14 AQUATIC DRIVE, FRENCHS FOREST

Noise Impact Assessment

Prepared for:

Goodman Property Services (Aust) Pty Ltd
1-11 Hayes Road
Rosebery, NSW 2018

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EXECUTIVE SUMMARY

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Goodman Property Services (Aust) Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
610.31042.00605-R02-v1.0	1 May 2025	LJ Jansen	A McKenzie	A McKenzie
610.31042.00605-R02-v1.0	1 April 2025	LJ Jansen	A McKenzie	A McKenzie

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1 Introduction

This Noise Impact Assessment Report has been prepared by SLR on behalf of Goodman Property Services Pty Ltd (Goodman) to accompany a development application for self storage units and warehouse and distribution centre uses at 14 Aquatic Drive, Frenches Forest.

SLR is suitably qualified and endorsed by the Planning Secretary to produce this noise impact assessment. SLR staff are members of the Australian Acoustical Society (AAS) and SLR is a member firm of the Association of Australasian Acoustical Consultants (AAAC).

This report summarises the assessment of the potential construction and operational noise and vibration impacts associated with the proposal.

The following report uses specialist acoustic terminology. An explanation of common terms is provided in **Appendix A**.

1.1 Proposal Description

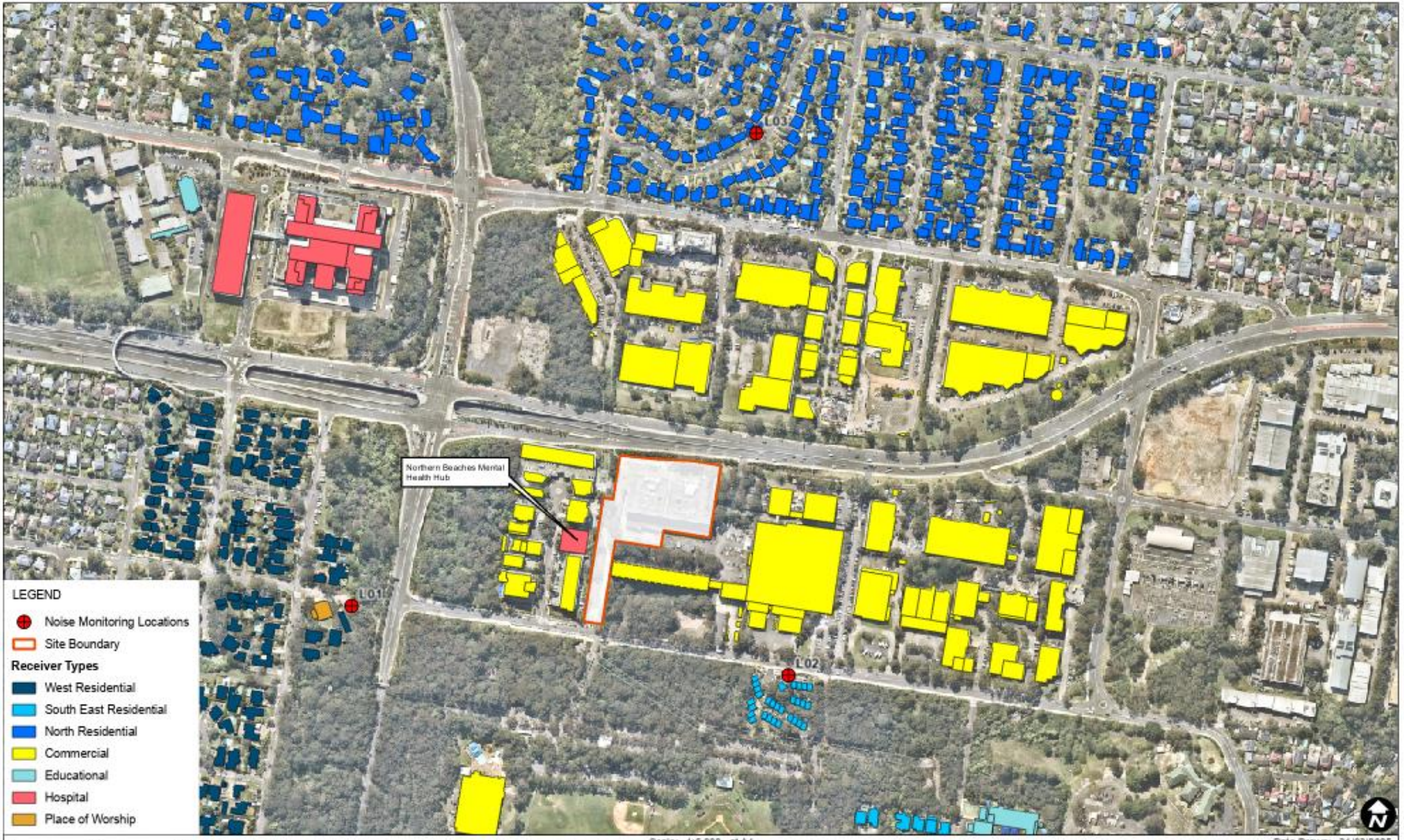
The site is located at 14 Aquatic Drive, Frenchs Forest. The site is legally described as Lot 102 in Deposited Plan 1211755 and is currently owned by Goodman. The site is bound by Warringah Road to the north and Aquatic Drive to the south.

