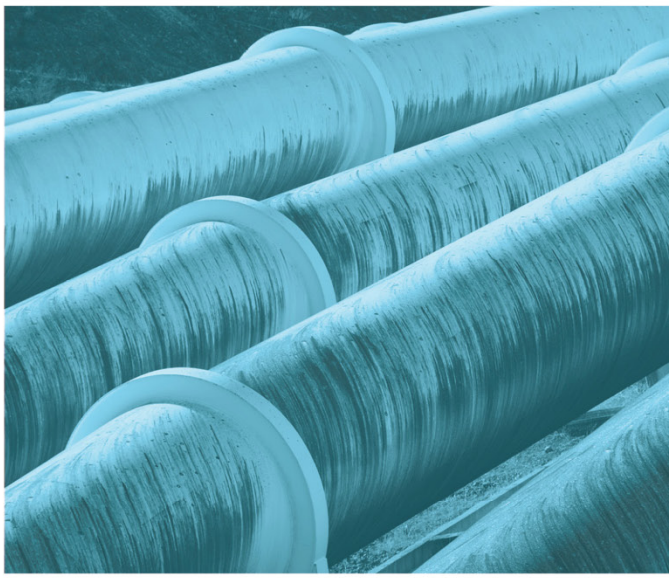
Schofields Commuter Car Park

Noise and Vibration Impact Assessment

Prepared for Transport for New South Wales
March 2021



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Schofields Commuter Car Park

Noise and Vibration Impact Assessment

Report Number

H200630 RP4

Client

Transport for New South Wales

Date

31 March 2021

Version

v4 Final

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This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

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1 Introduction

Transport for NSW is proposing to build the Schofields Commuter Car Park (the Proposal) to improve access to commuter car parking spaces at this location and in surrounding localities (Figure 1.1). Transport for NSW is the government agency responsible for the delivery of major transport infrastructure projects in NSW and is the proponent for the Proposal.

The Proposal forms part of the Commuter Car Park Program. The NSW Government is committed to delivering accessible public transport infrastructure, which is why Transport for NSW is providing more commuter car parks where they are needed. The delivery of commuter car parks at key transport interchanges would provide a range of benefits, including:

- improved customer access to the public transport network;
- encouraging mode shift away from private vehicles;
- providing customers with more flexibility in the first and last part of their journey; and
- contributing to reducing congestion on our road network.

1.1 Overview

As part of this program, the Proposal would aim to provide approximately 707 additional commuter car parking spaces west of Schofields Station (Figure 1.2).

The Proposal would include the following key features:

- enabling works including road modifications and removal of the Altrove Sales and Information Centre
- an at-grade car park with approximately 700 commuter car parking spaces including five accessible spaces and dedicated motorcycle parking
- conversion of 15 general parking spaces into 10 accessible spaces within the existing commuter car park on Bridge Street, outside the station
- a new accessible path from the car park to Schofields Station
- CCTV, lighting and wayfinding
- Transport Park&Ride infrastructure (i.e. Opal card activated boom gates), and
- provision for future electric vehicle charging spaces.

Access is to the car park is proposed under two operating scenarios:

- Scenario 1 – Altrove Boulevard and Calder Street completed and operational plus access/egress via Schofields Road and left in/left out from Bridge Street; and
- Scenario 2 – Altrove Boulevard and Calder Street incomplete, access/egress via Schofields Road and left in/left out from Bridge Street only.

Source: EMM (2021); TfNSW (2021); DFSI (2020, 2017); GA (2011); ASGC (2006)

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KEY

- Proposal site
- Altrove Boulevard/ Calder Street extension
- Train station
- Rail line
- Major road
- Minor road
- Watercourse/drainage line
- Waterbody
- NPWS reserve
- Local government area

INSET KEY

- Main road
- NPWS reserve
- State forest

Regional setting

Schofields Commuter Car Park
Noise and Vibration Impact Assessment
Figure 1.1

EMM creating opportunities

Source: EMM (2021); TfNSW (2021); NearMap (2020); DFSI (2020); GA (2011); ASGC (2006)

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KEY

- Proposal site
- Altrove Boulevard/ Calder Street extension
- Train station
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line
- Waterbody

Local setting

Schofields Commuter Car Park
Noise and Vibration Impact Assessment
Figure 1.2

EMM creating opportunities

1.2 Scope

The scope of this assessment is to:

- establish the existing background noise levels in the vicinity of the works;
- establish construction noise management levels and vibration limits which would apply to the works;
- predict construction noise and vibration levels at nearby residential and other sensitive assessment locations due to the works;
- recommend mitigation measures where necessary to reduce and manage noise and vibration impacts from the construction;
- establish operational project trigger levels which would apply to the use of the car park;
- predict operational noise of car park at nearby residential and other sensitive assessment locations;
- predict noise impacts from additional operational traffic generated by the car park; and
- recommend mitigation measures where necessary to reduce and manage noise impacts from use of the car park.

1.3 Guidelines

The following guidelines apply to construction noise and vibration and operational noise from the proposal:

- *NSW Interim Construction Noise Guideline* (ICNG) 2009, Department of Environment and Climate Change;
- *Construction Noise and Vibration Strategy* (CNVS) v4.2 2019, Transport for NSW;
- *NSW Assessing Vibration – a technical guideline* (AVTG) 2006, Department of Environment and Conservation;
- Australian Standard AS/NZS 2107:2016 *'Acoustics - Recommended design sound levels and reverberation times for building interiors'*;
- Australian Standard AS2436-1981 *'Guide to Noise Control on Construction, Maintenance and Demolition Sites'*;
- British Standard BS 6472-2008, *'Evaluation of human exposure to vibration in buildings (1-80Hz)'*;
- British Standard 7385: Part 2-1993 *'Evaluation and measurement of vibration in buildings'*;
- German Standard DIN4150-2016 *'Structural vibration Part 3: Effects of vibration on Structures'*;
- *Noise Policy for Industry* (NPfI) 2017, NSW Environment Protection Authority (EPA); and
- *Road Noise Policy* (RNP) 2011, NSW Environment Protection Authority (EPA).

2 Existing environment

The subject site is cleared and vacant, with the ambient noise environment dominated by road traffic on Schofields Road, Veron Road and Altrove Boulevard (Figure 1.2). Adjacent to the east of the site is the T1 Western Line whilst further to the east of the rail line is a commercial precinct including a Woolworths supermarket and BWS.

2.1 Noise and vibration assessment locations

The nearest representative noise sensitive locations to the proposed commuter car park have been identified for the purpose of assessing potential noise and vibration impacts. These locations were selected to represent the range and extent of noise impacts from the site. Details are provided in Table 2.1 and their locations are shown in Figure 2.1. They are referred to in this report as assessment locations.

Table 2.1 Noise assessment locations

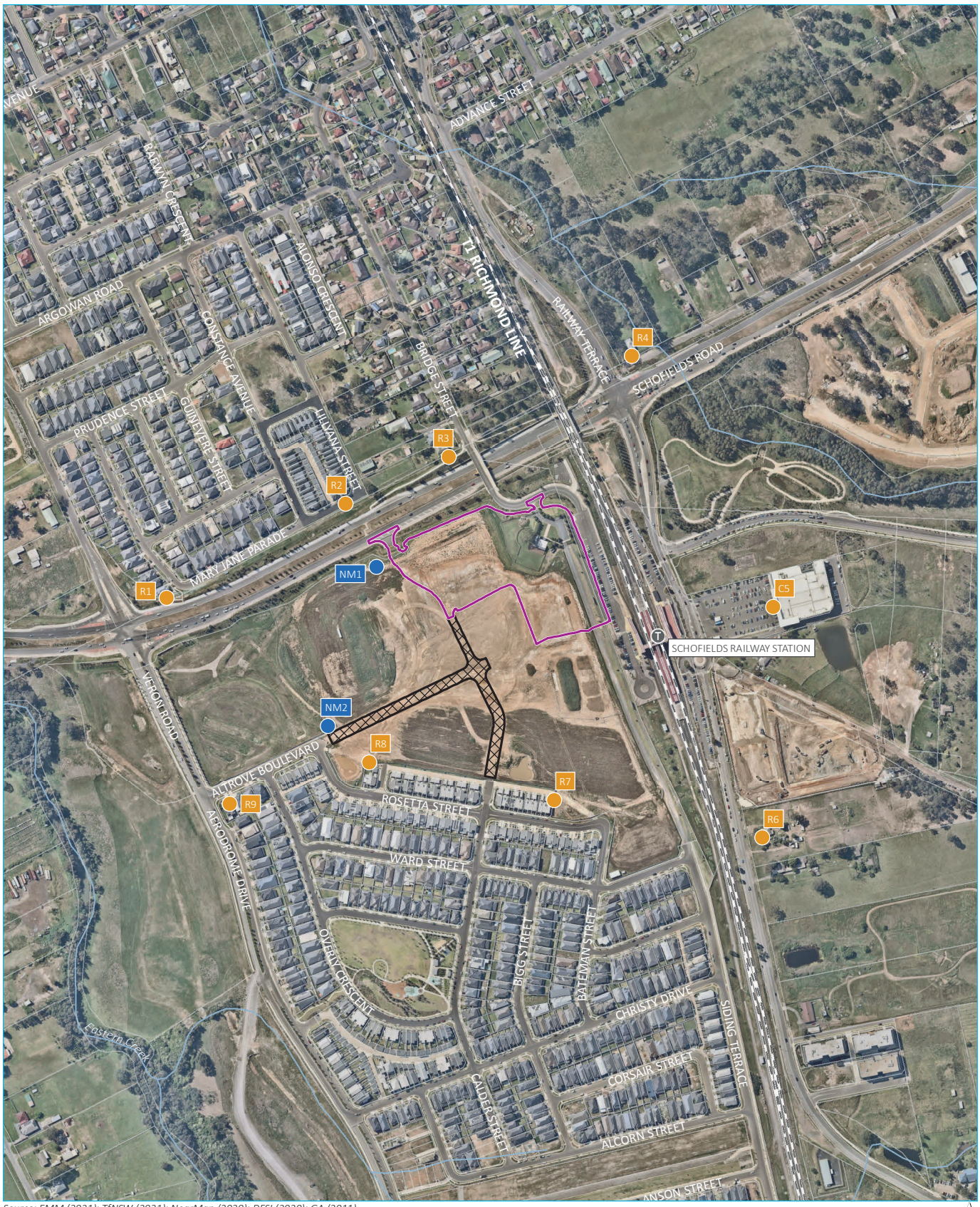
ID	Classification	Description of location
R1	Residential	West on the opposite side of Schofields Road
R2	Residential	North-west on the opposite side of Schofields Road
R3	Residential	North on the opposite side of Schofields Road
R4	Residential	North-east on the opposite side of Schofields Road and railway
C5	Commercial/Retail	East of opposite side of railway
R6	Residential	South-east of opposite side of railway
R7	Residential	South-east on Rosetta Street
R8	Residential	South on Rosetta Street
R9	Residential	South-west on Altrove Boulevard

2.2 Background noise survey

To establish the existing ambient noise environment of the area, unattended noise surveys and operator-attended aural observations were conducted at monitoring locations as guided by the procedures described in Australian Standard AS 1055-1997 - *Acoustics - Description and Measurement of Environmental Noise*.

Noise monitoring was conducted at two locations considered to be representative of the range of noise levels likely to be experienced by residential assessment locations in the vicinity of the site. The logger locations were selected after inspection of the site and its surrounds, giving due consideration to other noise sources which may influence the readings (e.g. domestic air-conditioners), the proximity of assessment locations to the site, security issues for the noise monitoring device and gaining permission for access from the residents or landowners.

The monitoring locations selected are presented in Table 2.2 and shown in Figure 2.1.



Source: EMM (2021); TfNSW (2021); NearMap (2020); DFSI (2020); GA (2011)

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KEY

- Proposal site
- Altrove Boulevard/ Calder Street extension
- Assessment location
- Monitoring location
- Train station
- Rail line
- Watercourse/drainage line
- Cadastral boundary

Noise monitoring and assessment locations

Schofields Commuter Car Park
Noise and Vibration Impact Assessment
Figure 2.1

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Table 2.2 Noise monitoring locations

ID	Address	Instrumentation
NM1	The site - north	ARL NGARA Serial 878113
NM2	The site - south	ARL NGARA Serial 878125

The noise loggers were programmed to record statistical noise level indices continuously in 15-minute intervals, 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 monitoring. All equipment carried appropriate and current National Association of Testing Authorities (NATA) (or manufacturer) calibration certificates.

A summary of existing background and ambient noise levels is given in Table 2.3. Results are provided for each day in Annexure A.

Table 2.3 Summary of existing background and ambient noise

Monitoring location	Period[1]	Rating background level (RBL)[2], dBA	Measured $L_{Aeq,\ period}$ noise level[3], dBA
NM1 – The site - north	Day	45	59
	Evening	45	57
	Night	35	52
NM2 – The site - south	Day	41	52
	Evening	43	51
	Night	36	48

1. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; Evening: 6 pm to 10 pm; Night: 10 pm to 7 am, Sunday to Friday and 10 pm to 8 am Saturday and public holidays.
2. The RBL is an NPfI term and is used to represent the background noise level. In accordance with the NPfI, minimum thresholds were adopted given measured values were lower. Measured noise levels are provided in brackets () where relevant.
3. The energy averaged noise level over the measurement period and representative of general ambient noise.

For the review and assessment of road traffic noise levels, Table 3.4 provides a summary of the measured day $L_{Aeq,15hr}$ and night $L_{Aeq,9hr}$ noise levels for measurement locations NM1, which includes traffic and other sources of noise.

Table 3.4 Summary of existing traffic noise levels

Monitoring location	Measured $L_{Aeq,15hr}$ Noise Level, dB	Measured $L_{Aeq,9hr}$ Noise Level, dB
NM1 – The site – north*	58	52

* located approximately 36m from edge of nearest lane

3 Assessment criteria

3.1 Construction noise

The ICNG (DECC 2009) has been jointly developed by NSW Government agencies, including the NSW Environment Protection Authority (EPA) and Department of Planning, Industry and Environment (DPIE). The objectives of the guideline relevant to the planning process are to promote a clear understanding of ways to identify and minimise noise from construction and to identify 'feasible' and 'reasonable' work practices. The guideline recommends standard construction hours where noise from construction activities is audible at residential premises (i.e. assessment locations), as follows:

- Monday to Friday 7 am to 6 pm;
- Saturday 8 am to 1 pm; and
- no construction work is to take place on Sundays or public holidays.

The ICNG acknowledges that works outside standard hours may be necessary, however, justification should be provided to the relevant authorities.

The ICNG provides two methodologies to assess construction noise emissions. The first is a quantitative approach, which is suited to major construction projects with typical durations of more than three weeks. This method requires noise emission predictions from construction activities at the nearest assessment locations and assessment against ICNG recommended noise levels.

The second is a qualitative approach, which is a simplified assessment process that relies more on noise management strategies. This method is suited to short-term infrastructure and maintenance projects of less than three weeks.

This assessment has adopted a quantitative approach. The qualitative aspects of the assessment include identification of assessment locations, description of works involved including predicted noise levels and proposed management measures that include a complaint's handling procedure.

3.1.1 Construction noise management levels

Table 3.1 provides ICNG noise management levels (NML) which apply to residential assessment locations.

Table 3.1 ICNG construction noise management levels for residences

Time of day	NML $L_{Aeq,15min}$	Application
Recommended standard hours: Monday to Friday 7 am to 6 pm, Saturday 8 am to 1 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 $L_{Aeq,15min}$ is greater than the noise-affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.

Time of day	NML $L_{Aeq,15min}$	Application
	Highly noise affected 75 dBA	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: 1. 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); 2. 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 dBA above the noise-affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see Section 7.2.2 of the ICNG.

Source: ICNG (EPA, 2009).

Table 3.2 summarises the ICNG recommendations and provides NML for other land uses.

Table 3.2 ICNG noise levels at other land use

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 project construction NMLs for recommended standard and out of hour periods are presented in Table 3.3 for all assessment locations. However, it is acknowledged that construction of the proposed car park would be during daytime hours only.

Table 3.3 Construction noise management levels – all assessment locations

Assessment location	Period	Adopted RBL[1]	NML $L_{Aeq,15min}$, dB
R1 to R4	Day (standard ICNG hours)	45	55
	Evening (out of hours)	45	50
	Night (out of hours)	35	40

Assessment location	Period	Adopted RBL[1]	NML $L_{Aeq,15min}$, dB
C5	When in use	-	70
R6 to R9	Day (standard ICNG hours)	41	51
	Evening (out of hours)	43	48
	Night (out of hours)	36	41

Note: 1. The RBLs adopted from Table 2.3.

3.2 Construction vibration

3.2.1 Human perception of vibration

Humans can detect vibration levels which are well below those causing any risk of damage to a building or its contents.

The actual perception of motion or vibration may not in itself be disturbing or annoying. An individual's response to that perception, and whether the vibration is "normal" or "abnormal", depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as "normal" in a car, bus or train is considerably higher than what is perceived as "normal" in a shop, office or dwelling.

Human tactile perception of random motion, as distinct from human comfort considerations, was investigated by Diekmann and subsequently updated in German Standard DIN 4150 Part 2 1975. On this basis, the resulting degrees of perception for humans are suggested by the vibration level categories given in Table 3.4.

Table 3.4 suggests that people would just be able to feel floor vibration at levels of approximately 0.15 millimetres per second (mm/s) and that the motion becomes "noticeable" at a level of approximately 1 mm/s.

Table 3.4 Peak vibration levels and human perception of motion

Approximate vibration level	Degree of perception
0.10 mm/s	Not felt
0.15 mm/s	Threshold of perception
0.35 mm/s	Barely noticeable
1 mm/s	Noticeable
2.2 mm/s	Easily noticeable
6 mm/s	Strongly noticeable
14 mm/s	Very strongly noticeable

Note: These approximate vibration levels (in floors of building) are for vibration having a frequency content in the range of 8 Hertz (Hz) to 80 Hz.

3.2.2 Assessing vibration - a technical guideline

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

The guideline presents preferred and maximum vibration values for the 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 that 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 3.5.

Table 3.5 Examples of types of vibration

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 ANZEC (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.

Continuous vibration associate with compaction of fill on the site is most relevant to the construction of the proposed car park.

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 heavy vehicle pass-bys and construction activities such as impact hammering, rolling or general excavation work.

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 is used (refer to Section 2.4.1 of the guideline):

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

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 VDV for intermittent vibration are reproduced in Table 3.6

Table 3.6 Acceptable vibration dose values for intermittent vibration

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	0.40	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 recommends that activities should be designed to meet the preferred values where an area is not already exposed to vibration.

3.2.3 Structural vibration

i Australian Standard AS 2187.2 – 2006

In terms of the most recent relevant vibration damage criteria, Australian Standard AS 2187.2 - 2006 *Explosives - Storage and Use - Use of Explosives* recommends that 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 (e.g. compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The recommended limits (guide values) for transient vibration to manage minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 3.7 and graphically in Figure 3.1.

Table 3.7 Transient vibration guide values - minimal risk of cosmetic damage

Line[1]	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	50 mm/s
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

Notes: Refers to the "Line" in Figure 3.1

The standard notes that the guide values in Table 3.7 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 3.7 may need to be reduced by up to 50%.

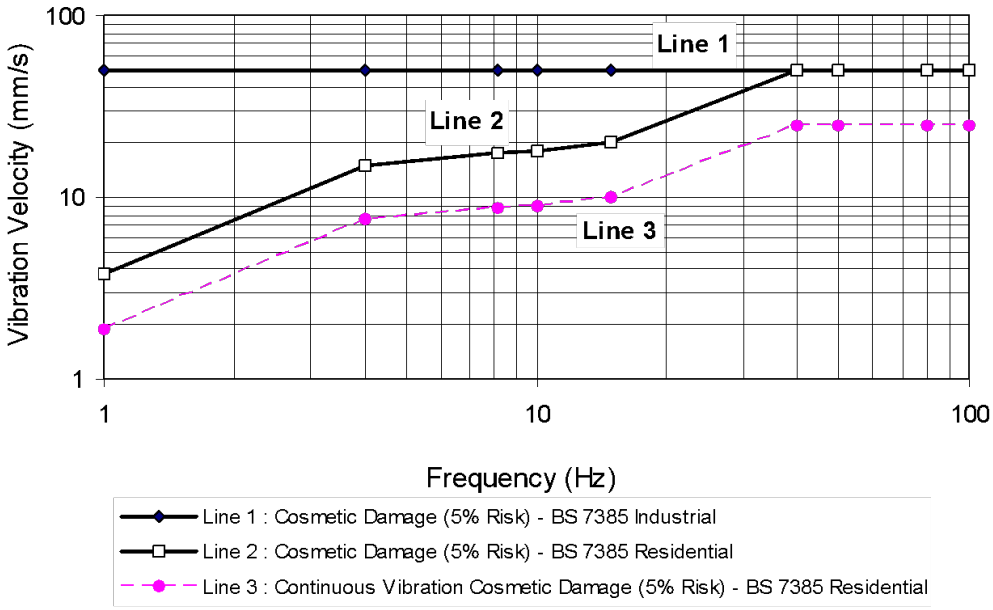


Figure 3.1 Graph of transient vibration guide values for cosmetic damage

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 (as shown in Figure 3.1).

