Recommended standard hours) 67 dB (Outside recommended standard hours)
Surrounding offices/retail outlets	5-100 m	Demolition and earthworks 75-101 dB Structural works 70-96 dB Internal fit-out and civil works 68-94 dB	70 dB (when in use)

Predictions presented in Table 6.2 are typical of construction works of this nature and in proximity to neighbours. Therefore, as would be expected, construction noise levels are likely to be above the recommended noise goals at times during all periods of proposed activity. Given that the predictions assume equipment operating simultaneously and at the nearest locations to the relevant residential dwellings it is likely that actual construction noise levels would be significantly less than those predicted for the majority of the time. Notwithstanding, the proponent will actively manage construction noise from the site. Further advice and discussion is provided in Section 8 in this regard and forms the focus of this CNVMP.

7 Construction vibration assessment and ground-borne vibration (safe working distances)

It is not yet known exactly what methods and/or vibration generating equipment will be utilised for the project. As a guide, safe working distances for typical items of vibration intensive plant are listed in Table 7.1. The safe working distances are quoted for both "Cosmetic Damage" (refer British Standard BS 7385) and "Human Comfort" (refer British Standard BS 6472-1).

Table 7.1 Recommended safe working distances for vibration intensive plant

Plant Item	Rating/Description	Safe working distance	
		Cosmetic damage (BS 7385)	Human response (BS 6472)
Vibratory Roller	<50kN (Typically 1-2 tonnes)	5 m	15 to 20 m
	<100kN (Typically 2-4 tonnes)	6 m	20 m
	<200kN (Typically 4-6 tonnes)	12 m	40 m
	<300kN (Typically 7-13 tonnes)	15 m	100 m
	>300kN (Typically 13-18 tonnes)	20 m	100 m
	>300kN (>18 tonnes)	25 m	100 m
Small hydraulic hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium hydraulic hammer	(900 kg - 12 to 18t excavator)	7 m	23 m
Large hydraulic hammer	(1600 kg - 18 to 34t excavator)	22 m	73 m
Vibratory pile driver	Sheet piles	2 m to 20 m	20 m
Pile boring	≤ 800 mm	2 m (nominal)	N/A
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

Source: From Transport Infrastructure Development Corporation Construction's Construction Noise Strategy (Rail Projects), November 2007.

The safe working distances presented in Table 7.1 are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions.

In relation to human comfort response, the safe working distances in Table 7.1 relate to continuous vibration and apply to residential receivers. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed, as discussed in BS 6472-1.

The nearest residences are located approximately 70 m from the western boundary and the nearest commercial premises are located approximately 5 m from the southern boundary. Further, the proposed development is located approximately 25 m from the edge of a rail corridor and 5 m from a busy road (Pacific Highway).

To predict the level of vibration that may occur at nearby structures is complex and therefore in the first instance the guide values presented in Table 7.1 should be followed. It is possible that some vibratory activities will occur within relatively close distance of nearby structures, roads and rail corridors and therefore management of vibration levels will be required. For example, if a large hydraulic hammer is operated within 22 m of a surrounding structure, then there is potential for cosmetic damage goals to be

exceeded and therefore triggering the need for management. Construction vibration management measures are presented in Section 8 and are the focus of this CNVMP.

8 Mitigation and management

As provided in Section 6, it is likely that noise levels will be above the relevant noise management levels at times during the likely construction activities. It is also possible that vibration levels generated at the project site could be above the relevant human comfort and structural vibration criteria.

Section 8.1 provides site-specific noise and vibration mitigation and management measures that will be implemented at the site and the subsequent sections provide further good practice recommendations in this regard.

8.1 Site-specific mitigation and management

The following measures will be implemented at the site with the aim of reducing construction noise and vibration levels below the relevant goals:

- Minimise the number of plant items operating concurrently when in close proximity to surrounding receivers.
- Minimise the need for vehicle reversing for example, by arranging for one-way site traffic routes.
- Noise and vibration monitoring will be adopted as a management strategy throughout the construction works. The purpose of monitoring would be to validate background noise levels, the construction noise predictions and to confirm that the noise and vibration levels from individual items of equipment are not excessive. Ideally, monitoring would be undertaken at the commencement of works and during (or soon after) any significant change in activity. Further information regarding the proposed monitoring program is provided in Section 9.

8.2 Adoption of general noise & vibration management practices (AS 2436-2010)

AS 2436-2010 *"Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites"* sets out numerous practical recommendations to assist in mitigating construction noise emissions. Examples of strategies that could be implemented on the subject project are listed below.

8.2.1 Universal work practices

These include:

- regular reinforcement (such as at toolbox talks) of the need to minimise noise and vibration;
- regular identification of noisy activities and adoption of improvement techniques;
- avoiding the use of portable radios, public address systems or other methods of site communication that may unnecessarily impact upon nearby residents;
- developing routes for the delivery of materials and parking of vehicles to minimise noise;
- where possible, avoiding the use of equipment that generates impulsive noise;
- minimising the movement of materials and plant and unnecessary metal-on-metal contact;
- minimising truck movements; and

- scheduling respite periods for intensive works as determined through consultation with potentially affected neighbours (eg a daily respite period for a minimum of one hour at midday).

8.2.2 Plant and equipment

Additional measures for plant and equipment include:

- choosing quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks;
- using temporary noise barriers (in the form of plywood hoarding or similar) to shield intensive construction noise activities from residences;
- operating plant and equipment in the quietest and most efficient manner; and
- regularly inspecting and maintaining plant and equipment to minimise noise and vibration level increases, to ensure that all noise and vibration reduction devices are operating effectively.

8.2.3 Work scheduling

- scheduling activities to minimise impacts by undertaking all possible work during hours that will least adversely affect sensitive receivers and by avoiding conflicts with other scheduled events;
- scheduling work to coincide with non-sensitive periods;
- scheduling noisy activities to coincide with high levels of neighbourhood noise so that noise from the activities is partially masked and not as intrusive;
- planning deliveries and access to the site to occur quietly and efficiently and organising parking only within designated areas located away from the sensitive receivers;
- optimising the number of deliveries to the site by amalgamating loads where possible and scheduling arrivals within designated hours;
- designating, designing and maintaining access routes to the site to minimise impacts;
- include contract conditions that include penalties for non-compliance with reasonable instructions by the principal to minimise noise or arrange suitable scheduling; and
- high vibration generating activities should only be carried out in continuous blocks, with appropriate respite periods as determined through consultation with potentially affected neighbours.

9 Noise and vibration monitoring

To maximise the effectiveness of management strategies to minimise noise emissions, a monitoring program has been developed to guide, manage, quantify and control emissions from construction activities. Where monitoring results indicate exceedances of the relevant noise and vibration goals, additional feasible and reasonable mitigation measures and controls would be considered to minimise impacts to nearby sensitive receivers.

9.1 Objectives

After the commencement of acoustically significant activities or where complaints are received, monitoring should be conducted to quantify construction noise and vibration levels and to verify these levels within the community.