The proposed development comprises the construction, fit out and operation of a three-storey industrial building including:

- 145 self storage units at ground floor
- 72 warehouse units on Levels 1 and 2
- 123 car parking spaces and across all levels
- outdoor breakout spaces for staff at ground floor and Level 2;
- shared lobby across all levels
- landscaping; and
- associated infrastructure/servicing works

Approval is sought for 24/7 operation of the proposed self-storage and warehouse and distribution units.

The site location is shown in **Figure 1** and the site layout in **Figure 2** - **Figure 4**.



Scale: 1:6,000 at A4
Coordinate System: GDA2020 MGA Zone 56

Date Drawn: 31/03/2025
Project Number: 610.31042

SLR

Data Source:
Nearmap Imagery Aug 2022

SITE PLAN

FIGURE 1

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Figure 2 Proposed Development – Ground Floor

Figure 3 Proposed Development – Level 1

Figure 4 Proposed Development – Level 2

1.1.1 Nearest Receivers

The nearest sensitive receivers are commercial properties located adjacent to the west, north and east of the site. The nearest residential receivers are located 300 m to the west, 320 m to the north and 200 m to the south-east. The nearest receivers are shown in **Figure 1** and detailed in **Table 1**.

Table 1 NCAs and Sensitive Receivers

Location	Receiver Type	Name	Distance (m)
West	Residential	-	300
	Place of Worship[1]	Frenchs Forest Anglican Church	320
	Commercial	-	20
	Medical Facility	Proposed Northern Beaches Mental Health Hub	20
North and north-west	Residential	-	320
	Commercial	-	85
	Education	The Forest High School	580
	Hospital	Northern Beaches Hospital	375
East	Commercial	-	50
South and south east	Residential	-	200
	Education	Arranounbai School	500
	Commercial	-	220

Two child care centres have been identified west of the development in the commercial area on Tilley Lane. These receivers have been included in the construction noise assessment with the criteria listed in **Section 3.1**, in accordance with the ICNG. The construction noise results are shown for the highest noise level of the two child care receivers in all cases.

The NPfI, however, does not include a recommended amenity noise level for child cares so there are no defined criteria for industrial noise. The child care centres are individual tenancies within larger commercial premises so the buildings have been included in the operational noise assessment as commercial receivers. Given the relatively high existing road traffic noise levels and existing industrial noise in the area, it is assumed that the child care tenancies have been designed appropriately (as per the Association of Australian Acoustical Consultants *Guideline for Child Care Centre Acoustic Assessment*) to ensure suitable internal noise levels. Therefore, noise emissions from the proposal are not expected to impact the child cares where they are predicted to comply with the recommended commercial amenity noise level.

1.1.2 New Developments

The Northern Beaches Mental Health Hub (NBMHH) is an adjacent development located at 11 Tilley Lane which is approved but not yet constructed (Environmental Impact Statement (EIS) SSD-30236074). The approved health facility has been identified as a potentially noise and vibration sensitive receiver near to 14 Aquatic Drive.