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 3.7 should not be reduced for fatigue considerations.

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 3.7.

It is noteworthy that in addition to the guide values nominated in Table 3.7 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.

ii German Standard DIN 4150-3:1999

The German Standard DIN 4150 - Part 3: 1999, provides the strictest guideline levels of vibration velocity for evaluating the effects of vibration in structures. The limits presented in this standard are generally recognised to be conservative.

The DIN 4150 values (maximum levels measured in any direction at the foundation, or maximum levels measured in (x) or (y) horizontal directions, in the plane of the uppermost floor), are summarised in Table 3.8 and shown graphically in Figure 3.1.

For residential and commercial type structures, the standard recommends safe limits as low as 5 mm/s and 20 mm/s respectively. These limits increase with frequency values above 10 Hz. The operational frequency of construction plant typically ranges between 10 Hz to 30 Hz, and hence according to DIN 4150, the safe vibration guide limit range for dwellings is 5 to 15 mm/s. For reinforced commercial type buildings, the limit is as low as 20 mm/s, while for heritage or sensitive structures the lower limit is 3 mm/s.

Table 3.8 Structural damage guideline values of vibration velocity – DIN4150

Line*	Type of structure	Vibration Velocity in mm/s			
		At foundation at a frequency of			Plane of floor of uppermost storey
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	5 to 20	15
3	Structures that because of their particular sensitivity to vibration do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

Notes: 1. "Line*" refers to curves in Figure 1 of DIN4150.
2. For frequencies above 100 Hz the higher values in the 50 Hz to 100 Hz column should be used.

These levels are "safe limits", for which damage due to vibration effects is unlikely to occur. "Damage" is defined in DIN 4150 to include even minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls.

Should such damage be observed without vibration levels exceeding the “safe limits” then it is likely to be attributable to other causes. DIN 4150 also states that when vibration levels higher than the “safe limits” are present, it does not necessarily follow that damage would occur.

As indicated by the guide levels from DIN 4150 in Table 3.8, high frequency vibration has less potential to cause damage than lower frequencies. Furthermore, the “point source” nature of vibration from plant causes the vibratory disturbances to arrive at different parts of nearby large structures in an out-of-phase manner, thereby reducing its potential to excite in-phase motion of the low order modes of vibration in such structures.

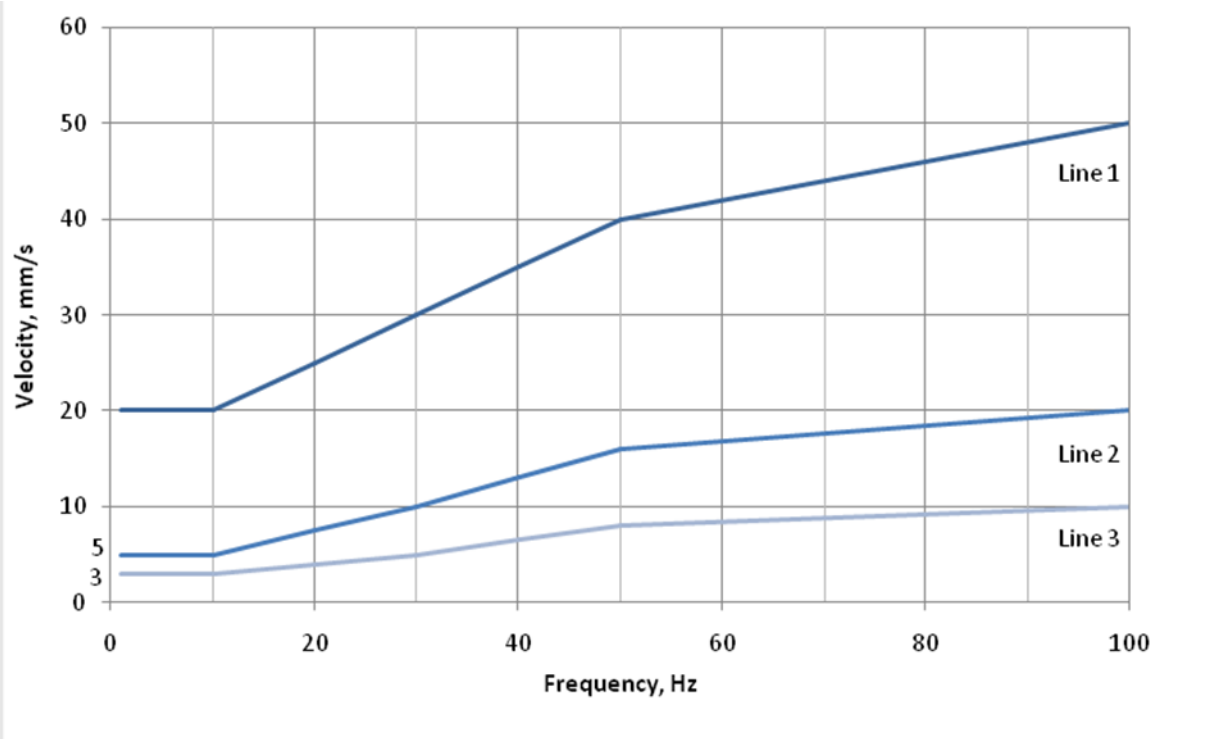


Figure 3.2 DIN4150 structural damage guideline values of vibration velocity

The potential effect of vibration on particular structures can vary depending on many factors including their existing structural integrity and use.

3.2.4 Project specific assessment criteria

Assessment of potential for cosmetic damage associated with construction activities of residential and commercial buildings, heritage structures, infrastructure items and transmission lines has adopted the criteria established in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2* be used as they are “applicable to Australian conditions”.

3.3 Operational noise

Following the construction of the commuter car park there would be noise emissions from vehicles associated with the car park use.

Noise from car park use is not specifically addressed in NSW by the local council, DPIE and/or the EPA guidelines or regulations. In the absence of specific guidelines this assessment has considered the noise trigger levels established

in accordance with the requirements of the NSW EPA *Noise Policy for Industry* (NPfI) for consideration of operational noise from use of the car park and represents a conservative approach.

The objectives of noise trigger levels for industry established in accordance with the NPfI are to protect the community from excessive intrusive noise and preserve amenity for specific land uses. It should be noted that the audibility of a noise source does not necessarily equate to disturbance at an assessment location.

To ensure these objectives are met, the EPA provides project specific noise trigger levels, namely intrusiveness and amenity.

3.3.1 Intrusiveness noise levels

The intrusiveness noise levels require that $L_{Aeq,15min}$ noise levels from the site during the relevant operational periods do not exceed the RBL by more than 5 dB. It is noted that intrusiveness noise levels are only applicable at residential assessment locations.

Table 3.9 presents the intrusiveness noise levels determined for the site based on the adopted RBLs established by the measurements. Where assessment locations have been grouped together in the following tables, it has been assumed that the ambient noise environment at these assessment locations is similar.

Table 3.9 Project intrusiveness noise levels

Residential assessment location	Assessment period[1]	Adopted RBL, dBA	Project intrusiveness noise level (RBL + 5 dB), $L_{Aeq,15min}$, dB
R1 to R4	Day	45	50
	Evening	45	50
	Night	35	40
R6 to R9	Day	41	46
	Evening	41[2]	46
	Night	36	41

1. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; Evening: 6 pm to 10 pm; 6 am to 7 am Monday to Saturday, 6 am to 8 am Sundays and public holidays; Night: remaining periods.
2. Section 2.3 of NPfI, evening should be no higher than day

3.3.2 Amenity noise levels

The assessment of amenity is based on noise levels specific to the land use. The noise levels relate only to industrial noise and exclude road or rail traffic noise.

The recommended amenity noise levels for an area are outlined in Table 2.2 of the NPfI. Where receivers are impacted by multiple industrial sites (or noise sources), the recommended amenity noise level is adjusted. Considering the lack of existing and likely future industry for the area, this assessment has adopted the recommended amenity level from the NPfI for suburban and commercial areas respectively, as presented in Table 3.10.

Residential areas potentially affected from operational noise are located to the west, north, east and south of the site.

Table 3.10 Project amenity noise levels

Assessment location	Time period[1]	Indicative area	Project amenity noise level[2] dB, $L_{Aeq,period}$
R1 to R4	Day	Suburban	55
	Evening		45
	Night		40
C5	When in use	Commercial	65
R6 to R9	Day	Suburban	55
	Evening		45
	Night		40

Source: NPfI (EPA 2017)

1. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; Evening: 6 pm to 10 pm; Night: 10 pm to 7 am Monday to Saturday; 10 pm to 8 am Sundays and public holidays.
2. Recommended Amenity noise level from Table 2.2 of NPfI

3.3.3 Project noise trigger level

The project noise trigger level (PNTL) is the lower of the calculated intrusiveness or amenity noise levels. Taking account of the measured background noise levels, project intrusive noise levels and project amenity levels for residential assessment locations, a summary of the PNTL for the assessment of operational noise from the proposed car park is presented in Table 3.11.

Table 3.11 Project noise trigger levels

Assessment location	Assessment period[1]	Intrusiveness noise level, $L_{Aeq,15min}$, dB	Project Amenity noise level[2], $L_{Aeq,15min}$, dB	PNTL[3], $L_{Aeq,15min}$, dB
R1 to R4	Day	50	58	50
	Evening	50	48	48
	Night	40	43	40
C5	When in use	-	68	68
R6 to R10	Day	46	58	46
	Evening	46	48	46
	Night	41	43	41

1. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; Evening: 6 pm to 10 pm; 6 am to 7 am Monday to Saturday, 6 am to 8 am Sundays and public holidays; Night: remaining periods.
2. Project amenity LAeq,15min noise level is the recommended amenity noise level $L_{Aeq,period}$ +3 dB as per the NPfI.
3. PNTL is the lower of the calculated intrusiveness or amenity noise levels.

3.3.4 Sleep disturbance

The NPfI suggests that a detailed maximum noise level event assessment should be undertaken where night-time operational noise levels at a residential location exceed:

- $L_{Aeq,15\ minute}$ 40 dB or the prevailing RBL plus 5 dB (whichever is the greater); and/or
- L_{Amax} 52 dB or the prevailing RBL plus 15 dB (whichever is the greater).

Guidance regarding potential for sleep disturbance is also provided in the RNP. The RNP calls upon numerous studies that have been conducted into the effect of maximum noise levels on sleep. The RNP acknowledges that, at the current level of understanding, it is not possible to establish absolute noise level criteria that would correlate to an acceptable level of sleep disturbance. However, the RNP provides the following conclusions from the research on sleep disturbance:

- maximum internal noise levels (L_{Amax}) below 50 to 55 dB are unlikely to awaken people from sleep; and
- one or two noise events per night, with maximum internal noise levels (L_{Amax}) of 65 to 70 dB, are not likely to affect health and wellbeing significantly.

It is commonly accepted by acoustic practitioners and regulatory bodies (i.e. EPA) that a facade including a partially open window would reduce external noise levels by 10 dB. Therefore, external noise levels in the order of 60 to 65 dB calculated at the facade of a residence is unlikely to awaken people according to the RNP.

If noise levels over the screening criteria are identified, then additional analysis would consider factors such as:

- how often the events would occur;
- the time the events would occur;
- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods); and
- current scientific literature available regarding the impact of maximum noise level events at night.

Table 3.12 provides the noise level event screening criteria for the residential assessment locations.

Table 3.12 Sleep disturbance screening criteria at residences

Assessment location	Adopted night RBL, dB	Night-time maximum noise level event screening criteria, dB	
		$L_{Aeq,15\ minute}$	L_{Amax}
All residential assessment locations	35	40	52

3.4 Road traffic noise

Construction and operational traffic require assessment for potential noise impacts where there is a likely increase in road traffic volumes as a result of a development. The principal guidance to assess the impact of the road traffic noise on assessment locations is in the NSW *Road Noise Policy* (RNP). Table 3.13 presents the road noise assessment criteria for residential land uses (i.e. assessment locations), reproduced from Table 3 of the RNP for road categories relevant to the proposed commuter car park.

Table 3.13 Road traffic noise assessment criteria for residential land uses

Road category	Type of project/development	Assessment criteria – dBA	
		Day (7 am to 10 pm)	Night (10 pm to 7 am)
Freeway/arterial/sub-arterial roads	Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use developments.	$L_{eq,15hr}$ 60 (external)	$L_{eq,9hr}$ 55 (external)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments.	$L_{eq,1hr}$ 55 (external)	$L_{eq,1hr}$ 50 (external)

Section 2.2 of the RNP outlines the different road categories based on functionality. Considering the procedures of the RNP this assessment has adopted arterial/sub-arterial for Schofields Road and local road for Altrove Boulevard and Bridge Street.

The RNP states that where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to an increase of up to 2 dB.

In addition to meeting the assessment criteria in Table 3.13 any significant increase in total traffic noise at the relevant residential assessment locations must be considered. Residential assessment locations experiencing increases in total traffic noise levels above those presented in Table 3.13 should be considered for mitigation.

Table 3.14 Road traffic relative increase criteria for residential land uses

Road category	Type of project/development	Total traffic noise level increase – dBA	
		Day (7 am to 10 pm)	Night (10 pm to 7 am)
Freeway/arterial/sub-arterial roads and transit ways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road.	Existing traffic $L_{eq(15\text{-}hr)}$+12 dB (external)	Existing traffic $L_{eq(9\text{-}hr)}$+ 12 dB (external)

Appendix B of the RNP, states that noise levels shall be rounded to the nearest integer, whilst difference between two noise levels are to be rounded to a single decimal place.

4 Assessment method

4.1 Noise modelling

This section presents the methods and base parameters used to model operational and construction noise and vibration emissions from the Proposal.

Operational and construction noise levels were predicted using a computer-generated model using DGMR Software proprietary modelling software, iNoise. The model utilised international standard ISO 9613-2:1996 'Acoustics – Attenuation of sound during propagation outdoors'. As per Section 1 of the standard:

> The method predicts the equivalent continuous A-weighted sound pressure level (as described in parts 1 to 3 of ISO 1996) under meteorological conditions favourable to propagation from sources of known sound emission.
>
> These conditions are for downwind propagation, as specified in 5.4.3.3 of ISO 1996-2:1987 or, equivalently, propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs at night.

The model calculates total noise levels at assessment locations from concurrent operation of multiple noise sources. It considers factors that influence noise propagation such as the lateral and vertical location of plant, source-to-receptor distances, ground effects, atmospheric absorption, topography of the site and surrounding area and applicable meteorological conditions.

The model was populated with 3-D topography of the Proposal site and surrounding area, extending out past nearest assessment locations. Plant and equipment representing the range of proposed construction and operation scenarios was placed at locations which would represent worse case noise levels throughout the construction and operational scenarios.

4.2 Construction noise

The construction noise impact assessment has adopted sound power levels from the Department of Environment, Food and Rural Affairs (DEFRA) and EMM noise database for plant and equipment items used on similar projects. Plant and equipment items, sound power levels and quantities adopted in the noise modelling are summarised in Table 4.1.

Construction of the car park is anticipated to take up to eleven months.

Construction of the car park would include four key phases:

- the establishment of a temporary construction site compound in a fenced-off area;
- service installation;
- earthworks; and
- kerbs and pavements.

Table 4.1 Typical construction plant and equipment

Description	Equipment	Quantity	Item $L_{Aeq,15min}$	Overall $L_{Aeq,15min}$
Site setup	Heavy vehicle	1	105	108
	Generator	1	101	
	Hand tools	2	94	
	Backhoe	1	102	
Service installation	Backhoe	1	102	112
	Heavy vehicle	1	105	
	Hand tools	1	94	
	20T excavator	1	99	
	Bogie tippers	2	107	
	Loader	1	102	
Earthworks	Heavy vehicle	1	105	114
	Backhoe	1	102	
	Grader	1	105	
	Watercart	1	98	
	996 loader	1	102	
	Bogie tippers	2	107	
	30T excavator	1	104	
	Hand tools	1	94	
Kerbs & pavements	Heavy vehicle	1	105	116
	Concrete agitator	1	106	
	Bogie tippers	2	107	
	Concrete boom pump	1	106	
	20T vibrating roller	2	109	
	Asphalt paver	1	105	

1. Standard hours: Monday to Friday 7 am to 6 pm, Saturday 8 am to 1 pm and no construction work on Sundays or public holidays.
2. Plant and equipment items have been assumed to operate continuously in any 15-minute period unless otherwise specified.
3. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; Evening: 6 pm to 10 pm; Night: 10 pm to 7 am Monday to Saturday; 10 pm to 8 am Sundays and public holidays.

4.2.1 Noise predictions - Construction

i Single point predictions

To assess a potential worst case construction scenario, the assessment has considered source noise levels outlined in Table 4.1. Construction noise levels were predicted to the assessment locations listed in Table 2.1 and identified in Figure 2.1.

ii Noise contours

Further to the above approach and acknowledging adjacent industrial land uses and other residential areas to the north, south and west of the site, noise contours have been generated for the day operational activities to determine the potential extent of noise exposure.

4.3 Operational noise

Operational noise from the car park is associated with vehicles moving, engines starting, vehicles accelerating and doors closing. For the assessment purposes the modelling has considered *Recommendations for the calculation of sound emissions of parking areas, motorcar centres and bus stations as well as of multi-storey car parks and underground car parks 6th Edition* (Bavarian Landesamt für Umwelt 2007) in terms of source noise data and adopted a sound power level of $L_{Aeq,15min}$ 74 dB for a single vehicle within the car park.

Considering a peak hour utilisation of 70 % of the car park the modelling has adopted a worst-case scenario of 150 vehicles within a 15 minute assessment period and considering that each vehicle would emit noise typically for 5 minutes whilst in the car park. The traffic report shows that peak usage is typically between 6-7 am in the morning and 6-7 pm in the evening, with relatively little activity during the majority of the night period (i.e. 10 pm – 7 am).

4.3.1 Noise predictions - Operation

i Single point predictions

To assess a potential worst-case scenario, the assessment has considered car park vehicles outlined in Section 4.3. Operational noise levels were predicted to the assessment locations listed in Table 2.1 and identified in Figure 2.1.

ii Noise contours

Further to the above approach and acknowledging adjacent industrial land uses and other residential areas to the north, south and west of the site, noise contours have been generated for the day to evaluate noise exposure surrounding the site.

4.4 Road traffic noise

The Calculation of Road Traffic Noise (CoRTN) and US EPA Federal Highways (FHWA) methods were considered in the assessment of road traffic noise. Where traffic flows were low (<200 vehicles per hour) the FHWA procedures were adopted as it is more sensitive to low traffic volumes. Where traffic volumes were greater than 200 vehicles per hour the CoRTN methodology was adopted. A summary of the road sections, average annual daily traffic (AADT) weekday and assessment methodology is provided Table 4.2.

Table 4.2 Road segments considered in noise assessment

Road segment / name	AADT (weekday)	Assessment methodology
Schofields Road	22,930	CoRTN
Altrove Boulevard	1,652	FHWA[1]
Bridge Street	787	FHWA[1]

Note: 1. FHWA adopted to night traffic assessment due to low traffic volumes.

Road traffic movements associated with operation of the car park have been referenced from the Traffic Impact Assessment (EMM 2020) and adapted to suit RNP assessment requirements (Section 3.4).

Road traffic noise levels from the project have been assessed by calculating existing and existing plus project traffic at representative residential assessment locations using FHWA and CoRTN methods. The following assumptions have been adopted:

- speed limit for Schofields Road 70 km/h as sign posted;
- speed limit for Altrove Boulevard 50 km/h local road unposted;
- speed limit for Bridge Street 50 km/h local road unposted;
- there are no buildings or other intervening objects that would act like a noise barrier between the road and the noise assessment point; and
- a facade reflection has been added to predicted noise levels as appropriate for each calculation method.

5 Impact assessment

5.1 Construction noise

5.1.1 Single point predictions

In accordance with procedures outlined in Section 4.2, prediction of construction noise levels are provided in Table 5.1 for standard day periods under ISO9613 conditions. The level presented for each assessment location represents the energy-average noise level over a 15 minute period and assumes all plant operating concurrently. The predicted exceedance of the ICNG noise affected NML at each assessment location is also provided.