The objectives of the monitoring program would be as follows:

- assess construction noise and vibration levels against relevant goals, with consideration given to non-site related ambient and background noise and vibration at the time of measurements;
- identify potential noise and vibratory sources and their relative contribution to impacts from construction activity;
- specify appropriate intervals for monitoring to evaluate, assess and report the relative contribution due to construction activity;
- outline the methodologies to be adopted for monitoring construction noise and vibration, including justification for monitoring intervals or triggers, weather conditions, monitoring location selection and timing; and
- incorporate noise and vibration management and mitigation strategies outlined in this plan.

9.2 General noise measurement procedures

The noise measurement procedures adopted for the project shall be in accordance with AS 1055-1997 *Acoustics - Description and Measurement of Environmental Noise*.

All acoustic instrumentation used in the monitoring of construction should comply with the requirements of IEC 61672.1-2004 and carry current NATA or manufacturer calibration certificates. All instrumentation will be programmed to record statistical noise level indices in 15 minute intervals which include the L_{Amax}, L_{A1}, L_{A10}, L_{A90}, L_{Amin} and the L_{Aeq}.

Instrument calibration shall be checked before and after each measurement survey, ensuring a valid variation in calibrated levels not exceeding ±0.5 dB(A).

9.3 Noise monitoring

Noise monitoring will be undertaken by a suitably qualified acoustic specialist or suitably qualified and trained environment officer.

Noise monitoring will be carried out at the complainant and/or nearest sensitive receivers.

Where ambient noise is a significant feature of the noise environment at the monitoring location, and the relative construction noise contribution cannot be directly quantified, intermediate monitoring locations may be selected so that the construction noise is clearly audible above the background noise level. Using this methodology, $L_{Aeq,15\ minute}$ noise levels can be estimated to the receiver using distance attenuation calculations, and compared with relevant construction noise goals.

9.4 Operator attended noise surveys

Operator attended noise measurements will be conducted at the potentially most affected receiver locations or representative thereof, relevant to the construction activities at the time of monitoring. Attended noise measurements are conducted to quantify noise emissions and estimate the $L_{Aeq,15\ minute}$ noise contribution from construction activities with respect to the overall level of ambient noise. Importantly, the background and ambient noise levels at that time and in the absence of site contribution must also be quantified.

The operator shall quantify and characterise noise levels from both extraneous (non-site) and construction noise sources over a period of 15 minutes for representative potentially affected receivers.

For each 15 minute attended noise monitoring period, the following information should be recorded:

- name of monitoring personnel;
- monitoring location;
- dates and times that monitoring began and ended at each location;
- height of the microphone above the ground and, if relevant, distances to building facades or property boundaries;
- quantitative meteorological data such as wind speed (including the height above ground at which the measurement was taken), wind direction and humidity;
- qualitative meteorological information such as cloud cover, fog or rainfall;
- instrument type and calibration details before and after the monitoring period;
- the $L_{Aeq,15\ minute}$ noise level for the 15 minute period;
- statistical noise level descriptors over the 15 minute interval: L_{Amin}, L_{A90}, L_{A10}, L_{A1} and L_{Amax};
- notes that identify the noise source that contribute to the maximum noise levels (L_{A1} or L_{Amax}) and noise sources that contribute to the overall noise environment or for periods of time when a specific noise source is audible presented on a run-chart of the recorded noise levels;
- an estimate of the noise contribution from the construction or from other identifiable noise sources;
- measurements in one-third octave bands from 10 Hz to 8 kHz inclusive (or a broader range of bands) for the 15 minute interval;
- any other data suitable for assessing the relative contribution of site-generated noise to the overall noise being measured;

- notes that identify the noise source that contributed to the overall noise environment; and
- recommendations or comments (where considered appropriate).

9.5 General vibration monitoring procedures

The level of vibration produced by construction activities depends on a number of factors, many of which are site specific. It is recommended, prior to significant vibration-generating activities, such as piling or vibratory compaction, that a series of trials be carried out to determine likely vibration levels from typical plant at the nearest potentially affected receiver(s). The likelihood of vibration levels exceeding the criteria (outlined in Section 4) will be able to be determined from these results.

Continuous vibration monitoring may also be required during significant vibration generating activities if the risk of damage or annoyance, as determined from trial monitoring results, is high. If initial vibration measurement trials conclusively demonstrate negligible vibration levels within close working distances, then additional monitoring may not be required, unless otherwise warranted for risk management purposes.

Supplementary vibration monitoring may also be carried out in response to complaints received from the neighbouring properties.

9.6 Vibration monitoring

Vibration monitoring will be undertaken by a suitably qualified specialist or suitably qualified and trained environment officer.

The vibration monitor should be generally installed at the nearest foundation point of the sensitive structure to the vibration generating works. In the event of a complaint, the monitoring shall also be carried out at the complainant location.

The monitoring equipment should be capable of recording the appropriate parameters to provide assessment against the relevant vibration goals.

The monitoring system should also be fitted with an auditory or visual alarm system (or similar) which will trigger when vibration levels approach and/or reach the nominated structural vibration criteria. This will also indicate if and when alternate work practices should be adopted (such as decrease vibratory intensity, alternate equipment selection etc.).

9.7 Reporting

A report will be prepared outlining the results of monitoring and how exceedances (where relevant) were managed. A site layout, outlining the locations of construction equipment and monitoring locations, is to be included in the monitoring reports.

9.8 Training

All personnel involved in noise and vibration monitoring will be adequately trained and up to date with relevant measurement standards, methodologies and product technology with respect to noise and vibration measurements.

10 Community consultation and complaints handling

A programme to engage in active community consultation and maintain positive relations with local residents will be implemented in order to minimise complaints by addressing their concerns. It is important that advice and detail be given to the community regarding any works outside the standard construction hours.

With regard to potentially offensive noise events associated with construction activities, AS 2436 – 1981 provides the following:

> If noisy operations must be carried out, then a responsible person should maintain liaison between the neighbouring community and the contractor. This person should inform the public at what time to expect noisy operations and also inform the contractor of any special needs of the public.
>
> Consultation and cooperation between the contractor and his neighbours and the removal of uncertainty and rumour can help to reduce the adverse reaction to noise.

The same approach can be taken to events likely to cause high levels of vibration at a nearby sensitive receiver.

In order to effectively manage any requests for information or respond to any public concerns in relation to the proposed construction activities and site operation, the following systems shall be maintained:

- The proponent will supply the relevant governing authorities with the names and appropriate contact numbers for the site construction manager during the construction period and one other senior staff member.
- An emergency after hours contact phone number will be put in place to allow contact with the proponent in relation to any environmental matter including those concerned with noise and vibration issues. This phone number will be clearly displayed on the fence surrounding the construction site.
- The proponent will use a complaint handling system to monitor environmental noise and vibration complaints. All information relating to such complaints will be kept in a register. The register will include but not be restricted to the following information:
    - Date and time of complaint;
    - Complainant details (ie full name, address and contact details);
    - Nature and source of complaint;
    - Action taken; and
    - Follow-up with complainant.
- The complaint register will be made available to any relevant regulatory authority upon request.
- The proponent will endeavour to respond to any complaint within one working day of its receipt.