The SSDA Noise and Vibration Assessment for the NBMHH has been prepared by JHA (Ref: 210390-AC-DA [D]). The report includes recommendations for facade glazing for the building. The recommended glazing systems for the various facades include:

- East/South/West: 6.38mm laminated glass (Weighted Sound Reduction Index = 32 dB R_w)
- North: 8.38mm laminated glass (Weighted Sound Reduction Index = 34 dB R_w)

2 Existing Noise Environment

Unattended noise monitoring was completed at the site during October and November 2022. The measured noise levels have been used to determine the existing noise environment and to set the criteria used to assess the potential noise impact of the proposal.

The monitoring equipment was positioned to measure existing noise levels that are representative of receivers potentially most affected by the proposal, within constraints such as accessibility, security and landowner permission.

The noise monitoring equipment continuously measured existing noise levels in 15-minute periods during the daytime, evening and night-time. All equipment carried current National Association of Testing Authorities (NATA) or manufacturer calibration certificates and equipment calibration was confirmed before and after each measurement.

The measured data has been processed to exclude noise from extraneous events and periods affected by adverse weather conditions, such as strong wind or rain (measured at Terry Hills Bureau of Meteorology Station), to establish representative existing noise levels in the study area.

The noise monitoring locations are shown in **Figure 1** and the results are summarised in **Table 2**. Details of each monitoring location together with graphs of the measured daily noise levels are provided in **Appendix B**.

Table 2 Summary of Unattended Noise Monitoring Results

ID	Address/Description	Measured Noise Levels (dBA)					
		Background Noise (RBL)			Average Noise (L_{Aeq})		
		Day[1]	Evening	Night[1]	Day[1]	Evening[1]	Night[1]
L01	67 Bantry Bay Road, Frenchs Forest	48	44	34	54	52	46
L02	11 Aquatic Drive, Frenchs Forest	48	44	33	60	57	53
L03	18 Bimbadeen Crescent, Frenchs Forest	39	35	24	49	46	42

Note 1: The assessment periods are the daytime which is 7 am to 6 pm Monday to Saturday and 8 am to 6 pm on Sundays and public holidays, the evening which is 6 pm to 10 pm, and the night-time which is 10 pm to 7 am on Monday to Saturday and 10 pm to 8 am on Sunday and public holidays. See the NSW EPA *Noise Policy for Industry*.

Short-term attended noise monitoring was also completed. The attended measurements allow the contributions of the various noise sources at each location to be determined. Detailed observations from the attended measurements are provided in **Appendix B**.

The attended measurements were generally found to be consistent with the results of the unattended noise monitoring and show that existing noise levels are typically dominated by road traffic noise from the surrounding road network and industrial noise from existing commercial and industrial developments.

3 Assessment Criteria

3.1 Construction Noise Criteria

The NSW *Interim Construction Noise Guideline* (ICNG) is used to assess and manage impacts from construction noise on residences and other sensitive land uses in NSW.

The ICNG contains procedures for determining project specific Noise Management Levels (NMLs) for sensitive receivers based on the existing background noise in the area. The 'worst-case' noise levels from the construction of a proposal are predicted and then compared to the NMLs in a 15-minute assessment period to determine the likely impact of the proposal.

The NMLs are not mandatory limits, however, where construction noise levels are predicted or measured to be above the NMLs, feasible and reasonable work practices to minimise noise emissions are to be investigated.

3.1.1 Residential Receivers

The ICNG approach for determining NMLs at residential receivers is shown in **Table 3**.

Table 3 ICNG NMLs for Residential Receivers

Time of Day	NML $L_{Aeq(15minute)}$	How to Apply
Standard Construction Hours Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays	Noise affected RBL[1] + 10 dB	• The noise affected level represents the point above which there may be some community reaction to noise • Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.

	Highly Noise Affected
	75 dBA
		• The Highly Noise Affected (HNA) 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 restructuring the hours that the very noisy activities can occur, taking into account:
		  • Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools or mid-morning or mid-afternoon for works near residences
		  • If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Outside Standard Construction Hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours • The proponent should apply all feasible and reasonable work practices to meet the noise affected level • Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.

Note 1: The RBL is the Rating Background Level and the ICNG refers to the calculation procedures in the NSW *Industrial Noise Policy* (INP). The INP has been superseded by the NSW EPA *Noise Policy for Industry* (NPfI).