The proponent would manage construction noise levels where exceedances of NMLs have been identified. The construction noise management methods would be detailed in a construction noise management plan as discussed further in Section 6.

The ICNG recommends the following where NMLs are predicted to be exceeded:

- application of feasible and reasonable work practices to minimise noise;
- inform potentially impacted residents of the nature of the works to be carried out, expected noise levels and duration and relevant contact details.

Table 5.1 Predicted construction noise levels

Assessment location	Classification	Period	Noise affected NML, dB	Highly noise affected NML, dB	Predicted construction noise level, dB $L_{Aeq,15min}$	Compliance with NML
R1	Residential	Standard	55	75	53	Yes
R2	Residential	Standard	55	75	59	No (+4)
R3	Residential	Standard	55	75	62	No (+7)
R4	Residential	Standard	55	75	53	Yes
C5	Commercial	When in use	70	75	55	Yes
R6	Residential	Standard	51	75	52	Yes
R7	Residential	Standard	51	75	56	No (+5)
R8	Residential	Standard	51	75	54	No (+3)
R9	Residential	Standard	51	75	53	No (+2)

Notes: Standard hours (7am to 6pm Monday to Friday, 8am to 1pm Saturday and no work on Sunday or public holidays.

Construction noise levels are predicted to exceed the NMLs at a number of assessment locations for standard day construction hours. There is limited opportunity to provide at source or mitigation in the form of acoustic barriers due to site topography and extent of working area for mobile plant. In accordance with the ICNG, residents would be notified prior to works commencing and inform them of the duration and noise level of the works and any proposed respite periods. It is noted that the highly noise affected NML of 75 dB is not expected to be exceeded at any assessment location.

5.1.2 Contours

Predicted $L_{Aeq,15minute}$ noise contours representing the worst-case noise level footprint from the project construction is provided in Figure 5.1. The figure represents the predicted construction noise levels under ISO9613 noise enhancing conditions.

5.2 Construction vibration

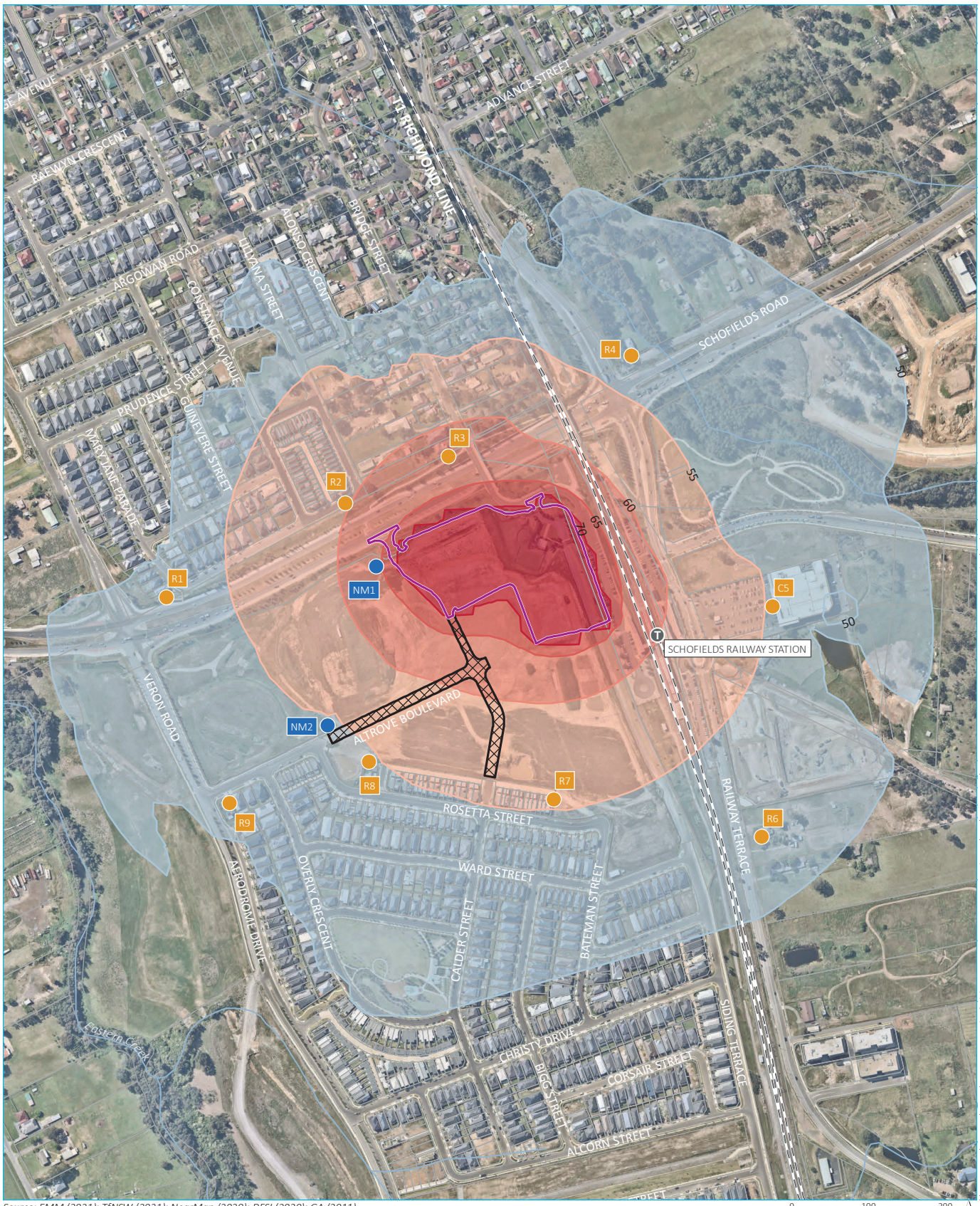
Table 5.2 provides an indication of potential offset distances required from sensitive receivers in order to comply with relevant vibration criteria. This information should be used by relevant personnel when planning their work to identify when other forms of construction methodology or vibration mitigation and/or management measures may need to be investigated or implemented. This data is based on publicly available data for other large infrastructure projects in Sydney.

The safe working distances provided are indicative and would vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions.

Table 5.2 Vibration levels and safe working distance guidance – transient vibration

Source	Estimated safe working distance			
	Human comfort	Commercial, Industrial or similar structures^	Dwellings and similar structures^	Heritage and other sensitive structures^
Large Vibratory Roller (20t)	100m	5m	33m	50m
Medium Vibratory Roller (10t)	100m	5m	20m	31m
Compactor (7t)	50m	5m	20m	20m
Medium Hydraulic Hammer (900kg hammer on 18t excavator)	23m	5m	10m	15m
Light Hydraulic Hammer (300kg on 5t excavator)	10m	5m	5m	5m

The closest existing residential properties are in excess of 100 metres from the proposed car park. In accordance with Table 5.2 both the human comfort and structural damage criteria for the potentially most critical works with vibratory roller are expected to be achieved. No additional mitigation is therefore required.



Source: EMM (2021); TfNSW (2021); NearMap (2020); DFSI (2020); GA (2011)

0 100 200 m

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KEY

- Proposal site
- Altrove Boulevard/ Calder Street extension
- Assessment location
- Monitoring location
- Train station
- Rail line
- Watercourse/drainage line
- Cadastral boundary

Day period noise level contour range

- 50 - 55 dB(A)
- 55 - 60 dB(A)
- 60 - 65 dB(A)
- 65 - 70 dB(A)
- 70 - 75 dB(A)

Construction noise contours, day, ISO9613

Schofields Commuter Car Park
Noise and Vibration Impact Assessment
Figure 5.1

EMM creating opportunities

5.3 Operational noise

5.3.1 Single point predictions

In accordance with procedures outlined in Section 4.3, prediction of single point operational noise levels are provided in Table 5.3 for peak car park use (6-7am and 6-7pm) and assessed against the day, evening and night PNTL. The levels presented for each assessment location represents the energy-average noise level over a 15 minute period and assumes vehicles operating concurrently in accordance with scenarios outlined in Section 4.3 under ISO9613 noise enhancing conditions.

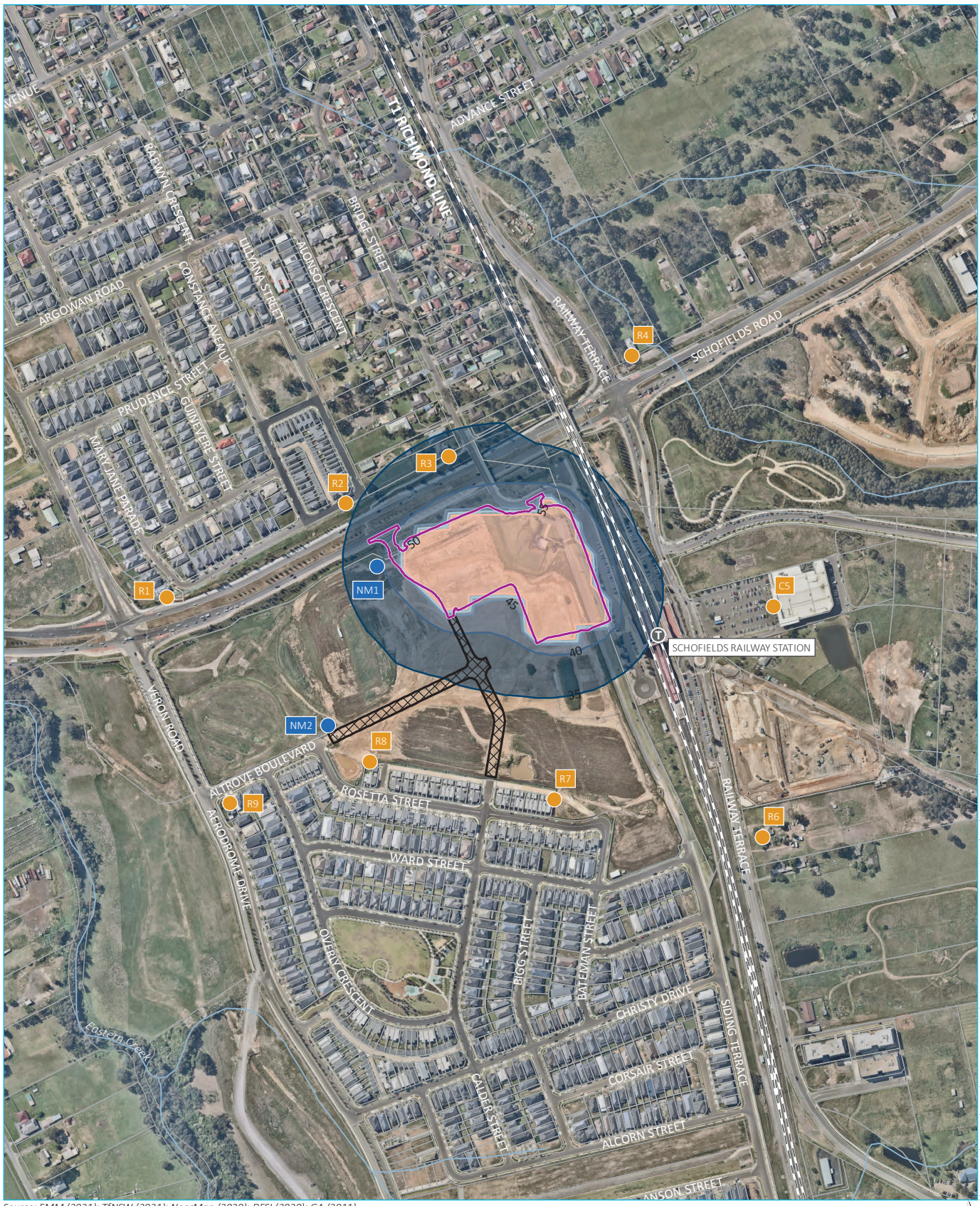
Table 5.3 Predicted operational noise levels – ISO9613

Assessment location	Classification	Period	PNTL, dB	Predicted noise level, dB $L_{Aeq,15min}$
R1	Residential	Day	50	<35
		Evening	48	
		Night	40	
R2	Residential	Day	50	<35
		Evening	48	
		Night	40	
R3	Residential	Day	50	36
		Evening	48	
		Night	40	
R4	Residential	Day	50	<35
		Evening	48	
		Night	40	
C5	Commercial	When in use	68	<35
R6	Residential	Day	46	<35
		Evening	46	
		Night	41	
R7	Residential	Day	46	<35
		Evening	46	
		Night	41	
R8	Residential	Day	46	<35
		Evening	46	
		Night	41	
R9	Residential	Day	46	<35
		Evening	46	
		Night	41	

Noise modelling has demonstrated the PNTLs are satisfied at all assessment locations during day, evening and night use of the car park facility. It is noted that 'night' use is associated with the peak morning shoulder is anticipated at 6-7am in the morning as established in the EMM Traffic Assessment based on Opal card statistics for Schofields Station, and that typical night operations would be relatively minimal.

5.3.2 Contours

Predicted $L_{Aeq,15min}$ noise contours representing day and night operations are provided in Figure 5.2. The figure represents the predicted worst case operational noise levels during adverse weather conditions for peak use during the shoulder night (6-7am) and evening (6-7pm) periods.



Source: EMM (2021); TfNSW (2021); NearMap (2020); DFSI (2020); GA (2011)

0 100 200 m

GDA 1994 MGA Zone 56

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KEY

- Proposal site
- Altrove Boulevard/ Calder Street extension
- Assessment location
- Monitoring location
- Train station
- Rail line
- Watercourse/drainage line
- Cadastral boundary

Day/night period noise level contour range

- 35 - 40 dB(A)
- 40 - 45 dB(A)
- 45 - 50 dB(A)
- 50 - 55 dB(A)
- 55 - 60 dB(A)

Operational noise contours, day/night (6-7am and 6-7pm), ISO9613

Schofields Commuter Car Park
Noise and Vibration Impact Assessment
Figure 5.2

EMM
creating opportunities

5.3.3 Intermittent noise events

Modelling of intermittent L_{Amax} noise events at night considered a typical event of car starting / accelerating and a source sound power level of 95-98 dBA. Potential for these events were considered for the full extent of the car parking area and predicted to the identified assessment locations. The results of the predictions under adverse weather (ISO9613) conditions are presented in Table 5.4.

Table 5.4 Predicted intermittent noise levels – ISO9613

Assessment location	Classification	Period	Screening Level, dB	Predicted intermittent noise level, dB L_{Amax}
R1	Residential	Night	52	35-38
R2	Residential	Night	n/a	44-47
R3	Residential	Night	52	46-49
R4	Residential	Night	52	38-41
C5	Commercial	Night	n/a	n/a
R6	Residential	Night	52	34-37
R7	Residential	Night	52	39-42
R8	Residential	Night	52	39-42
R9	Residential	Night	52	34-37

Results of modelling confirm compliance with the sleep disturbance screening level of 52 dBA for all residential assessment locations.

5.4 Road traffic noise

Road traffic noise level predictions for peak generation day and night are provided in Table 5.6 and Table 5.7, respectively. Traffic volumes were provided by EMM's Traffic and Transport team to represent generation of vehicles associated with use of the car park for envisaged 15hr/9hr volumes for Schofields Road and AM peak (6-7am) and PM peak (6-7pm) for Bridge Street. Peak one hour flows are anticipated to be approximately 70% of total car park capacity (approximately 707 spaces) with volumes distributed as shown in Table 5.5 for Scenario 1 and Scenario 2 options.

Table 5.5 Car park trip distribution (peak hour)

Access	AM Peak	PM Peak
Scenario 1		
Schofields Road[1]		
Entry	220	25
Exit	17	154
Altrove Boulevard		
Entry	198	22
Exit	25	220

Access	AM Peak	PM Peak
Bridge Street		
Entry	22	2
Exit	7	66
Scenario 2		
Schofields Road[1]		
Entry	396	45
Exit	22	198
Bridge Street		
Entry	44	5
Exit	27	243

1. Peak movements (two way) for Schofield Road occur from the East of entry/exit and were utilised for noise modelling

It is noted that for assessment purposes the AM peak falls in the night assessment period for road traffic noise impacts, and the PM peak falls into the day assessment period.

Table 5.6 Road traffic noise calculations, Day (7am to 10pm)

Approximate distance from façade to nearest carriageway	Road segment	Existing movements[3]			Existing plus project movements[3]			Noise level increase due to the Project, $L_{Aeq,T}$
		Total	%HV	Calculated level, $L_{Aeq,T}$	Total	%HV	Predicted level, $L_{Aeq,T}$	
Scenario 1								
33m	Schofields Road[1]	19,491	7	68.2	21,111	7	68.6	0.4
13m	Altrove Boulevard[2]	145	0	53.6	387	0	57.7	4.1[4]
12m	Bridge Street[2]	77	0	51.3	146	0	53.9	2.6[5]
Scenario 2								
33m	Schofields Road[1]	19,491	7	68.2	21,941	7	68.8	0.5
12m	Bridge Street[2]	77	0	51.3	325	0	57.3	6.0[4]

1. Assessed as $L_{Aeq,15hr}$ for arterial road – $L_{Aeq,15hr}$ 60dB
2. Assessed as $L_{Aeq,1hr}$ for local road – $L_{Aeq,1hr}$ 55dB
3. Considered 15hr volumes for Schofields Road and peak site generation for Altrove Boulevard and Bridge Street
4. Greater than 2dB increase and greater than RNP as $L_{Aeq,1hr}$ for local road 55dB trigger need for mitigation
5. Greater than 2dB increase but less that RNP as $L_{Aeq,1hr}$ for local road 55dB

For Scenario 1 (with Altrove Boulevard) assessment of day ($L_{Aeq,15hour}$) traffic predictions for Schofields Road confirm compliance with the ≤2 dB allowance criterion. An increase in the $L_{Aeq,1hr}$ for Altrove Boulevard of 4.1 dB during the day assessment period has been predicted as a result of the increased traffic from the commuter car park. This is a 2.7 dB exceedance of the 55 dB criterion recommended in the RNP for local roads under Scenario 1. Bridge Road $L_{Aeq,1hr}$ traffic noise level increases >2 dB but remains under the RNP baseline level for local roads of 55 dB for Scenario 1.

Under Scenario 2 (without Altrove Boulevard) operation day ($L_{Aeq,15hour}$) traffic predictions for Schofields Road confirm compliance with the ≤2 dB allowance criterion. An increase in the $L_{Aeq,1hr}$ for Bridge Street of 6.0 dB during the day assessment period has been predicted as a result of the increased traffic from the commuter car park and is a 2.3 dB exceedance of the 55 dB RNP baseline criterion for local roads.

Table 5.7 Road traffic noise calculations, Night (10pm to 7am)

Approximate distance from nearest carriageway	Road segment	Existing movements[3]			Existing plus project movements[3]			Noise level increase due to the Project, $L_{Aeq,T}$
		Total	%HV	Calculated level, $L_{Aeq,T}$	Total	%HV	Predicted level, $L_{Aeq,T}$	
Scenario 1								
33m	Schofields Road[1]	3,440	7	62.9	3,943	7	63.5	0.6
13m	Altrove Boulevard[2]	47	0	48.7	270	0	56.1	7.4[4]
12m	Bridge Street[2]	94	0	52.1	124	0	53.2	1.1
Scenario 2								
33m	Schofields Road[1]	3,440	7	62.9	4,666	7	64.3	1.3
12m	Bridge Street[2]	94	0	52.1	166	0	54.4	2.4[4]

1. Assessed as $L_{Aeq,9hr}$ for arterial road – $L_{Aeq,9hr}$ 55dB
2. Assessed as $L_{Aeq,1hr}$ for local road – $L_{Aeq,1hr}$ 50dB
3. Considered 9hr volumes for Schofields Road and peak site generation for Altrove Boulevard and Bridge Street
4. Greater than 2dB increase and greater than RNP as $L_{Aeq,1hr}$ for local road 50dB trigger need for mitigation

For Scenario 1 assessment of night ($L_{Aeq,9hour}$) traffic predictions for Schofields Road and $L_{Aeq,1hr}$ for Bridge Street confirm compliance with the ≤2 dB allowance criterion. An increase in the $L_{Aeq,1hr}$ road traffic noise for Altrove Boulevard of 7.4 dB during the night assessment period has been predicted. This is a 6.1 dB exceedance of the 50dB RNP baseline criterion for local roads.

Under Scenario 2 operation night ($L_{Aeq,9hour}$) traffic predictions for Schofields Road confirm compliance with the ≤2 dB allowance criterion. An increase in the $L_{Aeq,1hr}$ for Bridge Street of 2.4 dB during the night assessment period has been predicted as a result of the increased traffic from the commuter car park and is a 4.4 dB exceedance of the 50 dB RNP baseline criterion for local roads.