Response measures, which would be adopted following complaints regarding noise and/or vibration, would include:

- Identify the source that has caused the complaint. This would be done by consultation with the complainant and by conducting a noise and/or vibration survey to quantify the level of disturbance.

- Reassess the mitigation and management techniques employed at the site to reduce the impact of the source in question. Particular attention should be given to the scheduling of activities and the siting of equipment used on site.

- Following the adoption of additional or alternative mitigation, a further noise and/or vibration survey would be conducted at the complainant's location to demonstrate the effectiveness of the mitigation strategy.

11 Conclusion

EMM has prepared a construction noise and vibration management plan (CNVMP) to support a development application (DA) for a proposed mixed use development at 88 Christie Street, St Leonards (the project).

As would be expected with typical construction works of this nature and in proximity to neighbours, predictions indicate that construction noise levels are likely to be above the noise management levels without mitigation at times during proposed construction activity. This is common for such situations. Given that the predictions assume equipment operating simultaneously and at the nearest locations to the relevant residential dwellings and commercial spaces it is likely that actual construction noise levels would be less than those predicted for the majority of the time. Notwithstanding, the proponent will actively manage construction noise from the site.

For vibration, the guide values presented in Table 7.1 should be followed. It is possible that some vibratory activities will occur within close proximity to nearby structures and therefore management of vibration levels will be required.

Recommendations have been provided regarding work practices to be considered to minimise construction noise and vibration from the project.

Appendix A

Glossary of acoustic terms

A number of technical terms are required for the discussion of noise. These are explained in Table A.1.

Table A.1 Glossary of acoustic terms

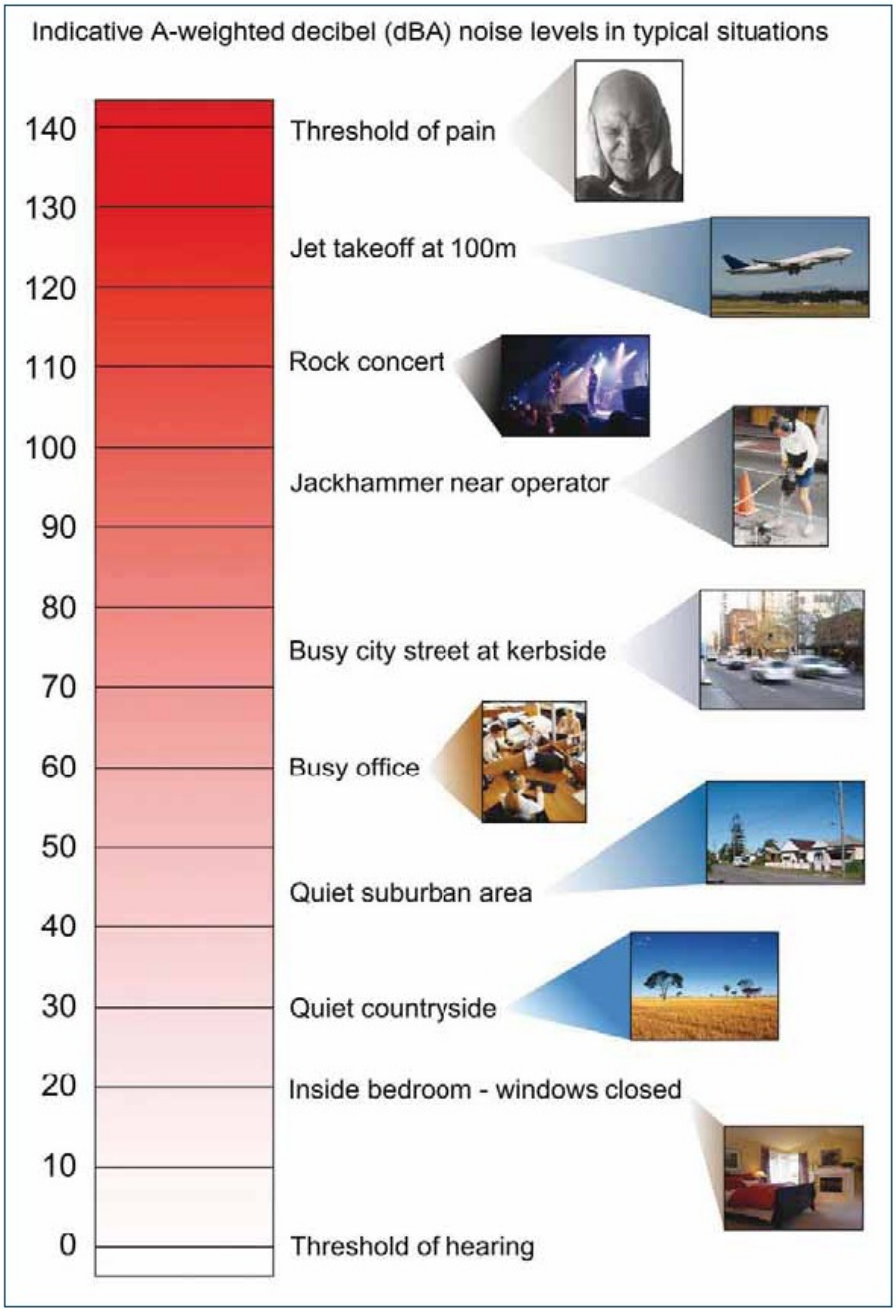
Term	Description
ABL	The assessment background level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L_{90} statistical noise levels.
dB	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
DECC	The NSW Department of Environment, Climate Change
ICNG	Interim Construction Noise Guideline
L_{A1}	The A-weighted noise level exceeded for 1% of the time.
L_{A10}	The noise level which is exceeded 10% of the time. It is roughly equivalent to the average of maximum noise level.
L_{A90}	The noise level that is exceeded 90% of the time. Commonly referred to as the background noise level.
L_{Aeq}	The energy average noise from a source. This is the equivalent continuous sound pressure level over a given period. The $L_{eq,15\ minute}$ descriptor refers to an L_{eq} noise level measured over a 15-minute period.
L_{Amax}	The maximum root mean squared sound pressure level received at the microphone during a measuring interval.
NPI	Noise Policy for Industry
RBL	The Rating Background Level (RBL) is an overall single value background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (L_w)	A measure of the total power radiated by a source. The sound power of a source is a fundamental property of the source and is independent of the surrounding environment.

It is useful to have an appreciation of decibels, the unit of noise measurement. Table A.2 gives an indication as to what an average person perceives about changes in noise levels:

Table A.2 Perceived change in noise

Change in sound level (dB)	Perceived change in noise
1 to 2	typically indiscernible
3	just perceptible
5	noticeable difference
10	twice (or half) as loud
15	large change
20	four times (or quarter) as loud

Examples of common noise levels are provided in Figure A.1.