3.1.2 'Other Sensitive' Land Uses and Commercial Receivers

Non-residential land uses have been identified in the study area. The NMLs for 'other sensitive' receivers are shown in **Table 4**.

Table 4 Construction Noise Management Levels at 'Other Sensitive' Land Uses

Land Use	Noise management level $L_{Aeq(15minute)}$ (dBA) (applied when the property is in use)	
	Internal	External
ICNG 'other sensitive' receivers		
Classrooms at schools and other educational institutions	45	55[1]
Hospital wards and operating theatres	45	65[2]
Places of worship	45	55[1]
Active recreation areas (characterised by sporting activities and activities which generate noise)	-	65
Passive recreation areas (characterised by contemplative activities that generate little noise)	-	60
Commercial	-	70
Industrial	-	75
Non-ICNG 'other sensitive' receivers		
Child care centres – sleeping areas[3]	40	50[1]

Note 1: It is assumed that these receivers have windows partially open for ventilation which results in internal noise levels being around 10 dB lower than the external noise level.

Note 2: It is assumed that these receivers have fixed windows which conservatively results in internal noise levels being around 20 dB lower than the external noise level.

Note 3: Taken from Association of Australian Acoustical Consultants *Guideline for Child Care Centre Acoustic Assessment*.

3.1.3 NML Summary

The construction NMLs for the proposal have been determined using the results from the unattended noise monitoring and are shown in **Table 5**.

Table 5 Project Specific Noise Management Levels

Receiver	Location	Measured RBL[1] (dBA)			NML (LAeq(15minute) (dBA)			
					Standard Construction (RBL+10dB)	Out of Hours (RBL+5dB)		
		Day	Eve.	Night	Day	Day[2]	Eve	Night
West Residential	L01	48	44	34	58	53	49	39
South East Residential	L02	48	44	33	58	53	49	38
North Residential	L03	39	35	30 (24 actual)[3]	49	44	40	35
Child Care	-	-	-	-	50	-	-	-
Place of Worship	-	-	-	-	55	-	-	-
Hospital[4]	-	-	-	-	65	-	-	-
Educational	-	-	-	-	55	-	-	-
Commercial	-	-	-	-	70	-	-	-

Note 1: RBL = Rating Background Level.

Note 2: Daytime out of hours is 7 am to 8 am and 1 pm to 6 pm on Saturday, and 8 am to 6 pm on Sunday and public holidays.

Note 3: The NPfI minimum RBL value has been used due to the measured RBL being below the NPfI minimum value.

Note 4: The Northern Beaches Mental Health Hub has been assessed against the 'Hospital' criteria.

3.2 Construction Vibration Criteria

The effects of vibration from construction works can be divided into three categories:

- Those in which the occupants of buildings are disturbed (human comfort)
- Those where building contents may be affected (building contents)
- Those where the integrity of the building may be compromised (structural or cosmetic damage).

3.2.1 Human Comfort Vibration

People can sometimes perceive vibration impacts when vibration generating construction works are located close to occupied buildings.

Vibration from construction works tends to be intermittent in nature and the EPA's *Assessing Vibration: a technical guideline* (2006) provides criteria for intermittent vibration based on the Vibration Dose Value (VDV). The 'preferred' and 'maximum' VDVs for human comfort impacts are shown in **Table 6**.

Table 6 Vibration Dose Values for Intermittent Vibration

Building Type	Assessment Period	Vibration Dose Value[1] ($m/s^{1.75}$)	
		Preferred	Maximum
Critical Working Areas (eg operating theatres or laboratories)	Day or night-time	0.10	0.20
Residential	Daytime	0.20	0.40
	Night-time	0.13	0.26
Offices, schools, educational institutions and places of worship	Day or night-time	0.40	0.80
Workshops	Day or night-time	0.80	1.60

Note 1: The VDV accumulates vibration energy over the daytime and night-time assessment periods, and is dependent on the level of vibration as well as the duration.

3.2.2 Effects on Building Contents

People perceive vibration at levels well below those likely to cause damage to building contents. For most receivers, the human comfort vibration criteria are the most stringent and it is generally not necessary to set separate criteria for vibration effects on typical building contents.

Exceptions to this can occur when vibration sensitive equipment, such as electron microscopes, are located in buildings near construction works.