Construction traffic would involve substantially lower volumes than the operational traffic for the site, albeit it would include medium and heavy vehicles. Access for the construction vehicles associated with the commuter car park construction would be via Schofields Road only.

6 Noise and vibration mitigation and management

6.1 Construction

The EPA's NSW ICNG requires that construction noise levels be assessed against NMLs. It is not uncommon for construction projects to exceed NMLs. For this reason, they are not considered as noise criteria, but as a trigger for all feasible and reasonable noise mitigation and management to be considered, once exceeded.

Additional mitigation measures (AMM) required under the procedures of the CNVS applicable to the proposed construction are restricted to project notification (PN) and verification (V) as all works are to be conducted during standard hours.

Considering the limited time frame of the works and restriction to standard hours, standard mitigation measures would be adopted by the project. Examples of these measures are listed in the following sections.

6.1.1 Work practices

Work practice methods 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 public address systems or other methods of site communication that may unnecessarily impact upon nearby residents;
- develop routes for the delivery of materials and parking of vehicles to minimise noise;
- where possible, avoid the use of equipment that generates impulsive noise;
- minimise the movement of materials and plant and unnecessary metal-on-metal contact;
- switch engines off when not required for more than five minutes;
- avoid metal on metal contact such as dropping materials, tail gate banging;
- only non-tonal reversing alarms permitted;
- set site up to avoid the need for trucks to reverse;
- consideration of site cyclone fencing hung with echo barrier or equivalent acoustic barrier (3-5dB reduction expected); and
- minimise truck movements.

6.1.2 Plant and equipment

Additional measures for plant and equipment include:

- where possible, choose quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks;
- operate plant and equipment in the quietest and most efficient manner; and
- regularly inspect and maintain plant and equipment to minimise noise and vibration level increases, to ensure that all noise and vibration reduction devices are operating effectively.

6.1.3 Work scheduling

Work scheduling measures include:

- where possible, schedule activities to minimise impacts by undertaking all possible work during hours that would least adversely affect sensitive receivers and by avoiding conflicts with other scheduled events;
- where possible, scheduling work to coincide with non-sensitive periods;
- where possible, scheduling noisy activities to coincide with high levels of neighbourhood noise so that noise from the activities is partially masked and not as intrusive;
- where possible, 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;
- optimise the number of deliveries to the site by amalgamating loads where possible and scheduling arrivals within designated hours; and
- where possible, designating, designing and maintaining access routes to the site to minimise impacts.

6.1.4 Community consultation

Community consultation shall include:

- periodic notification (such as monthly letterbox drop) detailing upcoming construction activities delivered to sensitive receivers seven days prior to commencement of works;
- register of most affected noise and vibration sensitive receivers (NVSRs) including:
  - address, category (residential, commercial, etc), contact name and phone number;
- preparation of a Construction Noise and Vibration Management Plan (CNVMP) for inclusion in Construction Environmental Management Plan (CEMP); and
- consideration of site attended noise monitoring for verification purposes at residences identified as R2 and R3 located north of the site on the opposite side of Schofields Road and R8 to the south (albeit exceedances are <10dB above NML).

6.2 Road traffic noise

Operational road traffic noise impacts on public roads due to project traffic has been assessed in accordance with relevant NSW *Road Noise Policy* (EPA 2011). Road traffic noise levels are predicted to satisfy RNP assessment requirements for Schofields Road and Bridge Street under Scenario 1. Exceedance of the RNP baseline and ≤2 dB allowance criterion for day and night-time traffic is predicted for Altrove Boulevard. The daytime and night-time baseline criteria are exceeded by 2.7 dB and 6.1 dB respectively.

Under Scenario 2 traffic predictions for Schofields Road confirm compliance with the ≤2 dB allowance criterion. An increase in the $L_{Aeq,1hr}$ for Bridge Street of 6.0 dB during the day and 2.4 dB during the night assessment periods has been predicted. These are exceedances of 2.3 dB and 4.4 dB respectively of the RNP baseline criterion for local roads. It is noted that exceedances are expected to be limited to 1 hour in each of the night and day periods.

Accordingly mitigation measures would need to be considered. In considering these levels of exceedances to a limited number of properties, context should be given to the overall and broad benefits of the project to the wider community which is to reduce road traffic volumes and consequently reduce related noise.

6.2.1 Feasible and reasonable noise mitigation

A noise mitigation measure is considered feasible if it can be engineered and is practical to build and/or implement, given project constraints such as safety, maintenance and reliability requirements.

Reasonableness relates to the application of judgement in arriving at a decision, considering if the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the mitigation measure.

The following factors have been considered when evaluating the available noise mitigation options:

- Noise impacts:
  - existing and future noise levels, and projected changes in noise levels;
  - the amount by which the RNP triggers are exceeded;
- Noise mitigation benefits:
  - amount of noise reduction expected;
  - number of people likely to benefit;
- Cost-effectiveness of noise mitigation:
  - total cost of mitigation measures (including capital and maintenance);
  - ongoing operational and maintenance cost borne by the community (eg running air conditioners if closing dwelling windows is required to improve noise);
- Community views:
  - aesthetic considerations; and
  - views of all potentially affected areas determined through community consultation.

6.2.2 Assessment of mitigation

Consideration of the feasibility and reasonableness of additional noise mitigation measures has been undertaken considering the key residential properties fronting Altrove Boulevard and Bridge Street exposed to increase in road traffic noise levels above the allowance criteria of the RNP.

Mitigation options have been considered as provided in Table 6.1. Mitigation strategies have been considered in the following hierarchical approach:

1. control of noise at the source;
2. once the feasible and reasonable controls at the source are exhausted, controlling the transmission of noise; and
3. once source and transmission feasible and reasonable controls are exhausted, considering mitigation measures at the noise-sensitive receivers.

Table 6.1 Mitigation decision-making matrix

Mitigation option	Feasible?	Reasonable?	Justification for adopting / disregarding and expected noise benefit
At-source controls			
Option 1 Reduction in noise from vehicles	No	No	Requires a complete cultural change in vehicle types within public ownership and use Benefits: Compliance with RNP criteria for residences on Altrove Boulevard and Bridge Street (e.g. 13 properties)
Option 2 Restriction in vehicles on Altrove Boulevard	No	No	The restriction of vehicles on Altrove Boulevard would warrant a major design change to remove access / egress from Altrove Boulevard and provide full left in/right in and left out/right out access from Schofields Road. Altrove Boulevard is earmarked for extension by Stockland for their future development in the area, regardless of the car park proposal. Extension of Altrove Boulevard and Calder Street to connect with Schofields Road will provide access to the growth area for the current and future residents so access from Altrove Boulevard cannot be restricted. Additionally, a new right in and right out access from Schofields Road would require a new signalised intersection which would not be supported due to its close proximity to existing intersections on Schofields Road. A non-signalised intersection is not considered due to multiple entry and exit points being a more cost-effective solution. Benefits: Compliance with RNP criteria for residences on Altrove Boulevard (e.g. 13 properties)

Mitigation option	Feasible?	Reasonable?	Justification for adopting / disregarding and expected noise benefit
Option 3 Restriction in vehicles on Bridge Street	No	No	The restriction of vehicles on Bridge Street would warrant a major design change to remove access / egress from Bridge Street and provide full left in/right in and left out/right out access from Schofields Road. A new right in and right out access from Schofields Road would require a new signalised intersection which would not be supported due to its close proximity to existing intersections on Schofields Road. A non-signalised intersection is not considered due to multiple entry and exit points being a more cost-effective solution. This option would limit circulation between the existing western car park and the proposed car park. Benefits: Residences (>30) on Bridge Street no longer impacted
Control transmission of noise			
Option 4 Provision of acoustic barriers on the Altrove Boulevard site boundaries of the affected residences	Yes	No	Rejected on basis of visual impact, cost , access restrictions, airflow implications Benefits: Compliance with RNP criteria for residences on Altrove Boulevard (e.g. 13 properties)
Option 5 Restriction in vehicles on Altrove Boulevard and provision of new private road with acoustic barrier for direct access to Veron Road	Yes	No	Land for location of potential private road is not owned by proponent and would limit future development by Stockland Benefits: Compliance with RNP and/or NPfI criteria for residences on Altrove Boulevard (e.g. 13 properties)
Option 6 Provision of acoustic barriers on the Bridge Street site boundaries of the affected residences	Yes	No	Rejected on basis of visual impact, cost, access restrictions, airflow implications. Benefits: Compliance with RNP criteria for residences on Bridge Street (e.g. >30 properties)

Mitigation option	Feasible?	Reasonable?	Justification for adopting / disregarding and expected noise benefit
Mitigation at the receptor			
Receptor mitigation	Yes	Yes	Potential for at receiver mitigation, comprising alternative ventilation to enable windows to be closed to achieve an equivalent internal design noise level. Existing residences may already have AC as alternate means of ventilation. Benefits: Compliance with RNP equivalent internal criteria for residences on Altrove Boulevard (eg 13 properties) and Bridge Street (eg >30 properties)

Access for the construction vehicles associated with the commuter car park construction would be via Schofields Road only.

7 Conclusion

This NVIA has been prepared to support the REF for the commuter car park at Schofields. It has documented the methods and results, the initiatives built into the project design to avoid and minimise associated impacts, and the mitigation and management measures proposed to address any residual impacts not able to be feasibly and reasonably avoided.

Construction noise levels from the project are predicted to exceed the ICNG NMLs at the majority of assessment locations. Accordingly, it is recommended that all works be conducted during standard hours. Furthermore, residents would be notified prior to works commencing and informed of the duration and noise level of the works and any proposed respite periods.

The potential for vibration impacts on residents and vibration sensitive structures near construction has been assessed. The nearest residence to construction activity is more than 100 metres away from construction activities. The assessment location is well outside of the safe working distances required to maintain acceptable human response and structural vibration levels. Vibration impacts from construction at residential assessment locations are therefore highly unlikely.

Operational noise associated with the car park has confirmed compliance with NPfI requirements for all residential assessment locations.

Intermittent night activities are predicted to satisfy the sleep disturbance screening criteria of L_{Amax} 52 dB as defined in the NSW NPfI (EPA 2017) for all residential assessment locations.

The potential for road traffic noise impacts on public roads due to project traffic has been assessed in accordance with relevant NSW *Road Noise Policy* (EPA 2011). In summary, road traffic noise levels are predicted to satisfy RNP assessment requirements for Schofields Road and Bridge Street. Exceedance of the RNP baseline and ≤2 dB allowance criterion for day and night-time traffic is predicted for Altrove Boulevard (e.g. 13 properties) and Bridge Street in Scenario 2 (e.g. >30 properties). Options for mitigation measures have been recommended for consideration to address noise impacts.

With the effective management and incorporation of mitigation measures listed in Section 6 in place, noise and vibration emissions from the project are generally predicted to satisfy relevant guidelines, standards and policies.

The delivery of commuter car parks at key transport interchanges would provide a range of benefits, including:

- improved customer access to the public transport network;
- encouraging mode shift away from private vehicles;
- providing customers with more flexibility in the first and last part of their journey; and
- contributing to reducing congestion on our road network.

The above aspects should be considering when evaluating the potential noise impacts to an isolated number of residences (13) on Altrove Boulevard and more than 30 residences on Bridge Street (Scenario 2) associated with the use of the car park and local road network, and the potential benefit to the greater community in terms of reduced travel and increased patronage of public transport facilities.

Glossary

Table G.1 Project and technical terms

Term	Meaning
ABL	The assessment background level (ABL) is defined in the INP as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L90 statistical noise levels.
Amenity noise criteria	The amenity noise criteria relate to existing industrial noise. Where industrial noise approaches base amenity noise criteria, then noise levels from new industries need to demonstrate that they would not be an additional contributor to existing industrial noise. See Section 3.3.2 for more detail.
Day period	Monday-Saturday: 7 am to 6 pm, on Sundays and public holidays: 8 am to 6 pm.
dBA	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.
Evening period	Monday-Sunday: 6 pm to 10 pm.
ICNG	Interim Construction Noise Guideline – for the assessment of construction noise from the project
Intrusive noise criteria	The intrusive noise criteria refers to noise that intrudes above the background level by more than 5 dB. The intrusiveness criterion is described in detail in Section 3.3.1
L1	The noise level exceeded for 1% of the time.
L10	The noise level which is exceeded 10% of the time. It is roughly equivalent to the average of maximum noise level.
L90	The noise level that is exceeded 90% of the time. Commonly referred to as the background noise level.
Leq	The energy average noise from a source. This is the equivalent continuous sound pressure level over a given period. The Leq(15min) descriptor refers to a Leq noise level measured over a 15-minute period.
Lmax	The maximum sound pressure level received during a measuring interval.
Night period	Monday-Saturday: 10 pm to 7 am, on Sundays and public holidays: 10 pm to 8 am.
NPfI	Noise Policy for Industry NVIA
NVIA	Noise and vibration impact assessment.
PNTL	The project-noise trigger level (PNTL) is criteria for a particular industrial noise source or industry. The PSNL is the lower of either the intrusive noise criteria or amenity noise criteria.
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 average background levels.
Sound power level (Lw)	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.

Common Noise Levels

The table below gives an indication as to what an average person perceives about changes in noise levels. Examples of common noise levels encountered on a daily basis are provided in the figure below.

Table G.2 Perceived change in noise

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

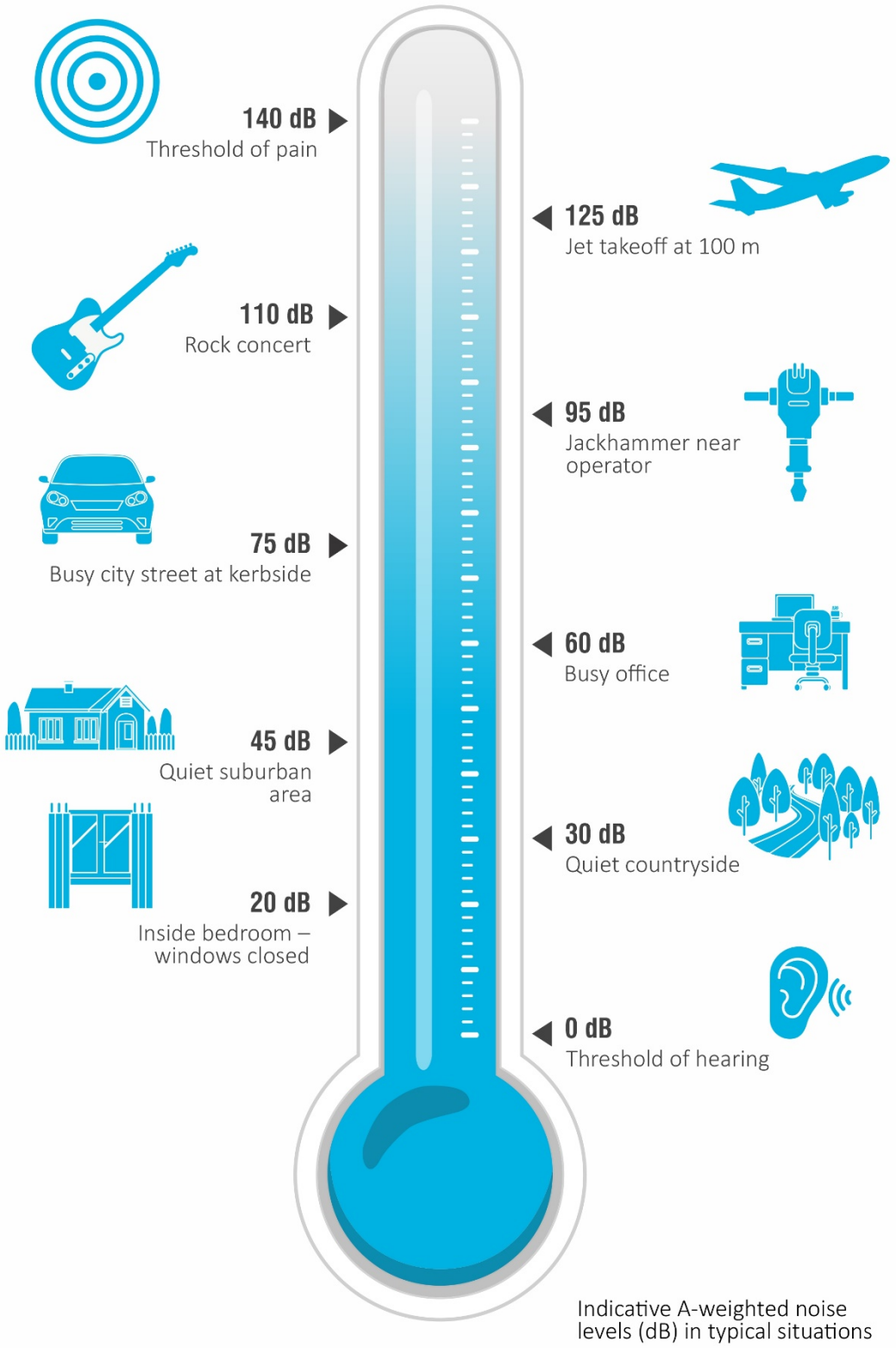


Figure G.1 **Common sources of noise with levels**

References

NSW Interim Construction Noise Guideline (ICNG) 2009, Department of Environment and Climate Change;

Construction Noise and Vibration Strategy (CNVS) v4.2 2019, Transport for NSW;

NSW Assessing Vibration – a technical guideline (AVTG) 2006, Department of Environment and Conservation;

Australian Standard AS/NZS 2107:2016 *'Acoustics - Recommended design sound levels and reverberation times for building interiors'*;

Australian Standard AS2436-1981 *'Guide to Noise Control on Construction, Maintenance and Demolition Sites'*;

British Standard BS 6472-2008, *'Evaluation of human exposure to vibration in buildings (1-80Hz)'*;

British Standard 7385: Part 2-1993 *'Evaluation and measurement of vibration in buildings'*;

German Standard DIN4150-2016 *'Structural vibration Part 3: Effects of vibration on Structures'*;

Noise Policy for Industry (NPfI) 2017, NSW Environment Protection Authority (EPA); and

Road Noise Policy (RNP) 2011, NSW Environment Protection Authority (EPA).