Source: *NSW Road Noise Policy (DECCW 2011)*

Figure A.1 Common noise levels

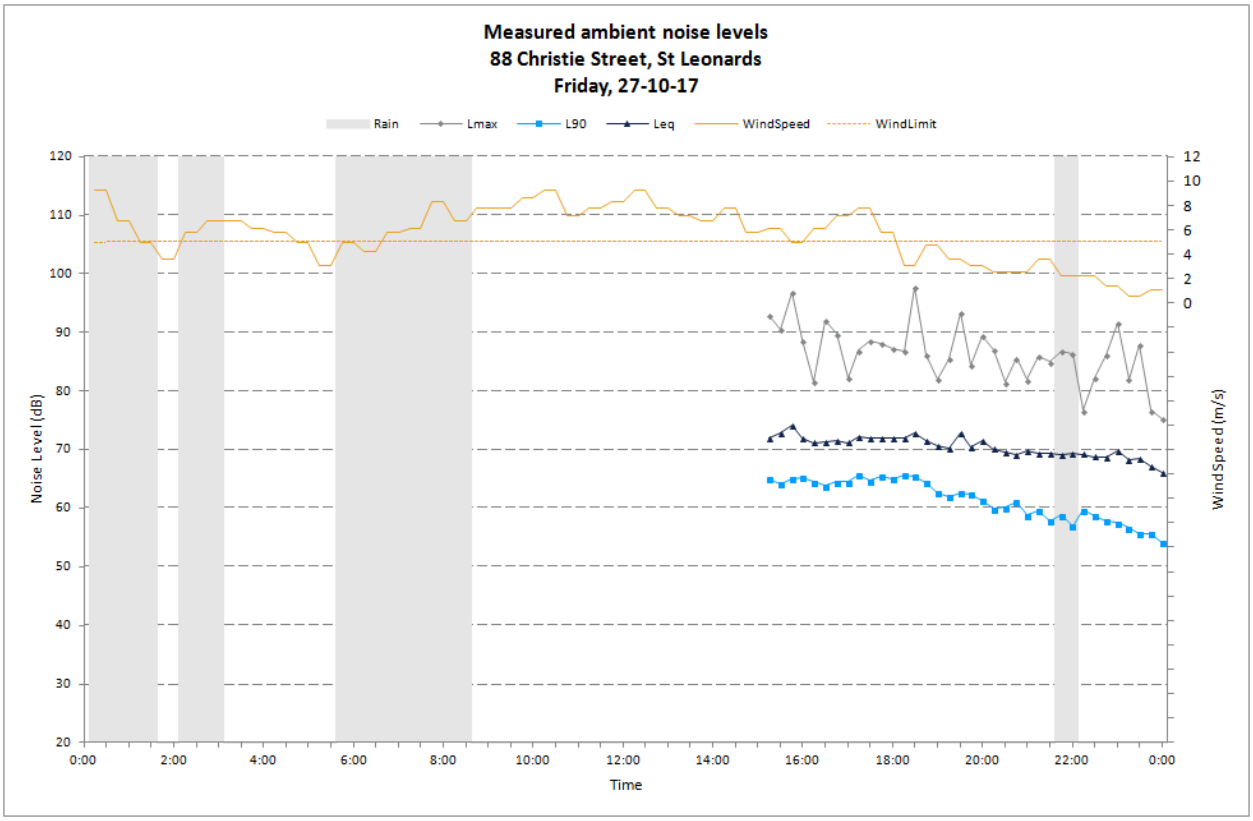
Appendix B

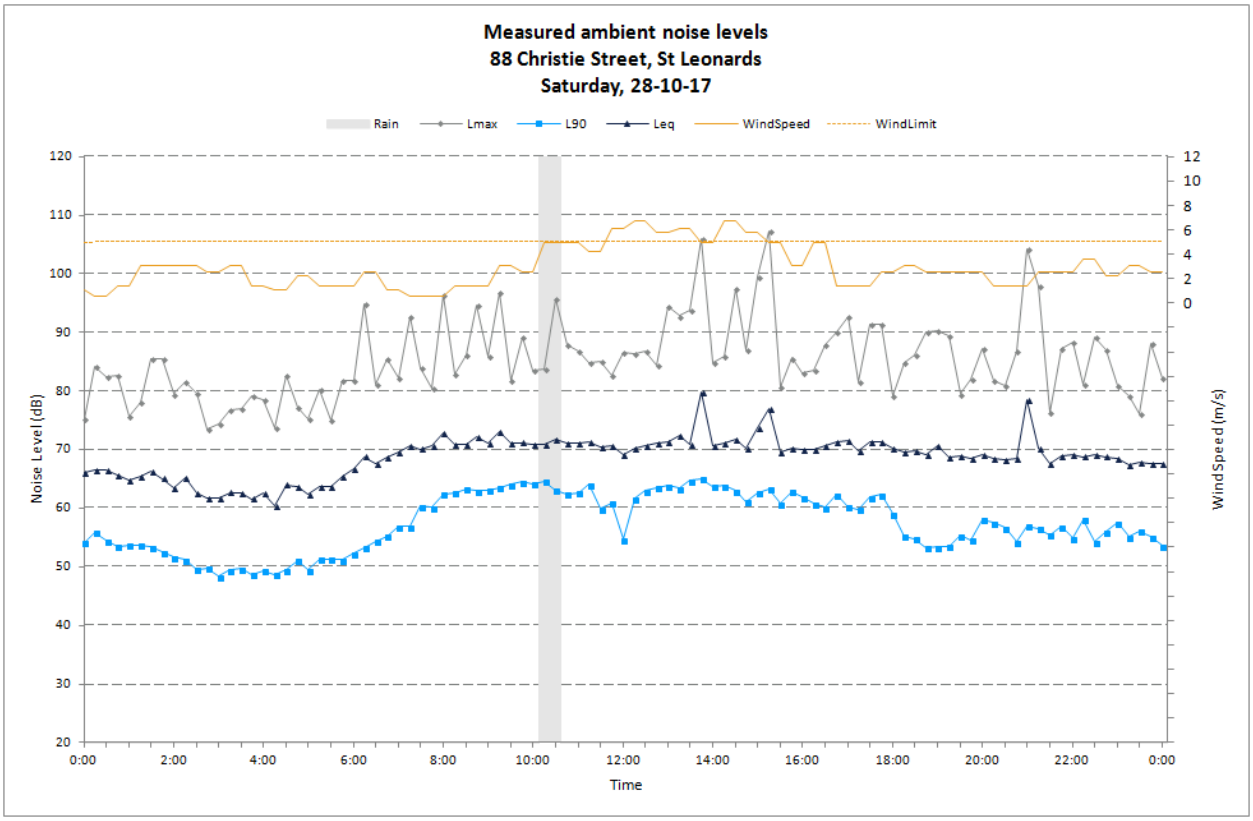
Unattended noise monitoring data

Table B.1 L1 unattended noise monitoring data

Date	ABL Day	ABL Evening	ABL Night	L_{Aeq} 11hr day	L_{Aeq} 4hr evening	L_{Aeq} 9hr night
Friday, 27-10-17	0	59	49	0	71	66
Saturday, 28-10-17	60	53	48	72	71	66
Sunday, 29-10-17	55	54	41	71	69	66
Monday, 30-10-17	0	0	44	0	0	66
Tuesday, 31-10-17	64	57	47	72	72	68
Wednesday, 01-11-17	62	55	46	73	71	67
Thursday, 02-11-17	63	57	46	74	72	67
Friday, 03-11-17	63	54	0	73	71	0
Saturday, 04-11-17	0	0	0	0	0	0
Sunday, 05-11-17	0	0	0	0	0	0
Overall	62	55	46	73	71	67

Notes: 1. 0 indicates periods with too few valid samples due to weather or logger operation.