3.2.3 Structural and Cosmetic Damage Vibration

Buildings

In terms of the most recent relevant vibration damage criteria, Australian Standard AS 2187: Part 2-2006 *Explosives – Storage and Use – Part 2: Use of Explosives* recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2* 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 the 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, piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are shown in **Table 7** and **Figure 5**.

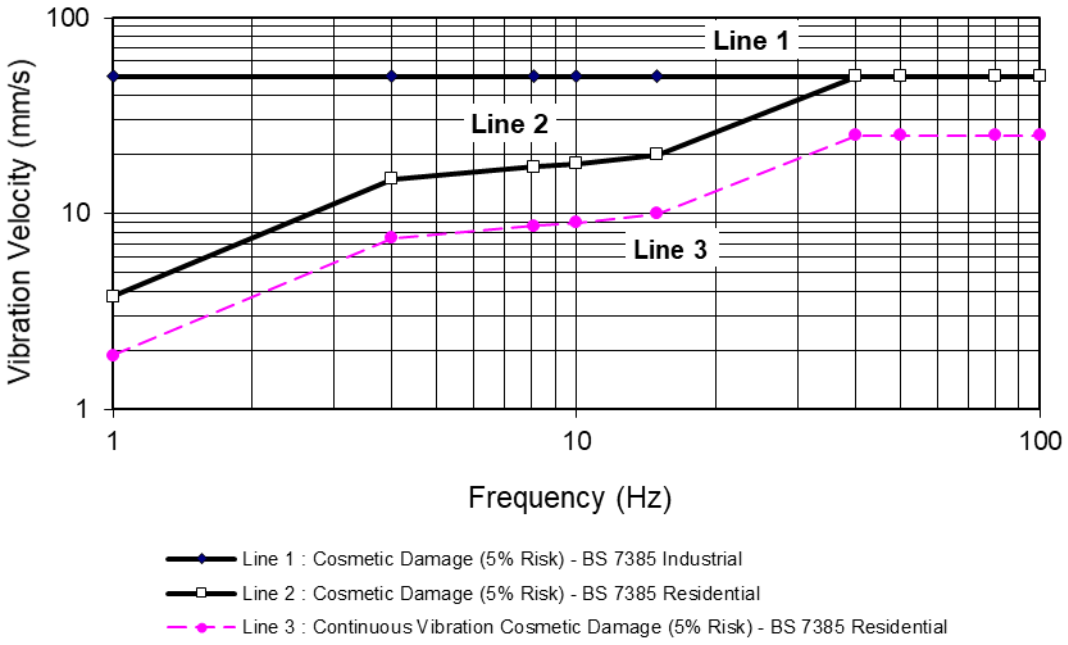
Table 7 Transient Vibration Guide Values – Minimal Risk of Cosmetic Damage

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

The standard states that the guide values in **Table 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 7** may need to be reduced by up to 50%. The proposed activities are considered to have the potential to cause dynamic loading in some structures (eg neighbouring commercial developments) and it may therefore be appropriate to reduce the transient values by 50%.

Figure 5 Graph of Transient Vibration Guide Values for Cosmetic Damage



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

The standard goes on to state that minor damage is possible at vibration magnitudes that are greater than twice those given in **Table 7**, and major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals are significant (in respect of the fatigue life of building materials) then the guide values in **Table 7** should not be reduced for fatigue considerations.

In order to assess the likelihood of cosmetic damage due to vibration, AS 2187 specifies that vibration measured 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 7**.

It is noteworthy that extra to the guide values nominated in **Table 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."*

Also that:

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

3.2.4 German Standard DIN 4150: Part 3-1999

For continuous long-term vibration or repetitive vibration with the potential to cause fatigue effects, DIN 4150 provides the following Peak Particle Velocity (PPV) values as safe limits, below which even superficial cosmetic damage is not to be expected:

- 2.5 mm/s for buildings of great intrinsic value (eg heritage listed buildings).