Appendix A

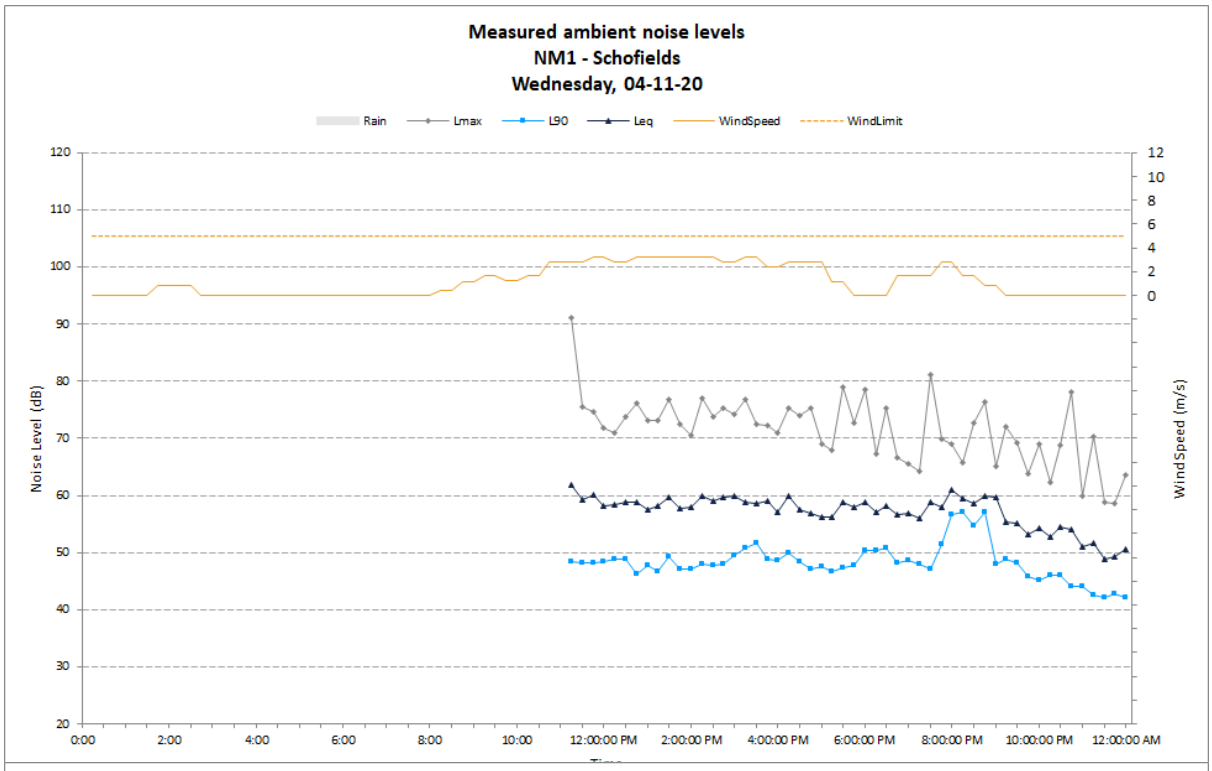
Unattended noise monitoring results

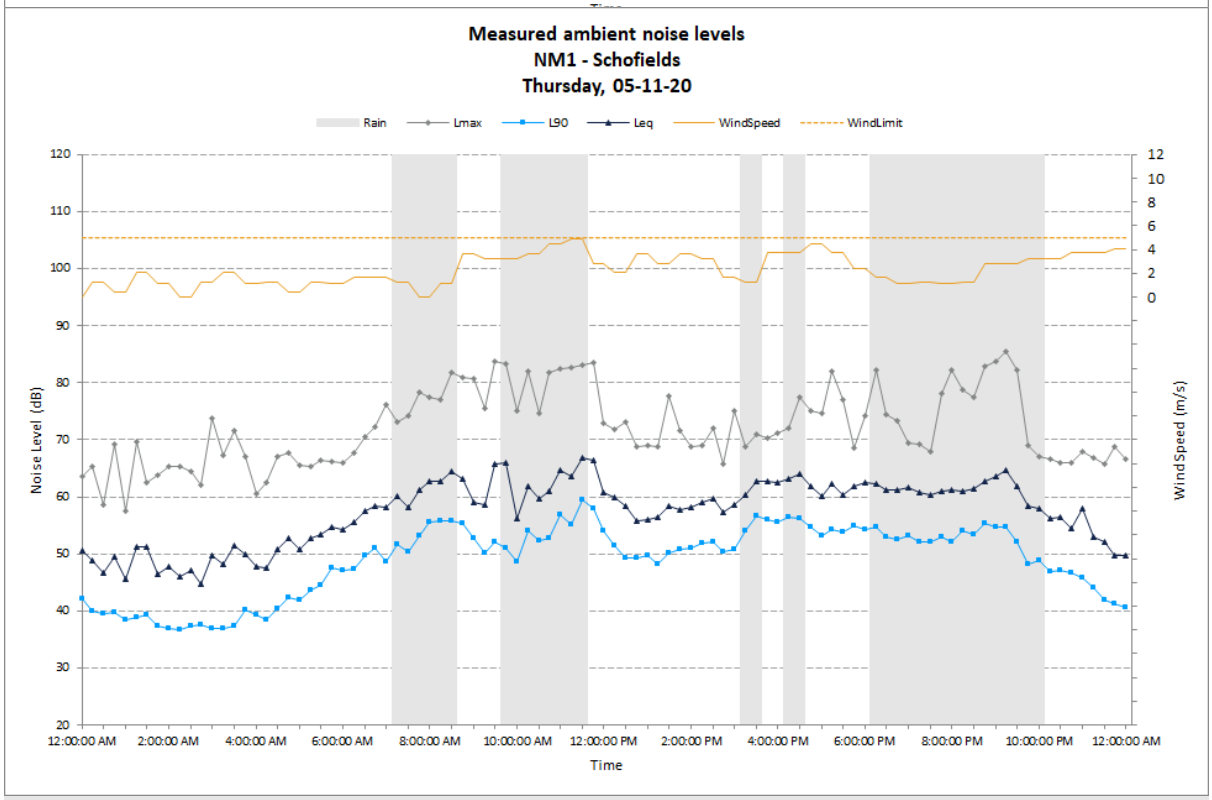
A.1 NM1

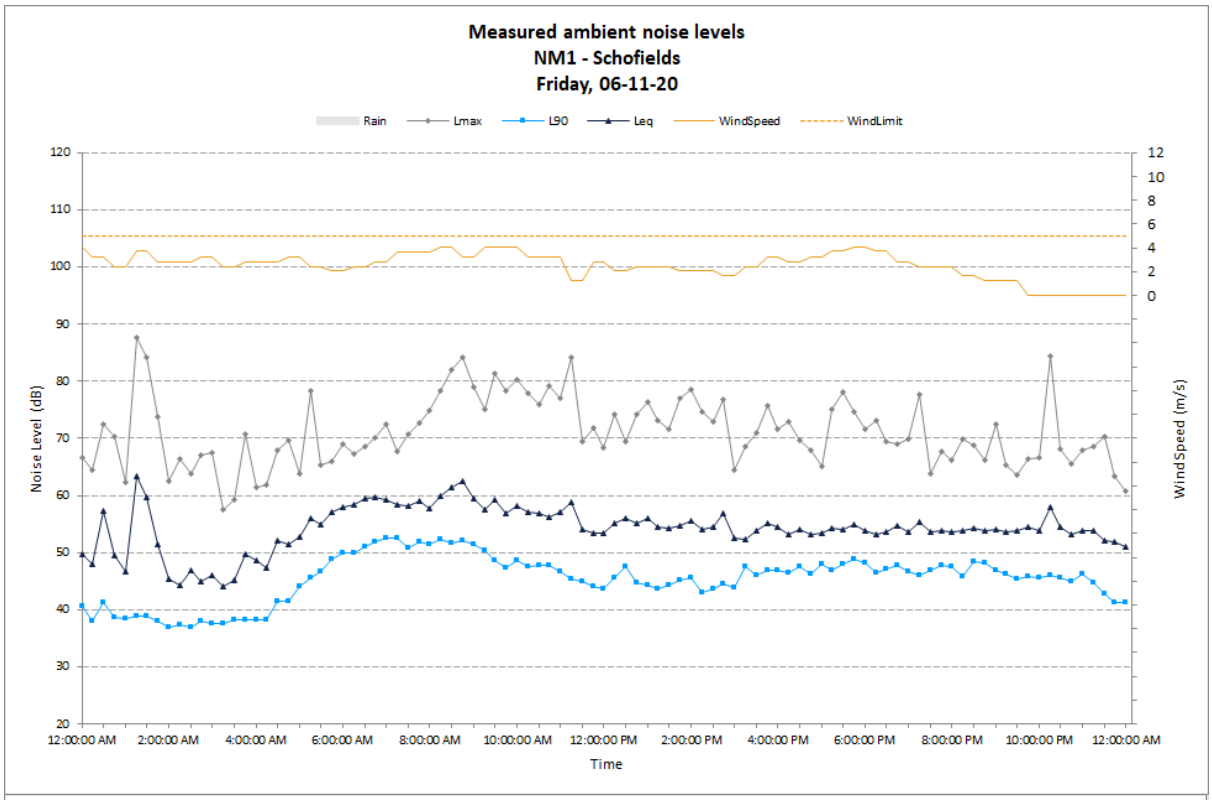
Table A.1 NM1 – Summary results

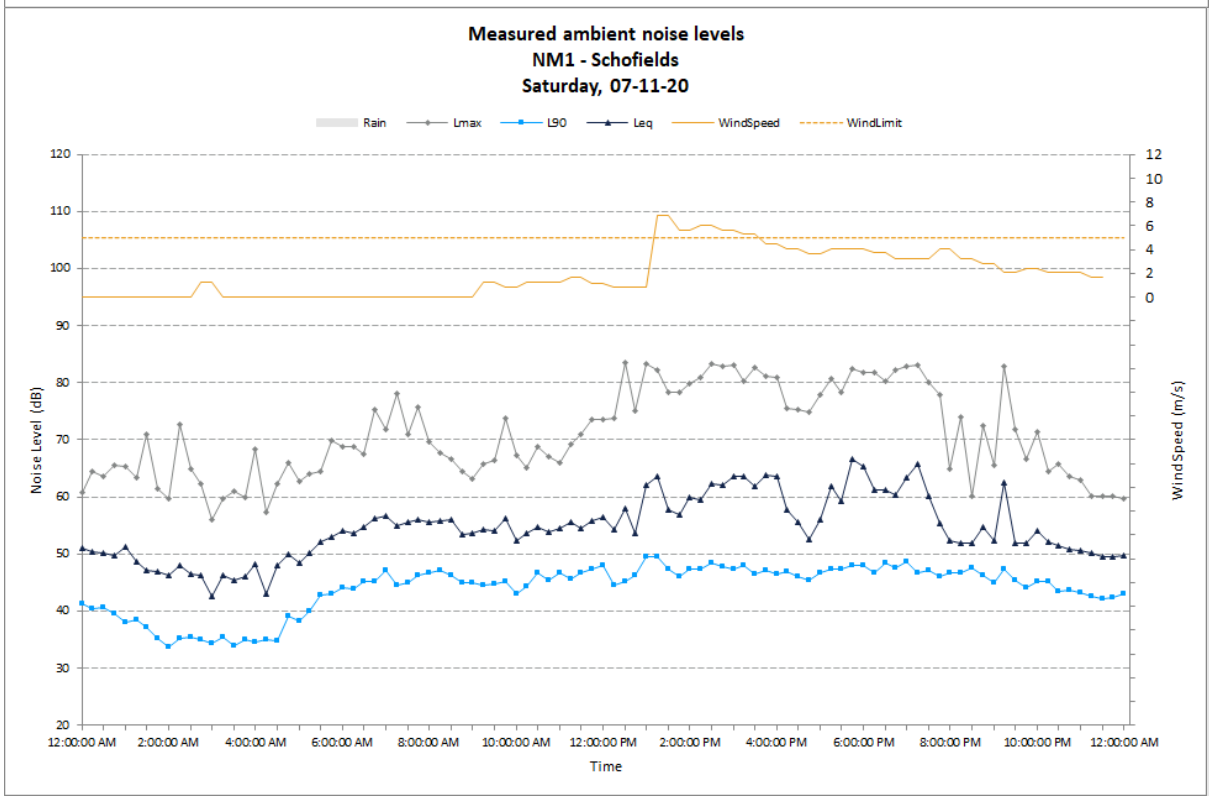
Date	ABL Day	ABL Evening	ABL Night	$L_{Aeq,11\ hour}$ Day	$L_{Aeq,4\ hour}$ Evening	$L_{Aeq,9\ hour}$ Night	$L_{Aeq,15\ hour}$ Day	$L_{Aeq,24\ hour}$ Day	$L_{Aeq,8\ hour}$ Night
Wednesday, 04-11-20	0	46	37	0	58	52	0	0	51
Thursday, 05-11-20	0	0	38	0	0	55	0	0	55
Friday, 06-11-20	44	46	35	57	54	52	56	55	51
Saturday, 07-11-20	0	45	35	0	60	49	59	57	49
Sunday, 08-11-20	38	41	35	52	54	53	53	53	51
Monday, 09-11-20	45	45	37	58	56	53	58	57	52
Tuesday, 10-11-20	47	46	37	59	58	53	59	57	52
Wednesday, 11-11-20	45	46	34	59	58	53	59	57	52
Thursday, 12-11-20	49	47	0	60	57	0	60	58	0
Friday, 13-11-20	45	41	34	60	50	48	59	57	47
Saturday, 14-11-20	0	0	0	0	0	0	0	0	0
Sunday, 15-11-20	0	0	0	0	0	0	0	0	0
Monday, 16-11-20	0	0	0	0	0	0	0	0	0
Summary Values	**45**	**45**	**35**	**57**	**56**	**52**	**57**	**56**	**51**

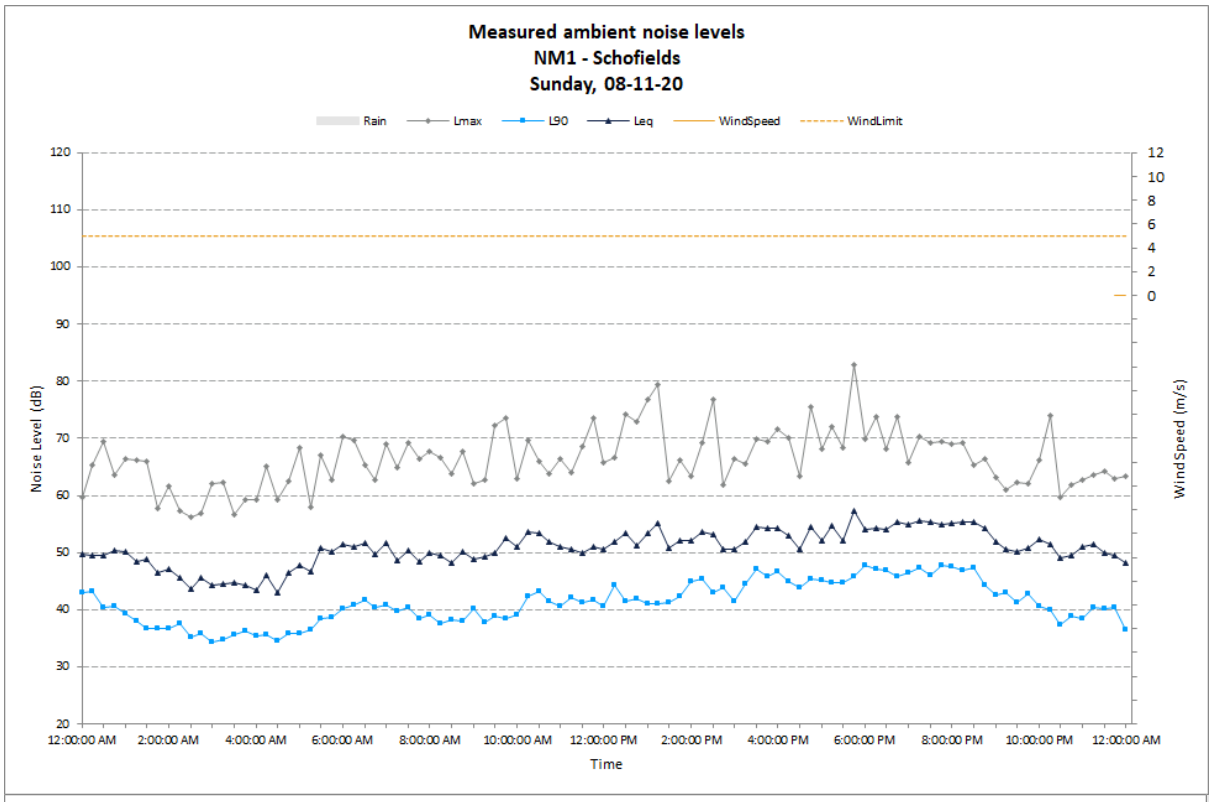
Notes: 1. 0 indicates periods with too few valid samples due to weather or logger operation
2. Leq24hr encompasses the period 7am to 7am

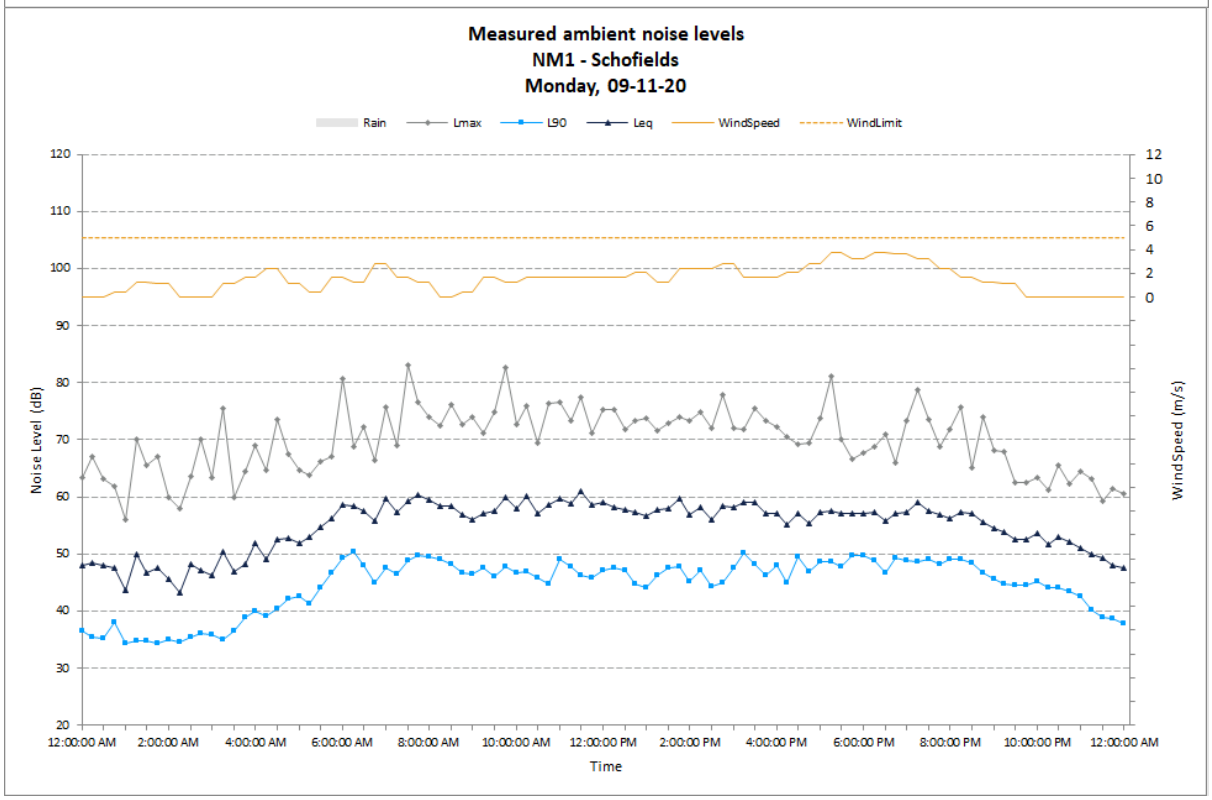

Measured ambient noise levels
NM1 - Schofields
Wednesday, 04-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
0:00
2:00
4:00
6:00
8:00
10:00
12:00:00 PM
2:00:00 PM
4:00:00 PM
6:00:00 PM
8:00:00 PM
10:00:00 PM
12:00:00 AM

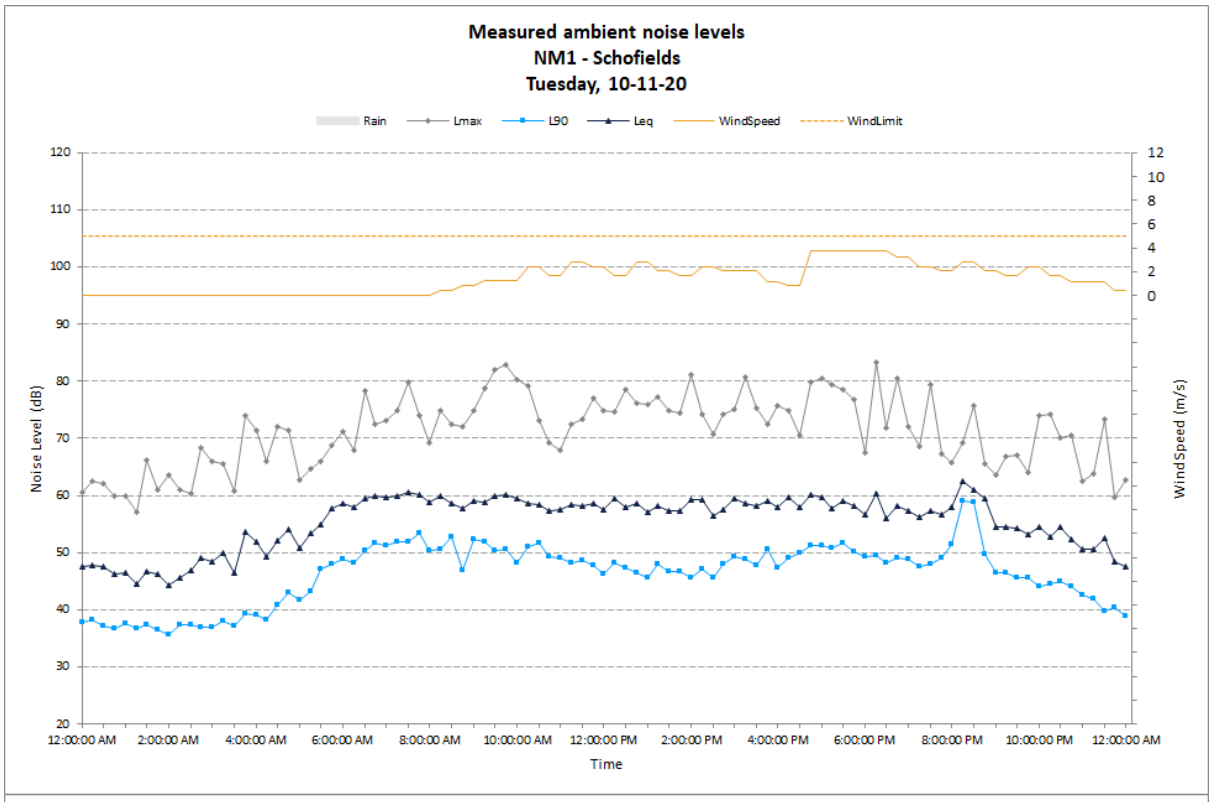

Measured ambient noise levels
NM1 - Schofields
Thursday, 05-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
12:00:00 AM
2:00:00 AM
4:00:00 AM
6:00:00 AM
8:00:00 AM
10:00:00 AM
12:00:00 PM
2:00:00 PM
4:00:00 PM
6:00:00 PM
8:00:00 PM
10:00:00 PM
12:00:00 AM
Time