Measured ambient noise levels
88 Christie Street, St Leonards
Friday, 27-10-17
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time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Saturday, 28-10-17
Rain
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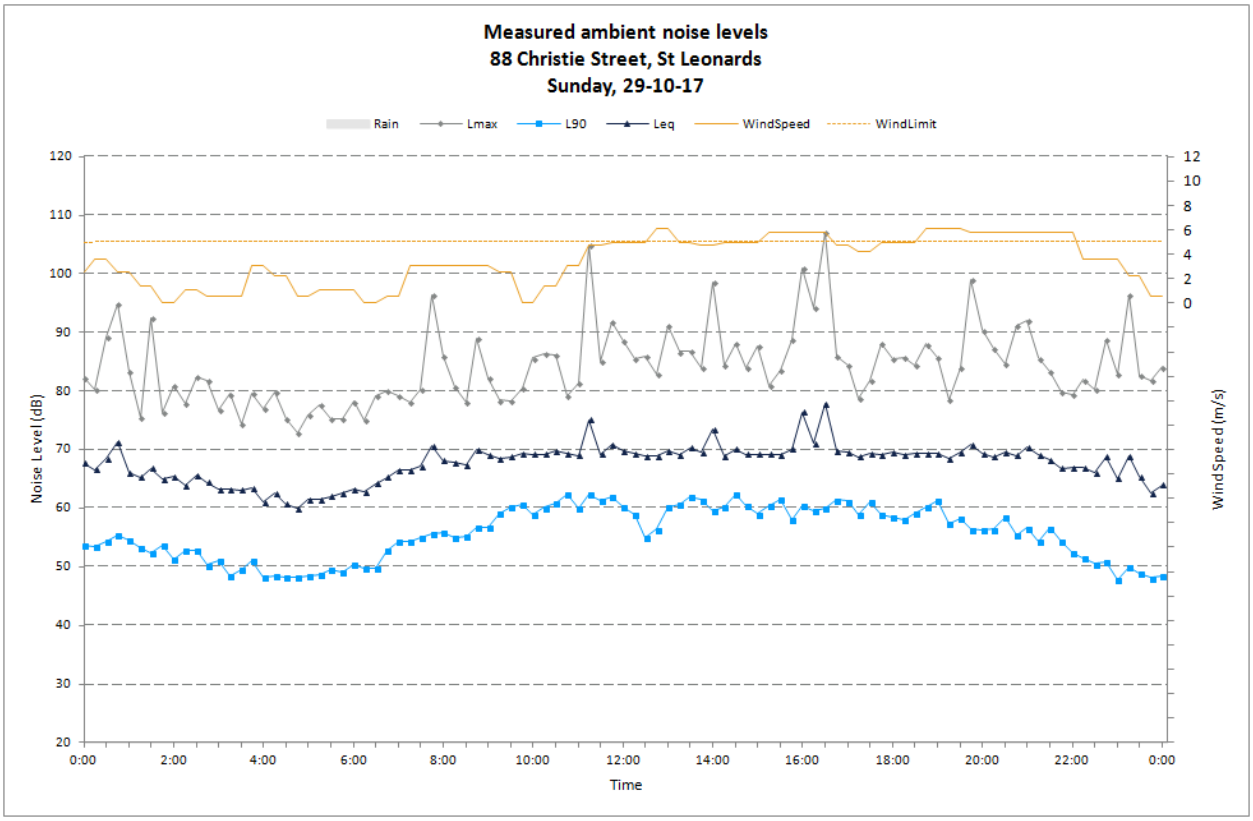
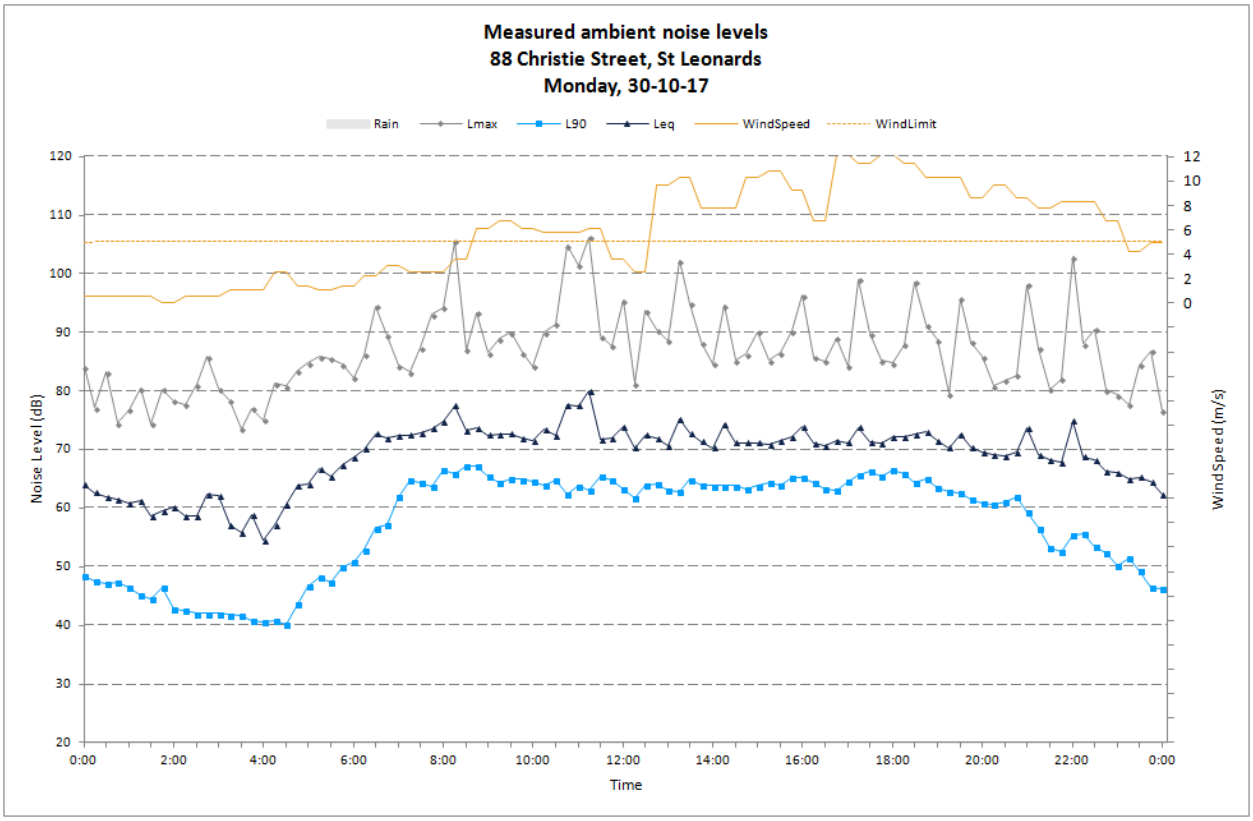
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time