3.2.5 General Vibration Screening Criteria

The TfNSW *Construction Noise and Vibration Strategy* specifies general vibration screening criteria based on BS 7385: Part 2 – 1993. It notes that for most construction activities involving intermittent vibration such as rock breakers, piling rigs, vibratory rollers, excavators and the like, vibration predominantly occurs at frequencies greater than 4 Hz and therefore specifies the following conservative vibration damage screening levels:

- Reinforced or heavy frame structures: 25 mm/s
- Unreinforced or light frame structures: 7.5 mm/s

At locations where the predicted and/or measured vibration levels are greater than shown above, a more detailed analysis of the building structure, vibration source, dominant frequency and dynamic characteristics of the structure would be required to determine the applicable safe vibration levels.

3.2.5.1 Heritage

Heritage structures are also assessed against the above screening criteria as they should not be assumed to be more sensitive to vibration unless they are found to be structurally unsound following an inspection. Where they are found to be unsound a 2.5 mm/s criterion can be applied in accordance with DIN 4150. It is understood that there are no heritage buildings in the vicinity of the site (ie within 50 m) that would require inspection.

3.2.6 Minimum Working Distances for Vibration Intensive Works

Minimum working distances for typical vibration intensive construction equipment are provided in the Roads and Maritime (now Transport for NSW) *Construction Noise and Vibration Guideline* (CNVG) and are shown in **Table 8**. The minimum working distances are for both cosmetic damage (from BS 7385 and DIN 4150) and human comfort (from the NSW EPA Vibration Guideline). They are based on empirical data which suggests that where works are further from receivers than the quoted minimum distances then impacts are not considered likely.

The minimum working distances are indicative and will vary depending on the particular item of equipment and local geotechnical conditions. The distances apply to cosmetic damage of typical buildings under typical geotechnical conditions.

Table 8 Recommended Minimum Working Distances from Vibration Intensive Equipment

Plant Item	Rating/Description	Minimum Distance		
		Cosmetic Damage		Human Response (NSW EPA Guideline)
		Residential and Light Commercial (BS 7385)	Heavy Commercial and Industrial (BS 7385)	
Vibratory Roller	<50 kN (1–2 tonne)	5 m	3 m	15 m to 20 m
	<100 kN (2–4 tonne)	6 m	3 m	20 m
	<200 kN (4–6 tonne)	12 m	6 m	40 m
	<300 kN (7–13 tonne)	15 m	8 m	100 m
	>300 kN (13–18 tonne)	20 m	10 m	100 m
	>300 kN (>18 tonne)	25 m	12 m	100 m
Small Hydraulic Hammer	300 kg (5 to 12 t excavator)	2 m	1 m	7 m
Medium Hydraulic Hammer	900 kg (12 to 18 t excavator)	7 m	4 m	23 m
Large Hydraulic Hammer	1,600 kg (18 to 34 t excavator)	22 m	12 m	73 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	1 m to 10 m	20 m
Piling Rig – Bored	≤ 800 mm	2 m (nominal)	1 m (nominal)	4 m
Jackhammer	Hand held	1 m (nominal)	<1 m (nominal)	2 m

3.3 Operational Noise Criteria

The NSW *Noise Policy for Industry* (NpfI) was released in 2017 and sets out the requirements for the assessment and management of operational noise from industry in NSW.

The NpfI defines how to determine 'trigger levels' for noise emissions from industrial developments. Where a development is likely to exceed the trigger levels at existing noise sensitive receivers, feasible and reasonable noise management measures are required to be considered to reduce the impacts.

There are two types of trigger levels – one to account for 'intrusive' noise impacts and one to protect the 'amenity' of particular land uses:

- The **intrusiveness** of an industrial noise source is generally considered acceptable if the L_{Aeq} noise level of the source, measured over a period of 15-minutes, does not exceed the representative background noise level by more than 5 dB. Intrusive noise levels are only applied to residential receivers. For other receiver types, only the amenity levels apply.
- To limit continual increases in noise levels from the use of the intrusiveness level alone, the ambient noise level within an area from all industrial sources should remain below the recommended **amenity** levels specified in the NpfI for that particular land use.

Intrusive and amenity noise levels are not used directly as regulatory limits. They are used to assess the potential impact of noise, assess feasible and reasonable mitigation options and subsequently determine achievable noise requirements.

The NpfI provides guidance on assigning residential receiver amenity noise categories based on the site-specific features shown in **Table 9**.