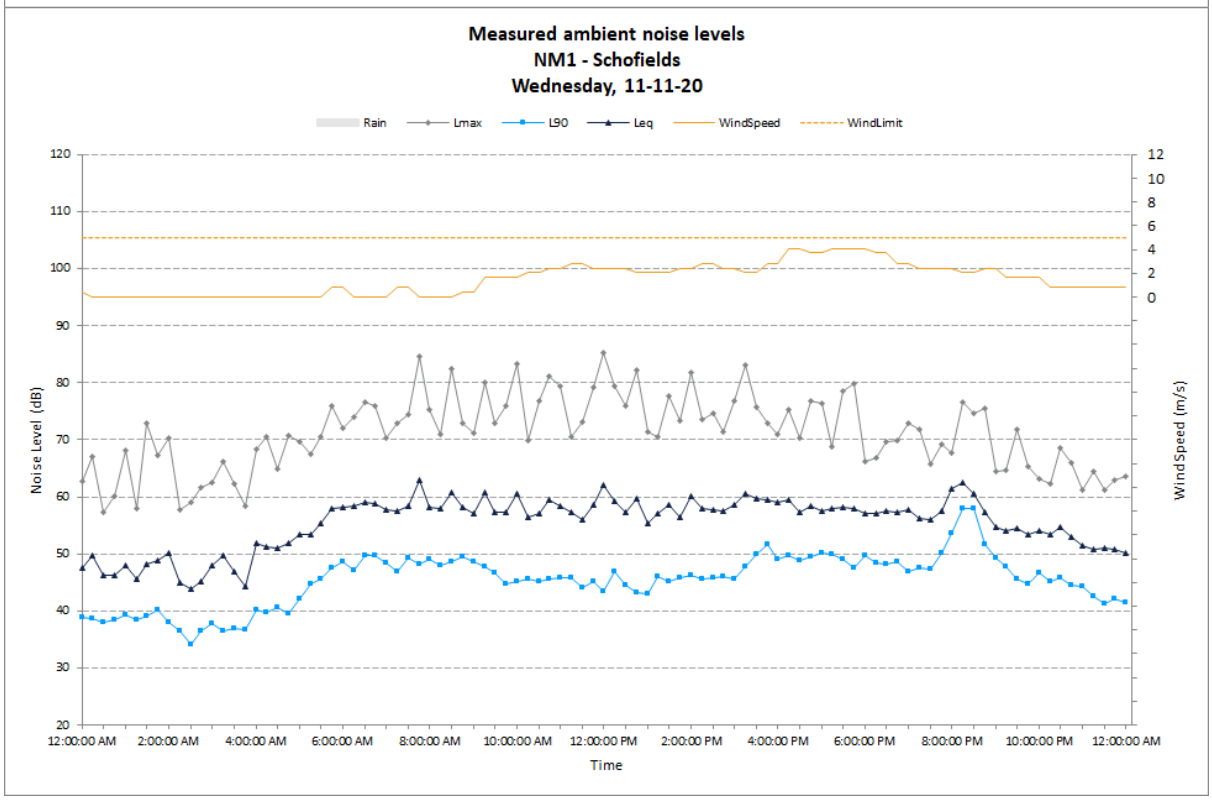

Measured ambient noise levels
NM1 - Schofields
Friday, 06-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time
12:00:00 AM
2:00:00 AM
4:00:00 AM
6:00:00 AM
8:00:00 AM
10:00:00 AM
12:00:00 PM
2:00:00 PM
4:00:00 PM
6:00:00 PM
8:00:00 PM
10:00:00 PM
12:00:00 AM

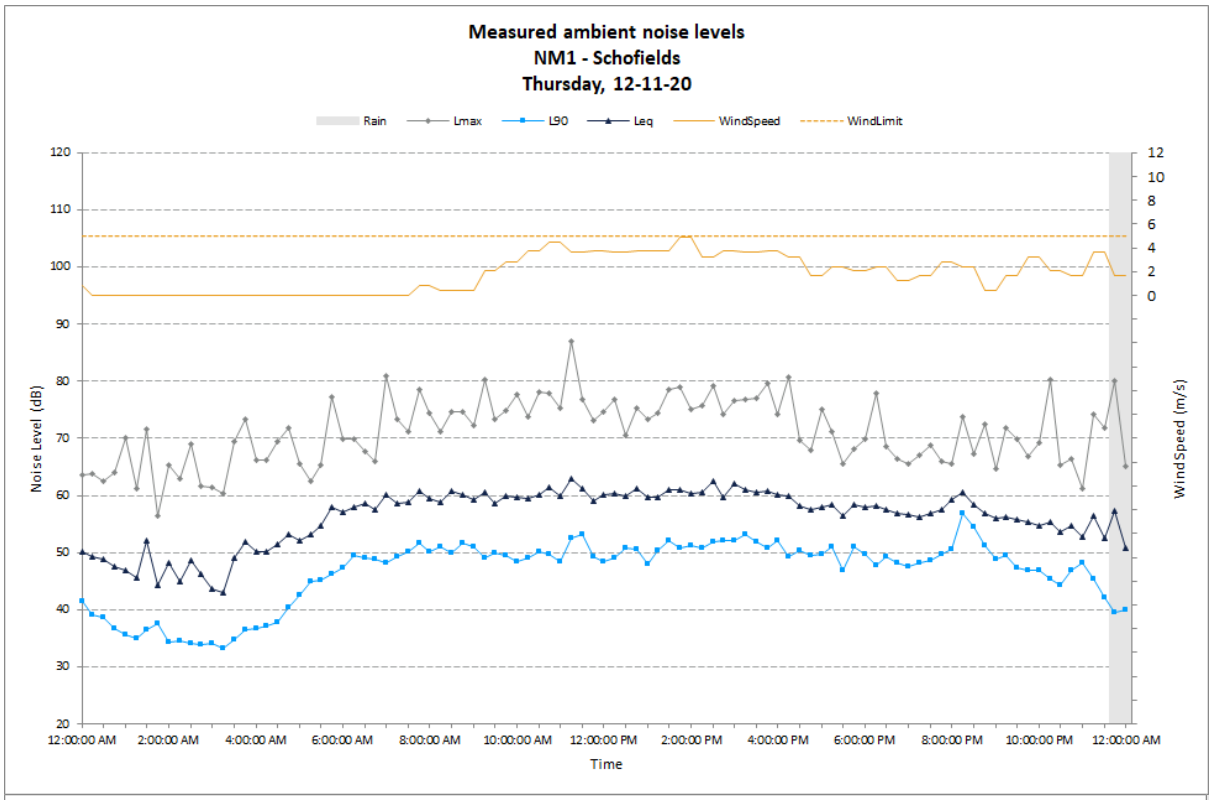

Measured ambient noise levels
NM1 - Schofields
Saturday, 07-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time
12:00:00 AM
2:00:00 AM
4:00:00 AM
6:00:00 AM
8:00:00 AM
10:00:00 AM
12:00:00 PM
2:00:00 PM
4:00:00 PM
6:00:00 PM
8:00:00 PM
10:00:00 PM
12:00:00 AM

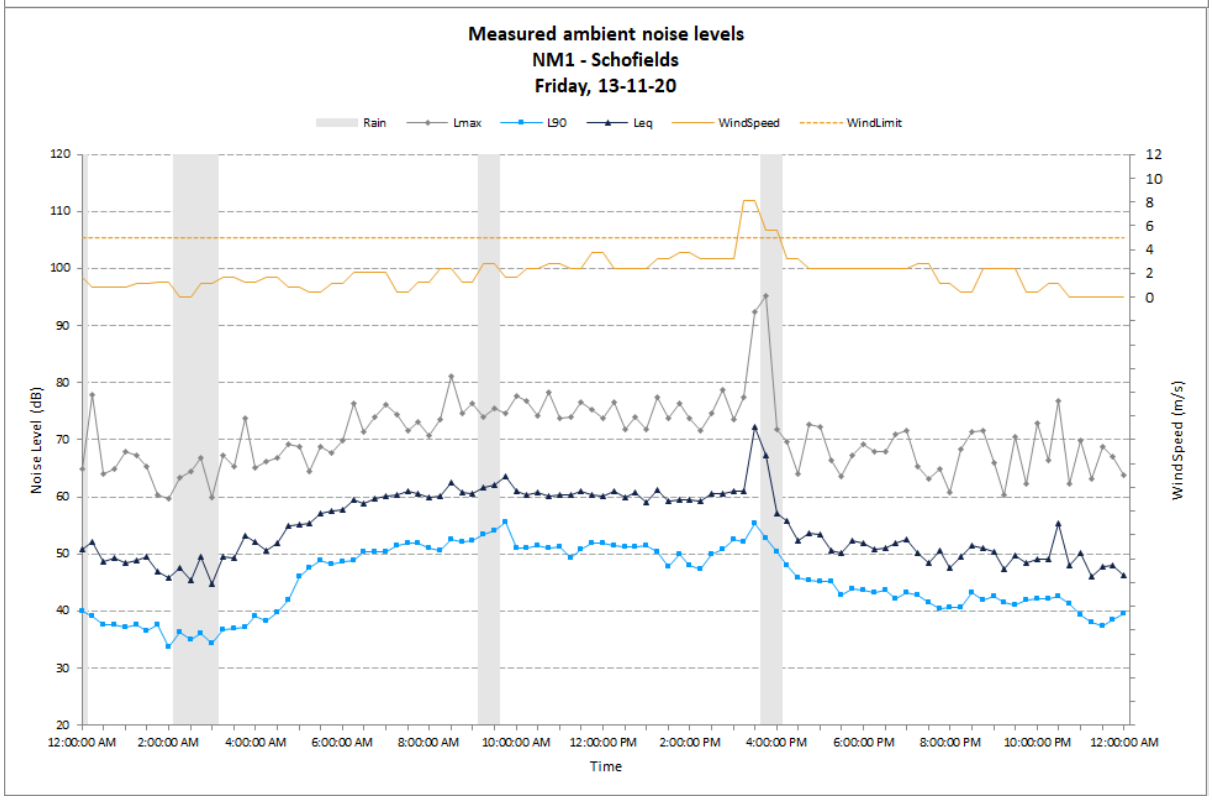

Measured ambient noise levels
NM1 - Schofields
Sunday, 08-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time

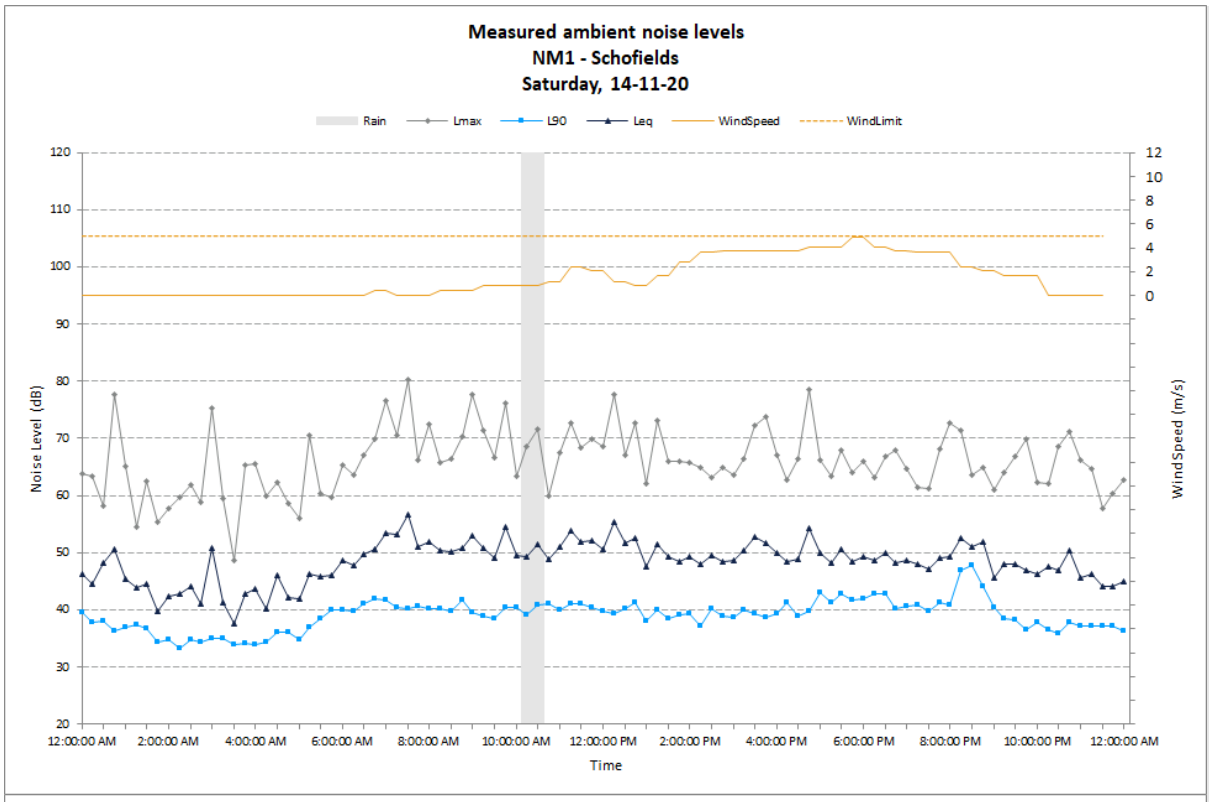

Measured ambient noise levels
NM1 - Schofields
Monday, 09-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time

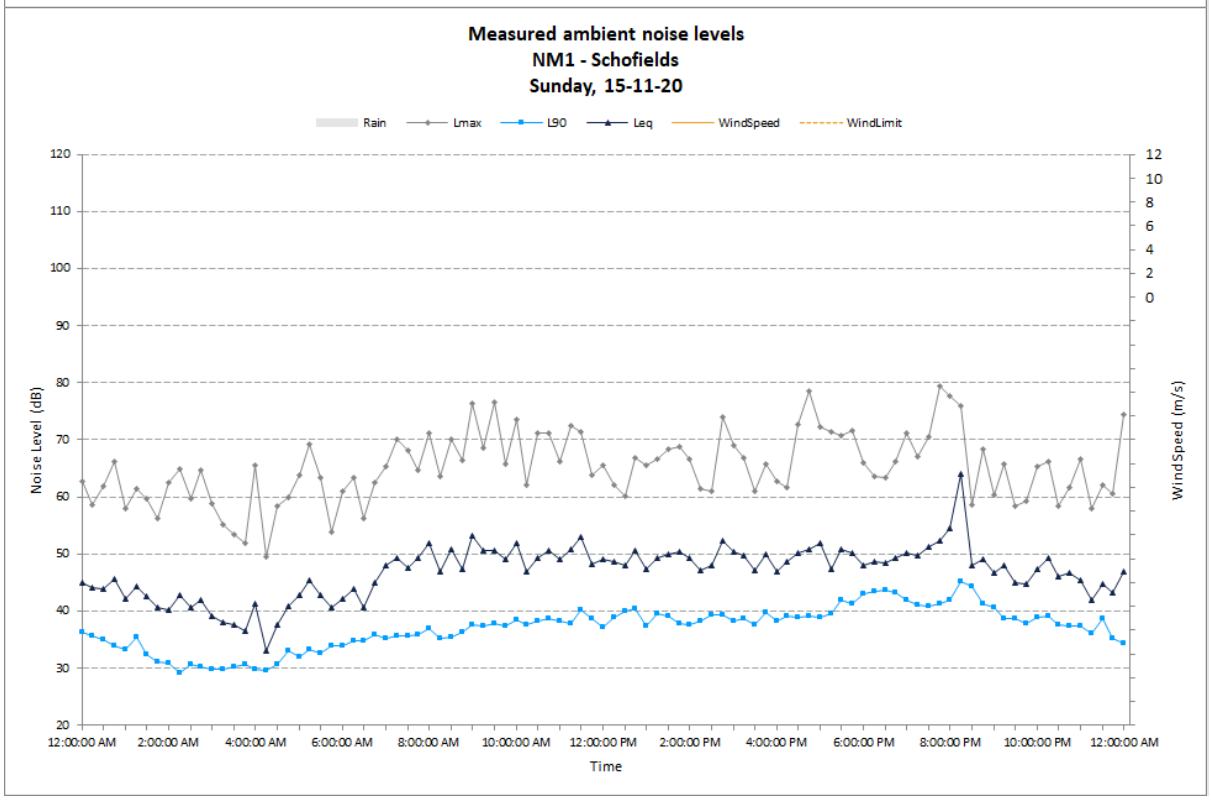

Measured ambient noise levels
NM1 - Schofields
Tuesday, 10-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time

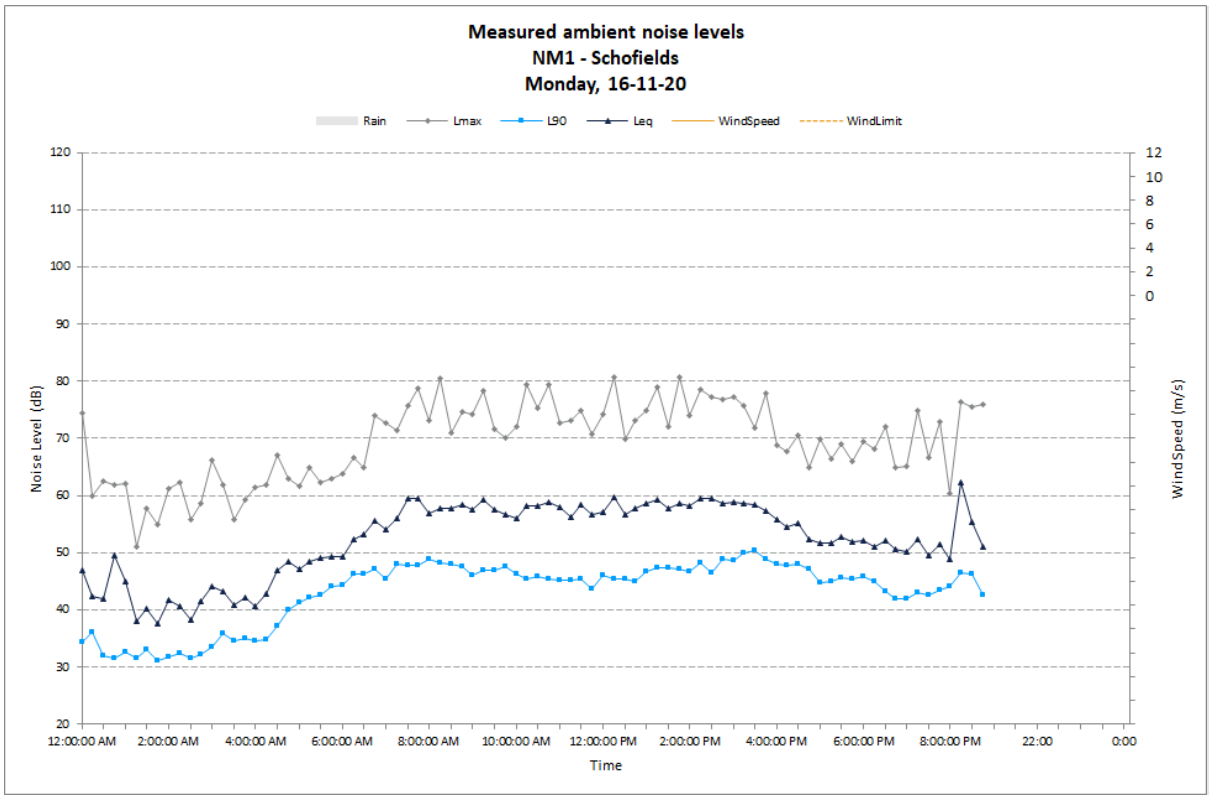

Measured ambient noise levels
NM1 - Schofields
Wednesday, 11-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time