Measured ambient noise levels
88 Christie Street, St Leonards
Sunday, 29-10-17
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time
120
110
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00


Measured ambient noise levels
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Monday, 30-10-17
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time
120
110
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
0:00
2:00
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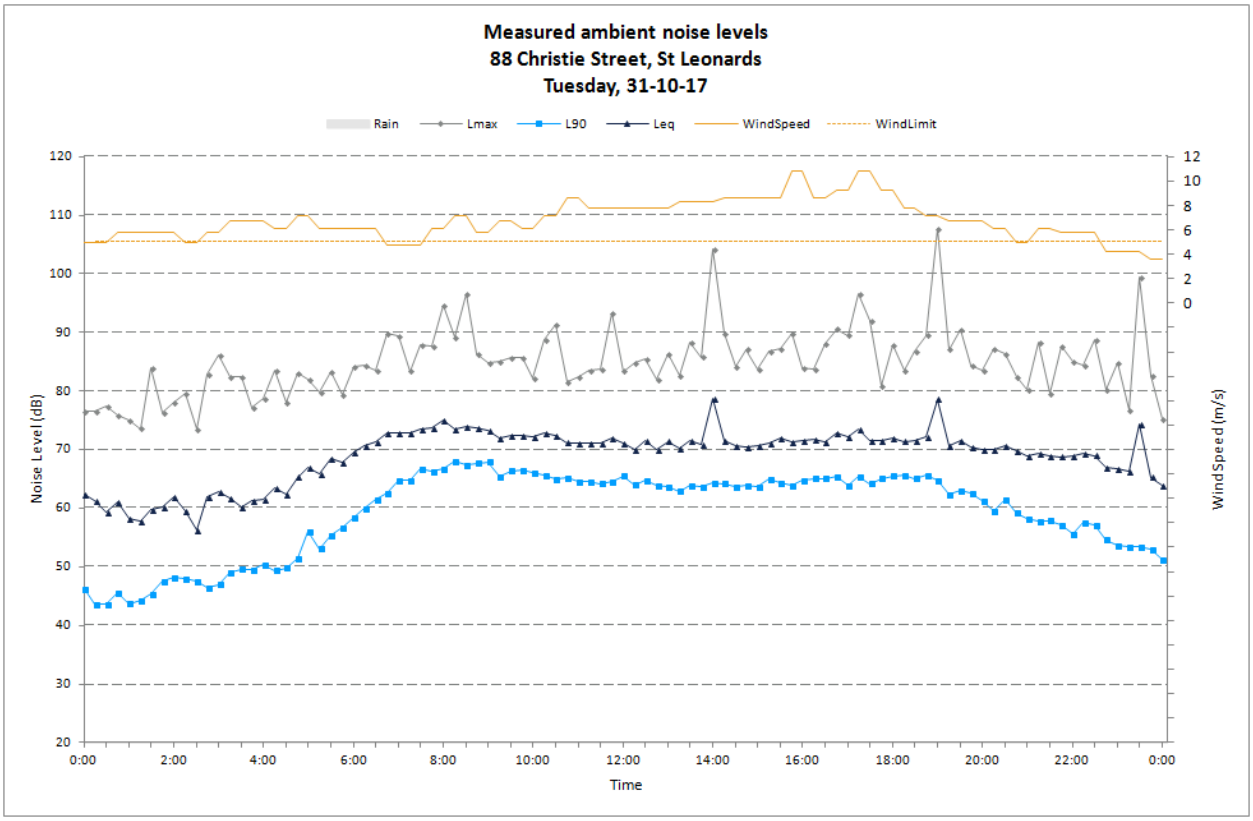
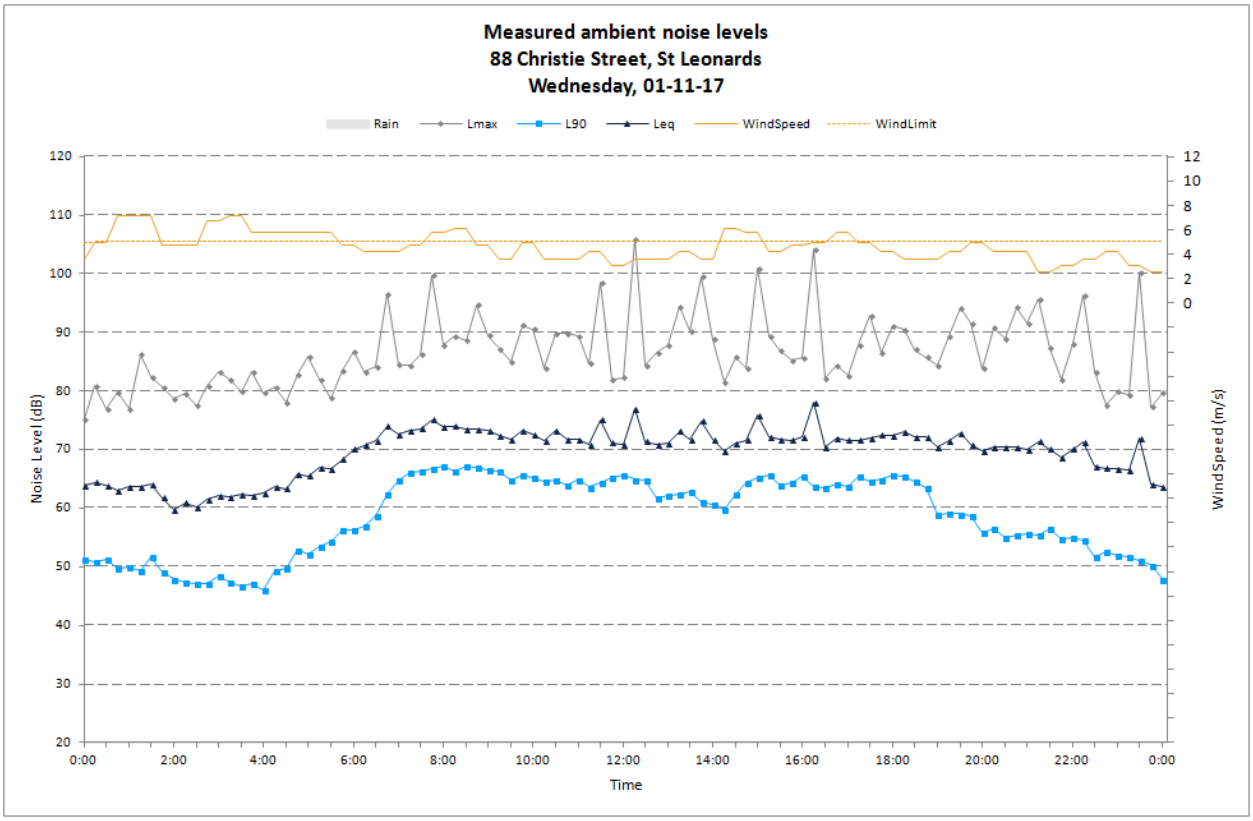