Table 9 Residential Receiver Amenity

Receiver Category	Typical Planning Land Use Zoning	Typical Existing Background Noise Levels (RBL)	Description
Rural	RU1 – primary production RU2 – rural landscape RU4 – primary production small lots R5 – large lot residential E4 – environmental living	Daytime <40 dBA Evening <35 dBA Night <30 dBA	Rural – an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels. Settlement patterns would be typically sparse. Note: Where background noise levels are higher than those presented due to existing industry or intensive agricultural activities, the selection of a higher noise amenity area should be considered.
Suburban residential	RU5 – village RU6 – transition R2 – low density residential R3 – medium density residential E2 – environmental conservation E3 – environmental management	Daytime <45 dBA Evening <40 dBA Night <35dBA	Suburban – an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry. This area often has the following characteristic: evening ambient noise levels defined by the natural environment and human activity.
Urban residential	R1 – general residential R4 – high density residential B1 – neighbourhood centre (boarding houses and shop-top housing) B2 – local centre (boarding houses) B4 – mixed use	Daytime >45 dBA Evening >40 dBA Night >35 dBA	Urban – an area with an acoustical environment that: • Is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable, mostly traffic and/or industrial related sound sources • Has through-traffic with characteristically heavy and continuous traffic flows during peak periods • Is near commercial districts or industrial districts • Has any combination of the above.

Amenity noise categories for the surrounding receivers have been determined with reference to the NpfI. The assessment is shown in **Table 10**.

Table 10 Residential Receiver Amenity Category Assessment

Area	Land Use Zoning	Existing Background Noise Levels RBL (dBA)			Resulting Amenity Classification	Discussion
		Day	Eve	Night		
West Residential	R2 – low density residential	48	44	34	Suburban	The surrounding area is zoned as R2 – low density residential and therefore residences have been classed as suburban.
South East Residential		48	44	33		
North Residential		39	35	24		

3.3.1 Project Noise Trigger Levels

The trigger levels for industrial noise from the project are summarised in **Table 11**. The Project Noise Trigger Levels (PNTL) are the most stringent of the intrusiveness and amenity trigger levels for each period and are highlighted below.

Table 11 Project Noise Trigger Levels

Receiver Type	Period	Recommended Amenity Noise Level $L_{Aeq(period)}$	Measured Noise Level (dBA)		Project Noise Trigger Levels $L_{Aeq(15minute)}$ (dBA)	
			RBL[1]	$L_{Aeq(period)}$	Intrusiveness	Amenity[2,3]
West Residential	Daytime	55	48	54	**53**	53
	Evening	45	44	52	49	**43**
	Night-time	40	34	46	39	**38**
South East Residential	Daytime	55	48	60	**53**	53
	Evening	45	44	57	49	**43**
	Night-time	40	33	53	**38**	38
North Residential	Daytime	55	39	49	**44**	53
	Evening	45	35	46	**40**	43
	Night-time	40	30 (24 actual)[4]	42	**35**	38
Place of Worship	When in use	50[5]	-	-	-	48
Hospital	Noisiest 1-hour	50 (External)	-	-	-	48
		35 (Internal)[6]	-	-	-	33
Educational	When in use	50[5]	-	-	-	48
Commercial	When in use	65	-	-	-	63

Note 1: RBL = Rating Background Level

Note 2: The recommended amenity noise levels have been reduced by 5 dB to give the project amenity noise levels due to other sources of industrial noise likely to be present in the future, as outlined in the NPfI. This addresses the potential cumulative impacts from the development and any existing/future projects.

Note 3: The project amenity noise levels have been converted to a 15-minute level by adding 3 dB, as outlined in the NpfI.

Note 4: The NPfI minimum RBL value has been used due to the measured RBL being below the NpfI minimum value.

Note 5: The criterion is specified as an internal noise level for this receiver category. As the noise model predicts external noise levels, it has been conservatively assumed that all places of worship and schools have openable windows and external noise levels are therefore 10 dB higher than the corresponding internal level, which is generally considered representative of windows being partially open for ventilation.

Note 6: The noise impacts on the Northern Beaches Mental Health Hub have been assessed against the internal criteria for hospitals.