Measured ambient noise levels
NM1 - Schofields
Thursday, 12-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time


Measured ambient noise levels
NM1 - Schofields
Friday, 13-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time


Measured ambient noise levels
NM1 - Schofields
Saturday, 14-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time


Measured ambient noise levels
NM1 - Schofields
Sunday, 15-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time

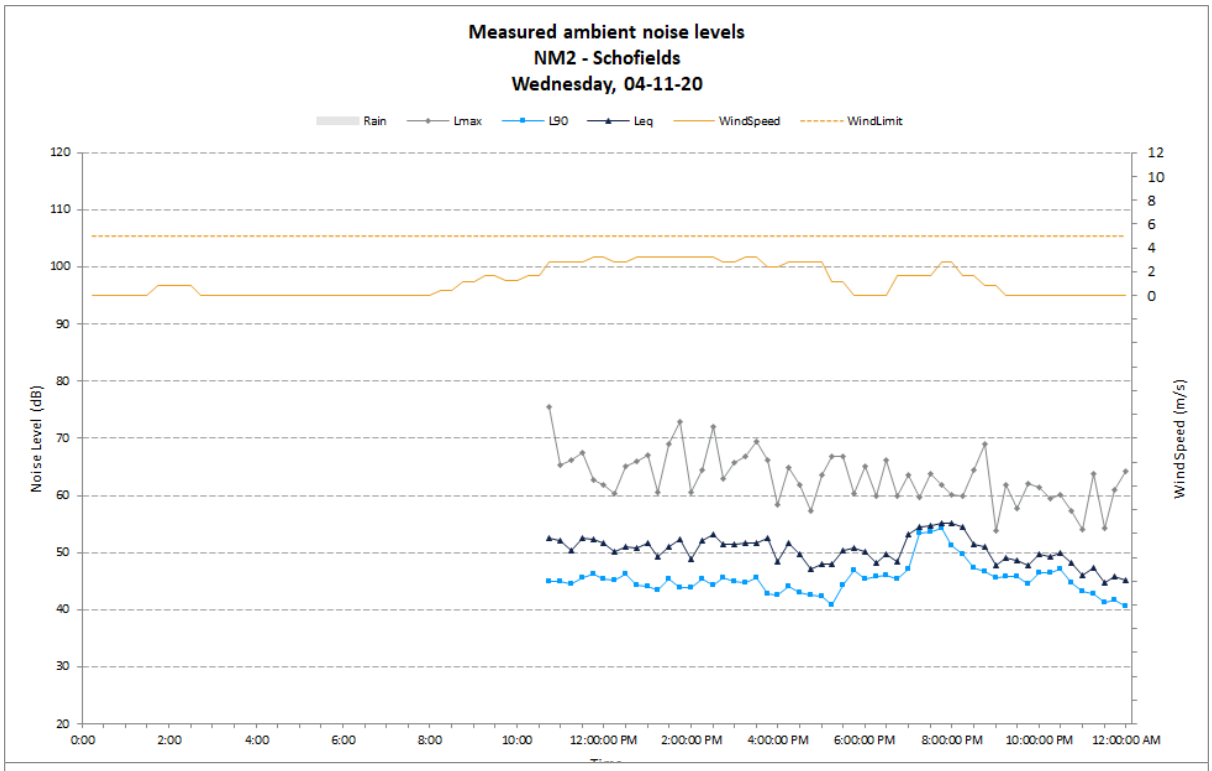

Measured ambient noise levels
NM1 - Schofields
Monday, 16-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time
120
110
100
90
80
70
60
50
40
30
20
12
10
8
6
4
2
0
12:00:00 AM
2:00:00 AM
4:00:00 AM
6:00:00 AM
8:00:00 AM
10:00:00 AM
12:00:00 PM
2:00:00 PM
4:00:00 PM
6:00:00 PM
8:00:00 PM
22:00
0:00

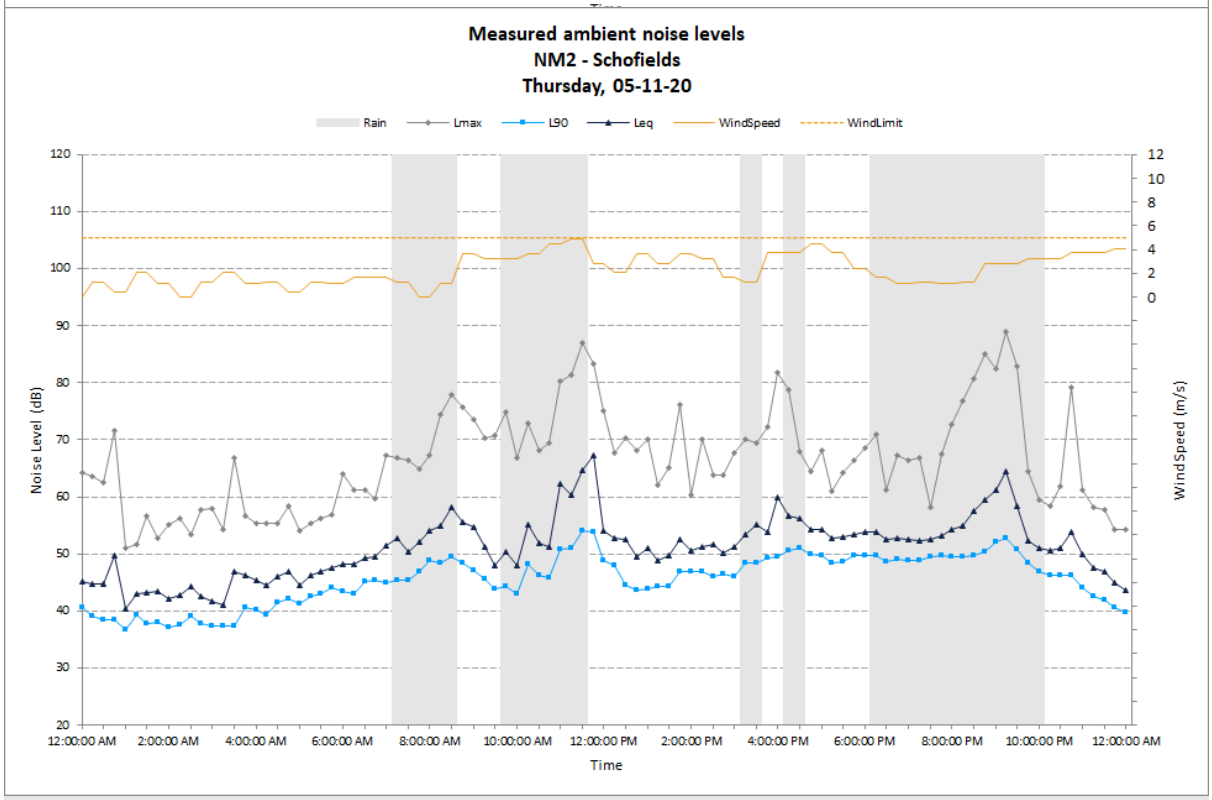
A.2 NM2

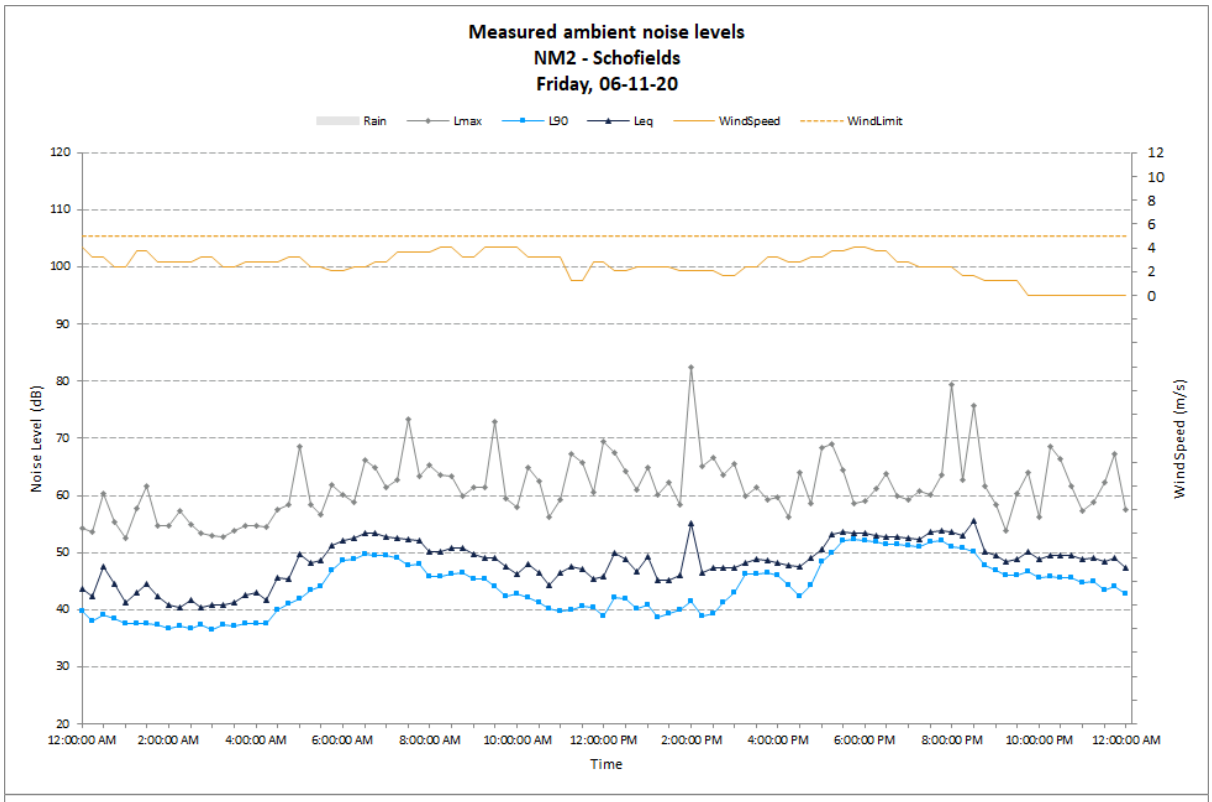
Table A.2 NM2 – Summary results

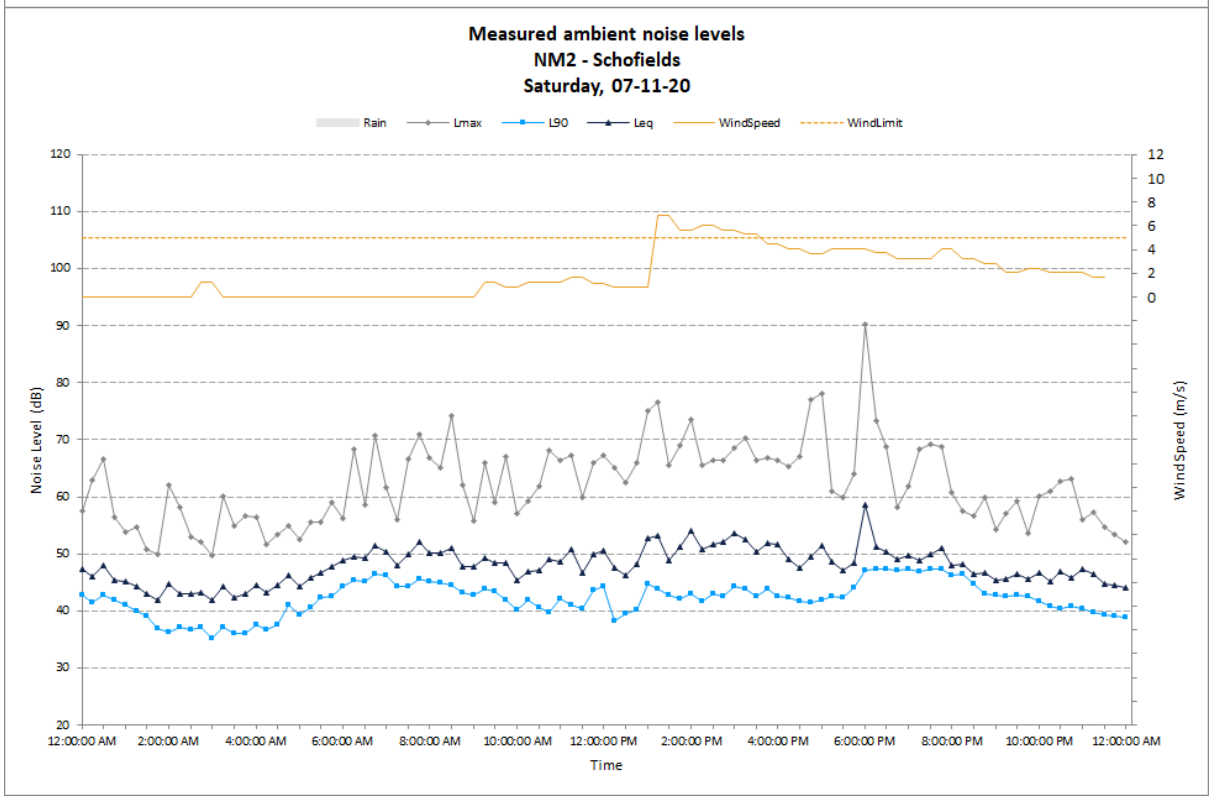
Date	ABL Day	ABL Evening	ABL Night	$L_{Aeq,11\ hour}$ Day	$L_{Aeq,4\ hour}$ Evening	$L_{Aeq,9\ hour}$ Night	$L_{Aeq,15\ hour}$ Day	$L_{Aeq,24\ hour}$ Day	$L_{Aeq,8\ hour}$ Night
Wednesday, 04-11-20	0	45	37	0	52	47	0	50	46
Thursday, 05-11-20	0	0	37	0	0	48	0	0	47
Friday, 06-11-20	39	46	36	50	52	47	51	50	46
Saturday, 07-11-20	0	43	35	0	49	45	50	48	45
Sunday, 08-11-20	36	39	34	47	48	48	47	47	47
Monday, 09-11-20	40	43	34	51	48	48	51	50	46
Tuesday, 10-11-20	42	42	34	53	49	47	53	51	46
Wednesday, 11-11-20	41	42	36	51	50	49	51	50	48
Thursday, 12-11-20	46	44	0	53	49	0	53	52	0
Friday, 13-11-20	46	44	36	54	49	47	53	52	47
Saturday, 14-11-20	37	39	34	48	50	44	49	47	44
Sunday, 15-11-20	0	0	0	0	0	0	0	0	0
Summary Values	**41**	**43**	**36**	**52**	**50**	**47**	**51**	**50**	**46**

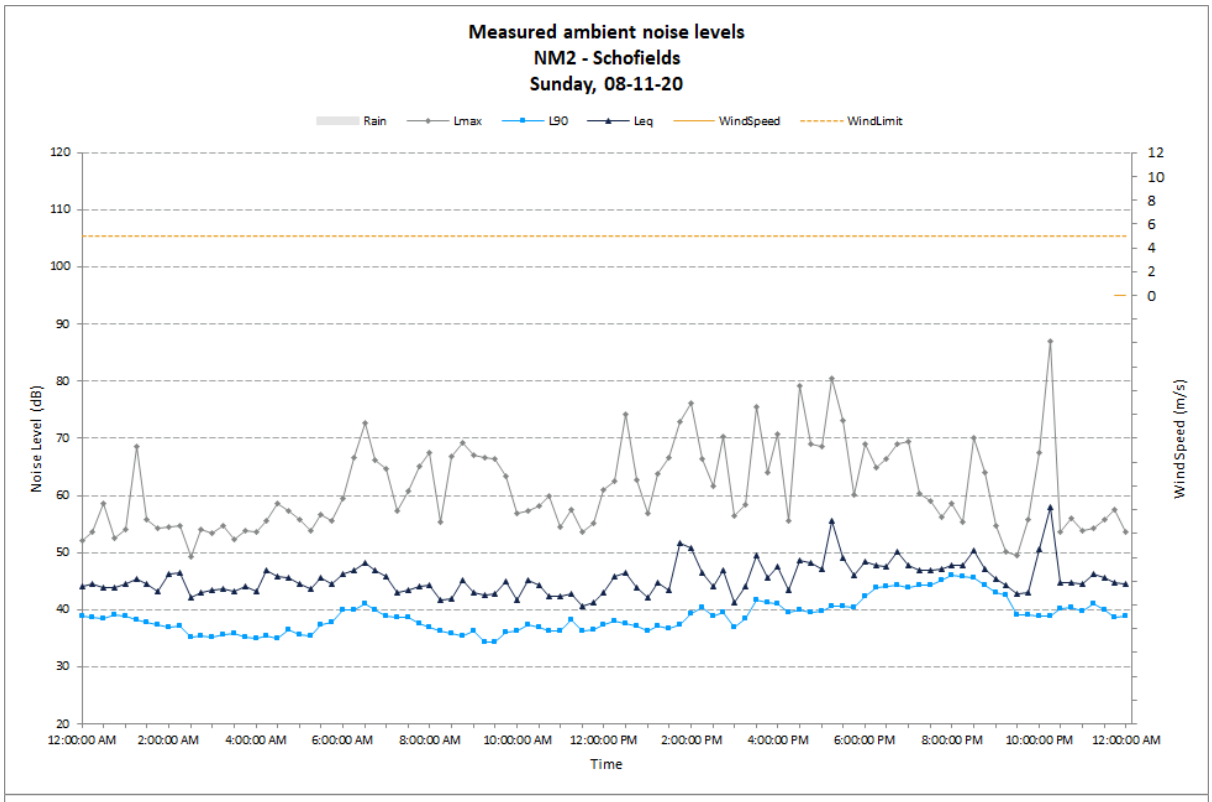
Notes: 1. 0 indicates periods with too few valid samples due to weather or logger operation
2. Leq24hr encompasses the period 7am to 7am

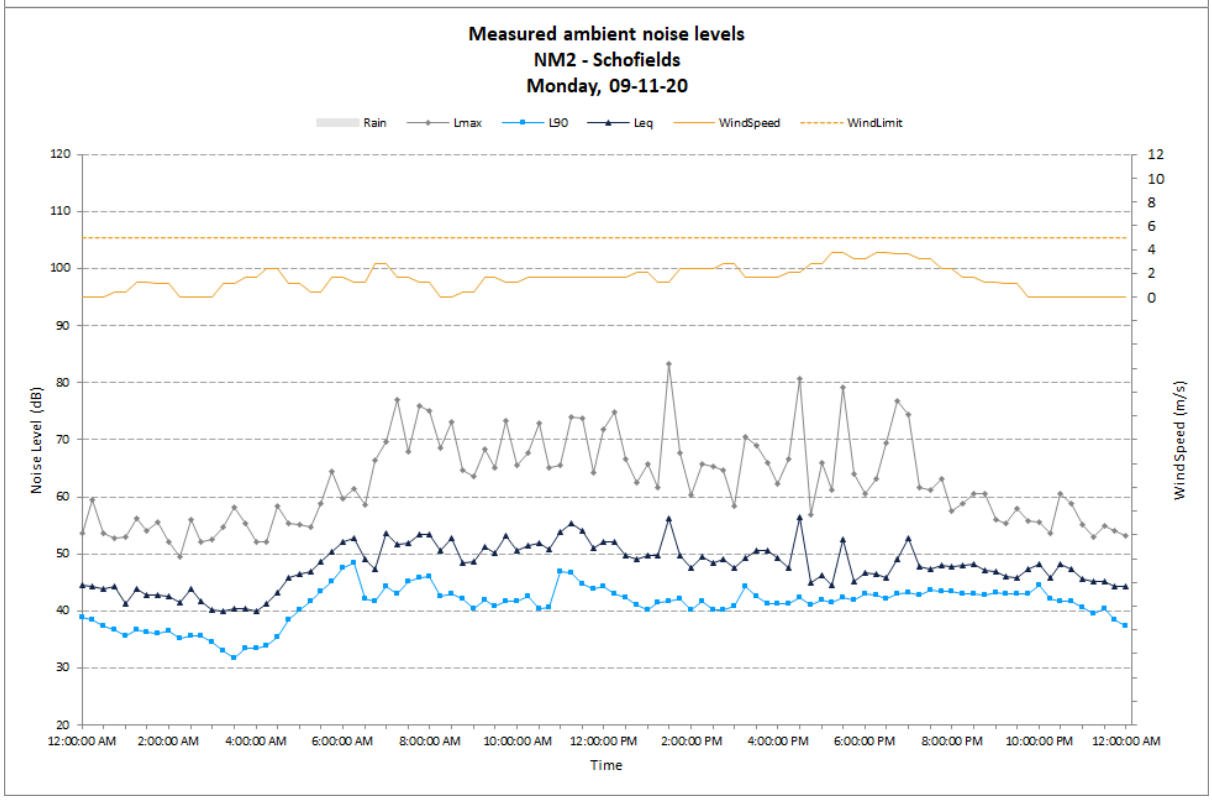

Measured ambient noise levels
NM2 - Schofields
Wednesday, 04-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
0:00
2:00
4:00
6:00
8:00
10:00
12:00:00 PM
2:00:00 PM
4:00:00 PM
6:00:00 PM
8:00:00 PM
10:00:00 PM
12:00:00 AM