Measured ambient noise levels
88 Christie Street, St Leonards
Tuesday, 31-10-17
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time


Measured ambient noise levels
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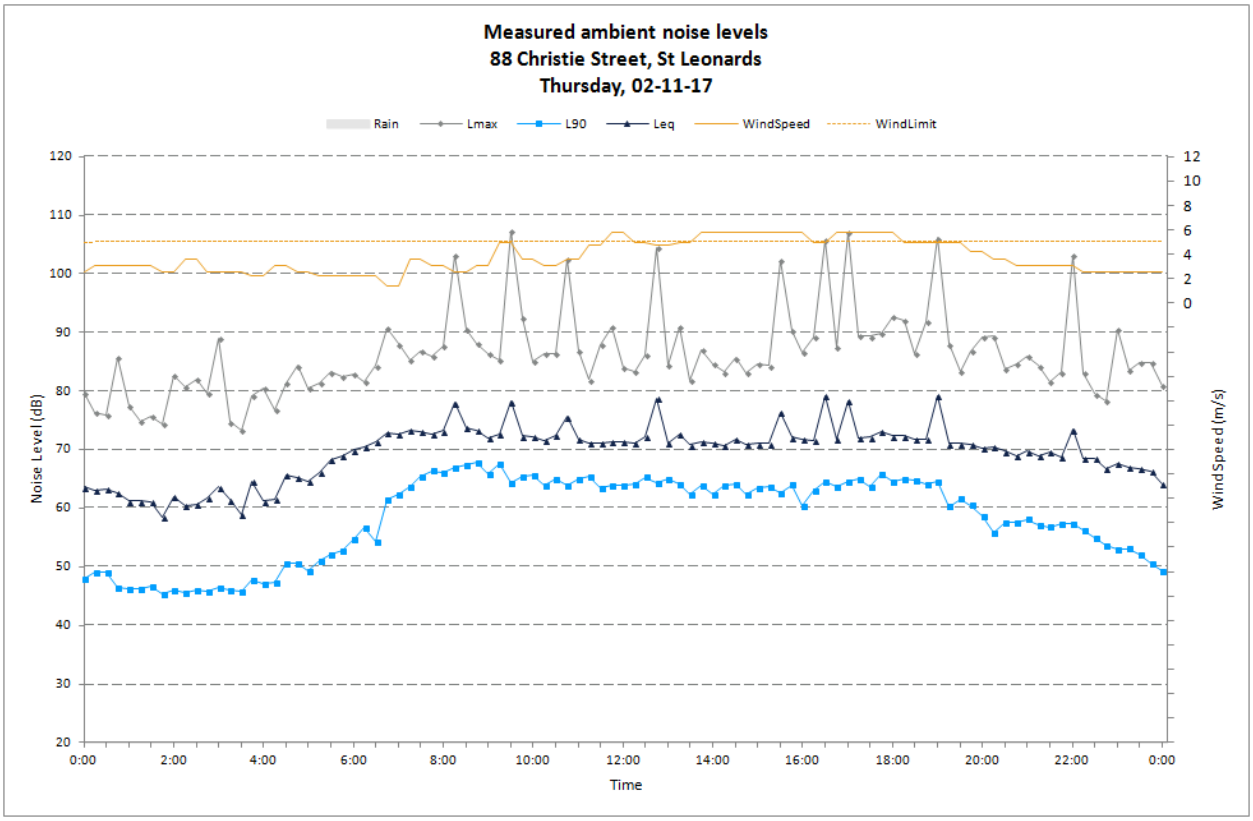
Wednesday, 01-11-17
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time