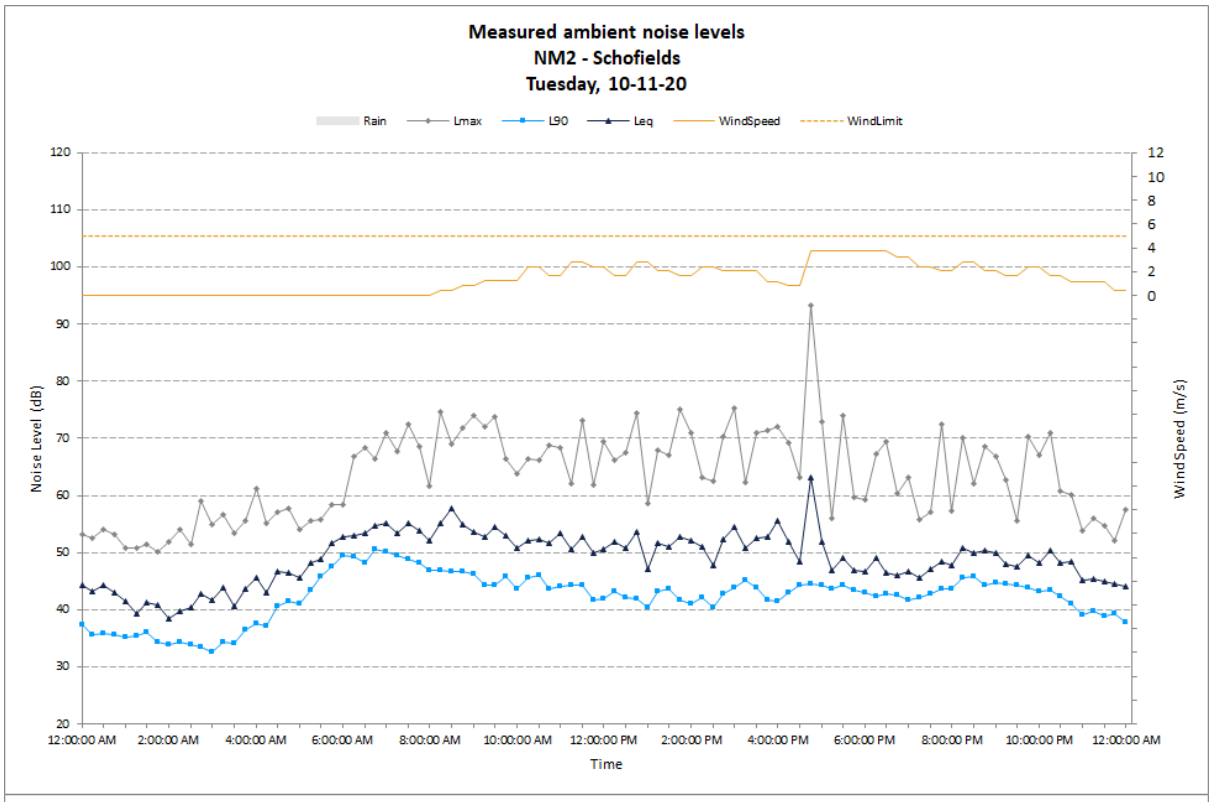

Measured ambient noise levels
NM2 - Schofields
Thursday, 05-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
12:00:00 AM
2:00:00 AM
4:00:00 AM
6:00:00 AM
8:00:00 AM
10:00:00 AM
12:00:00 PM
2:00:00 PM
4:00:00 PM
6:00:00 PM
8:00:00 PM
10:00:00 PM
12:00:00 AM
Time

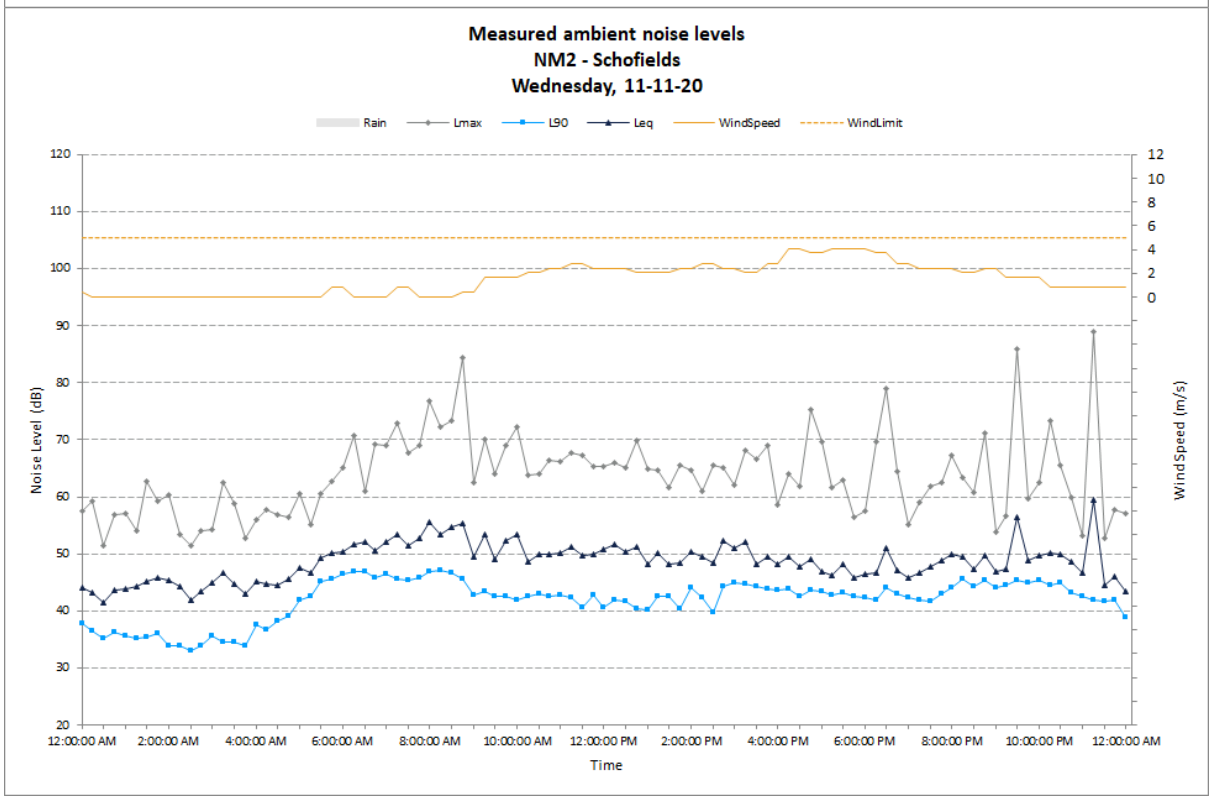

Measured ambient noise levels
NM2 - Schofields
Friday, 06-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time

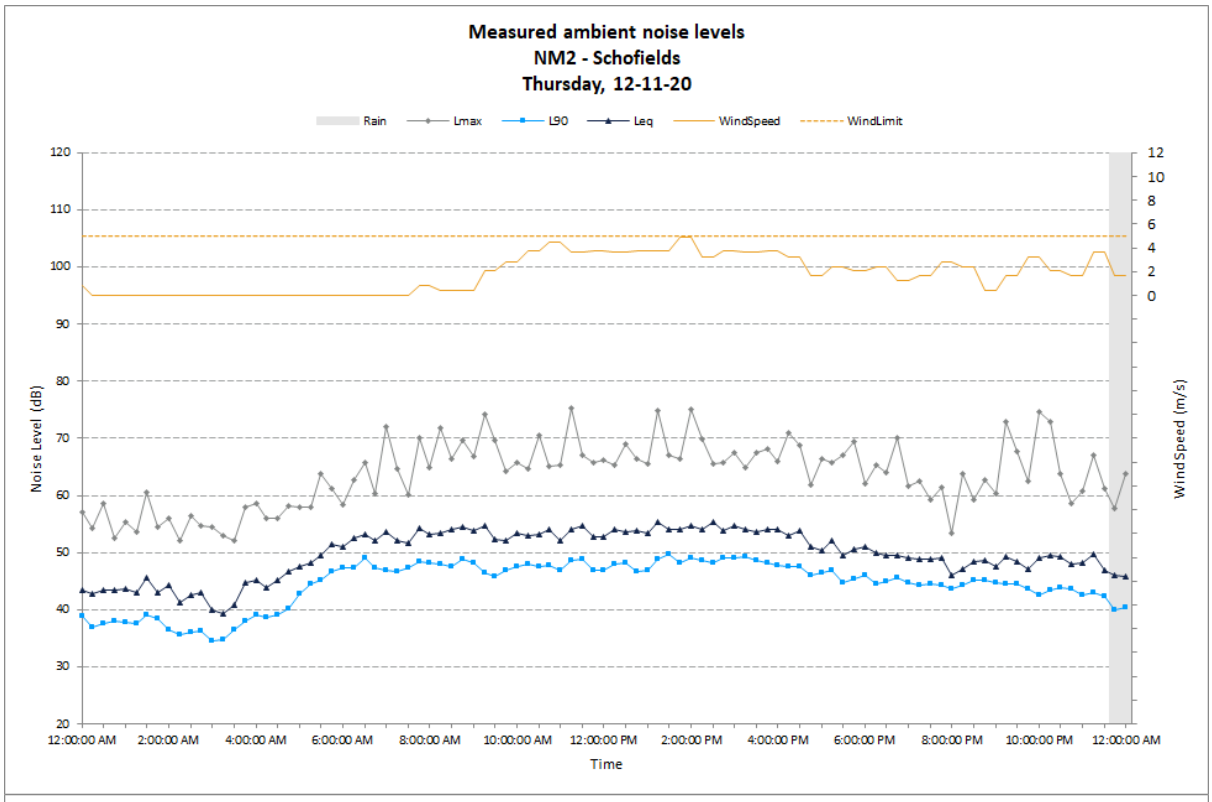

Measured ambient noise levels
NM2 - Schofields
Saturday, 07-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time

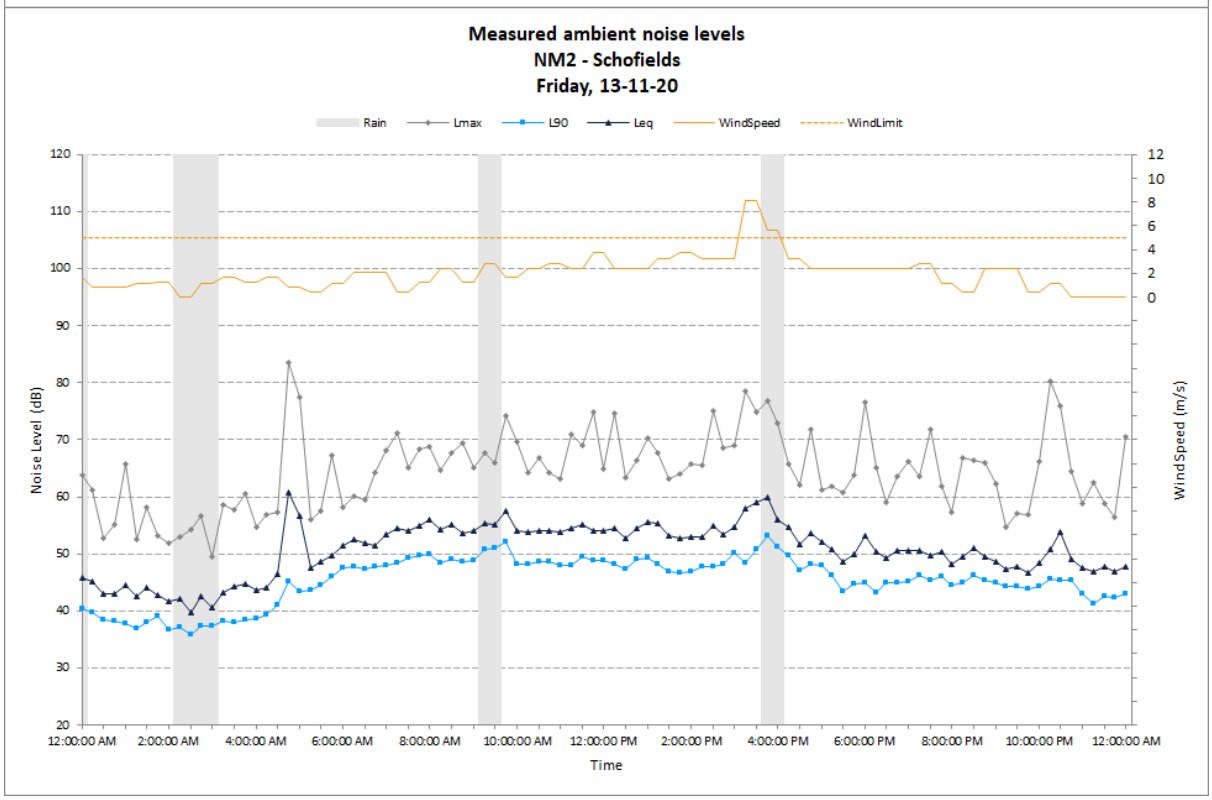

Measured ambient noise levels
NM2 - Schofields
Sunday, 08-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time

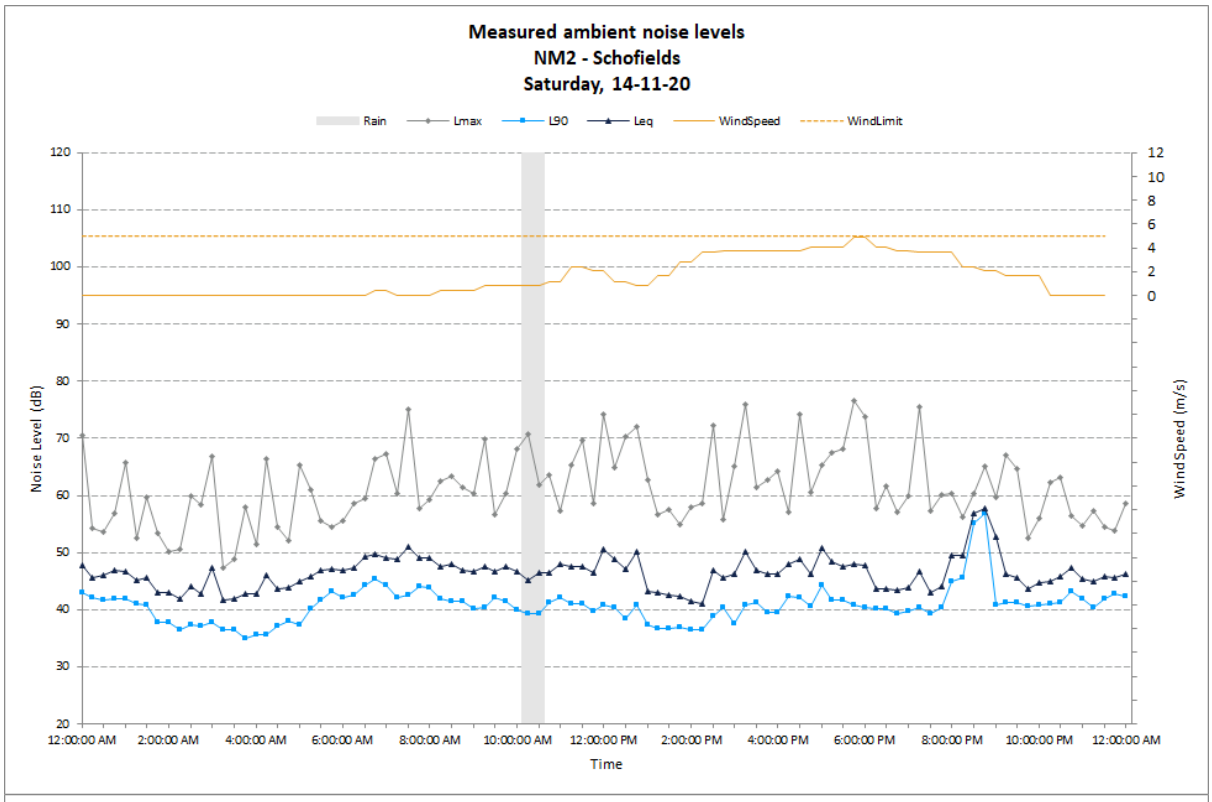

Measured ambient noise levels
NM2 - Schofields
Monday, 09-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time

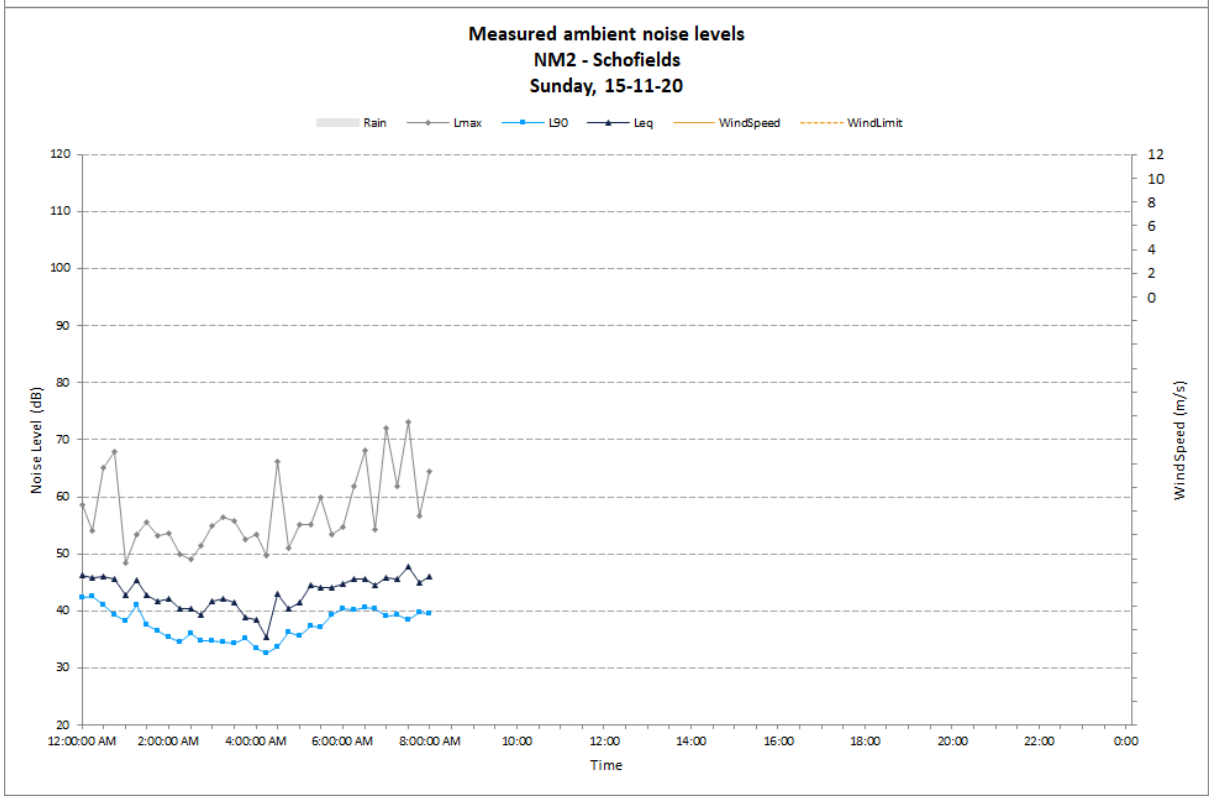

Measured ambient noise levels
NM2 - Schofields
Tuesday, 10-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time


Measured ambient noise levels
NM2 - Schofields
Wednesday, 11-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time


Measured ambient noise levels
NM2 - Schofields
Thursday, 12-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time


Measured ambient noise levels
NM2 - Schofields
Friday, 13-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time


Measured ambient noise levels
NM2 - Schofields
Saturday, 14-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time


Measured ambient noise levels
NM2 - Schofields
Sunday, 15-11-20
Rain
Lmax
L90
Leq
WindSpeed
WindLimit
Noise Level (dB)
WindSpeed (m/s)
Time

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