Measured ambient noise levels
88 Christie Street, St Leonards
Thursday, 02-11-17
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time
0:00
2:00
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8:00
10:00
12:00
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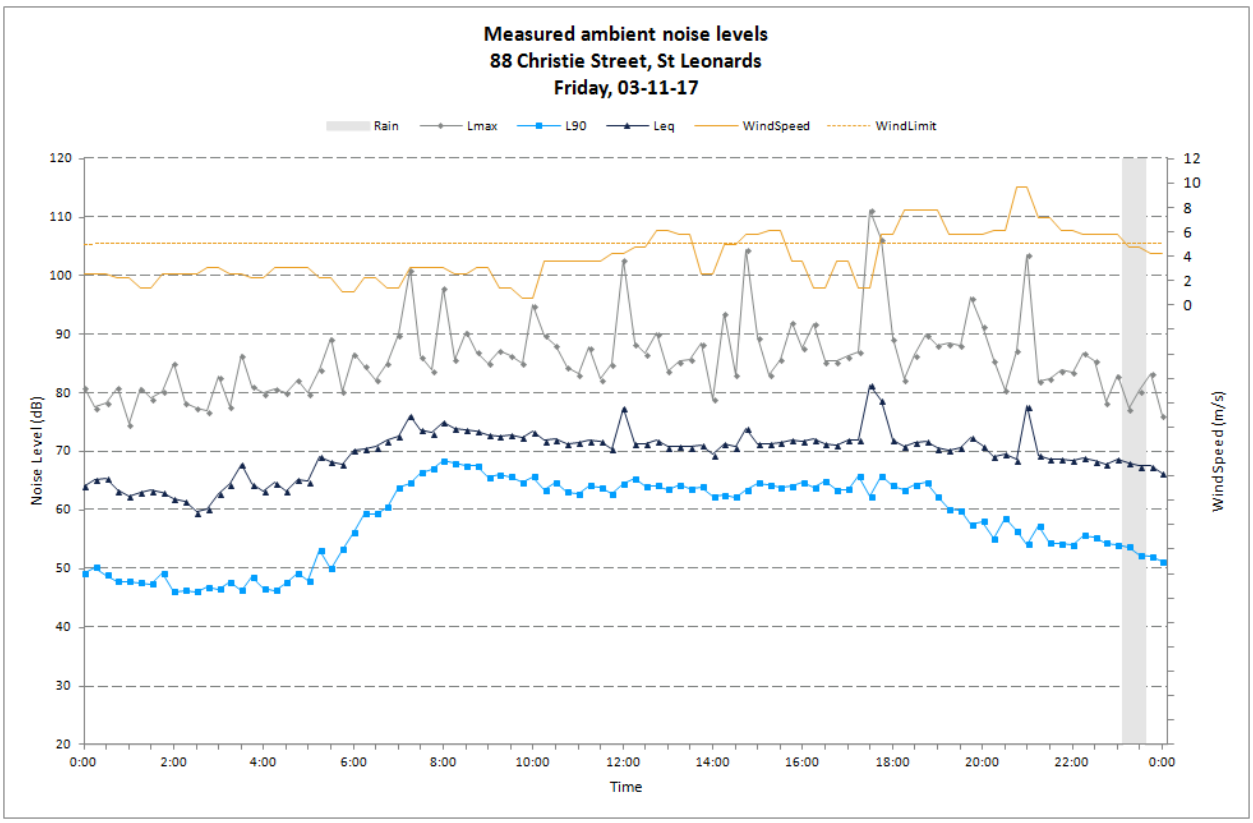
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Friday, 03-11-17
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time
0:00
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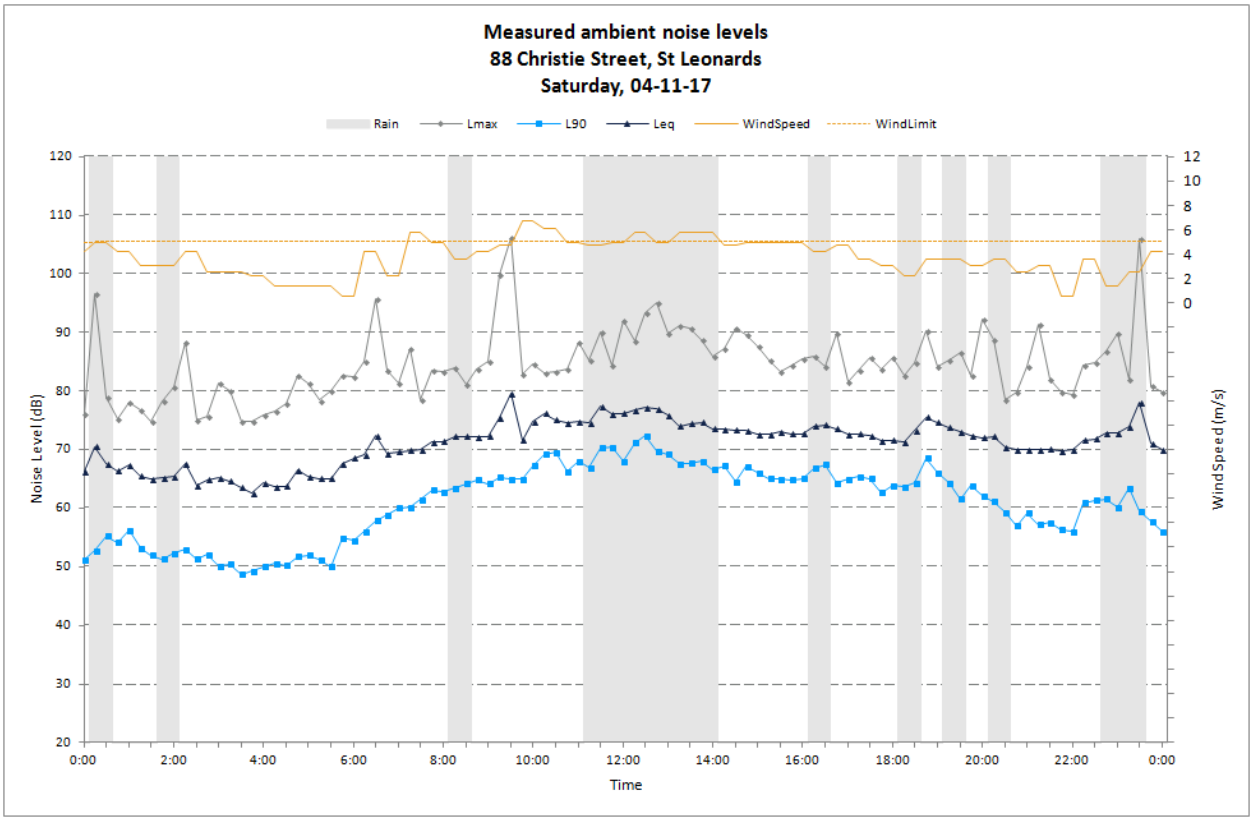
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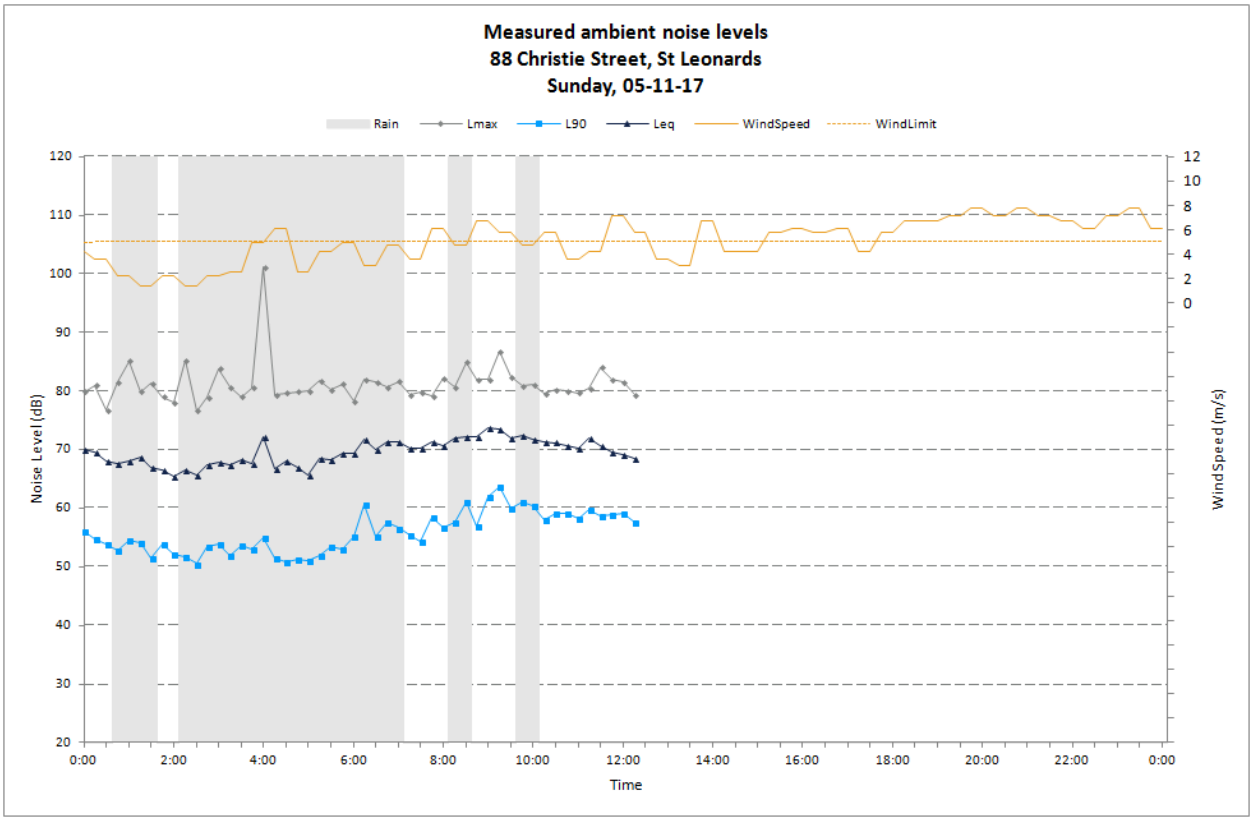
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time


Measured ambient noise levels
88 Christie Street, St Leonards
Sunday, 05-11-17
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time

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