3.3.1.1 Cumulative Noise Impacts

The NPfI aims to limit continuing increases in industrial noise through the application of amenity noise levels. The project amenity noise levels are reduced by 5 dB relative to the recommended amenity levels to allow for other sources of industrial noise in the area (existing and new). By doing this, the policy accounts for potential cumulative impacts by lowering the criteria for each individual development. The NPfI states that *"where the project amenity noise level applies and it can be met, no additional consideration of cumulative industrial noise is required."*

3.3.2 Sleep Disturbance

The potential for sleep disturbance from maximum noise level events during the night-time period from the development is required to be considered.

The NPfI defines the sleep disturbance screening level as 52 dBA L_{AFmax} or the prevailing background level plus 15 dB, whichever is greater.

The sleep disturbance screening levels for the development are shown in **Table 12**.

Table 12 Sleep Disturbance Screening Levels

Location	Noise Level (dBA)	
	Measured Prevailing Night-time Background Level	Sleep Disturbance Screening Level[1]
West Residential	34	52
South Residential	33	52
North Residential	24	52

Note 1: The sleep disturbance screening level as 52 dBA L_{AFmax} or the prevailing background level plus 15 dB, whichever is greater

A detailed maximum noise level event assessment should be completed where the sleep disturbance screening level is exceeded. The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the RBL, and the number of times this happens during the night-time period.

The NPfI refers to the *Road Noise Policy* (RNP) for additional information regarding sleep disturbance. Health Council studies are referenced which indicate that for short-term or transient noise events, for good sleep over eight hours the indoor L_{AFmax} sound pressure level should ideally not exceed around 45 dBA more than 10 or 15 times per night.

The RNP goes on to conclude that from the research on sleep disturbance to date:

- Maximum internal noise levels below 50 dBA to 55 dBA are unlikely to awaken people from sleep
- One or two events per night with maximum internal noise levels of 65-70 dBA are not likely to affect health and wellbeing significantly.

3.3.3 Corrections for Annoying Noise Characteristics

Sources of industrial noise can cause greater annoyance where they contain certain characteristics, such as tonality, intermittency or dominant low-frequency content. The NPfI specifies the following modifying factor corrections, shown in **Table 13**, which are to be applied where annoying characteristics are present.

Details of the modifying factor corrections applied in the assessment are provided in **Section 4.3**.

Table 13 NPfI Modifying Factor Corrections

Factor	Assessment/ Measurement	When to Apply	Correction[1]
Tonal noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of the adjacent bands on both sides by the levels defined in the NPfI.	5 dB[2]
Low-frequency noise	Measurement of source contribution C-weighted and A-weighted level and one-third octave measurements	Measure/assess source contribution C and A weighted $L_{eq,t}$ levels over same time period. Correction to be applied where the C minus A level is 15 dB or more and the level to which the thresholds defined in the NPfI are exceeded.	2 or 5 dB[2]
Intermittent noise	Subjectively assessed but should be assisted with measurement to gauge the extent of change in noise level	The source noise heard at the receiver varies by more than 5 dB and the intermittent nature of the noise is clearly audible. The NPfI further defines intermittent noise as noise where the level suddenly drops/increases several times during the assessment period, with a noticeable change in source noise level of at least 5 dB, for example, equipment cycling on and off. The intermittency correction is not intended to be applied to changes in noise level due to meteorology.	5 dB[3]
Maximum adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated.	Maximum correction of 10 dB[2] (excluding duration correction)

Note 1: Corrections to be added to the measured or predicted levels.

Note 2: Where a source emits tonal and low-frequency noise, only one 5 dB correction should be applied if the tone is in the low-frequency range, that is, at or below 160 Hz.

Note 3: Adjustment to be applied to night-time only.

3.3.4 Traffic on Surrounding Roads

The potential impacts from project related traffic on the surrounding public roads are assessed using the NSW EPA *Road Noise Policy* (RNP).

An initial screening test is first applied to evaluate if existing road traffic noise levels are expected to increase by more than 2.0 dB. Where this is considered likely, further assessment is required using the RNP criteria shown in **Table 14**.

Table 14 RNP Criteria for Assessing Traffic on Public Roads

Road Category	Type of Project/Land Use	Assessment Criteria (dBA)	
		Daytime (7 am – 10 pm)	Night-time (10 pm – 7 am)
Freeway/ arterial/ sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq(15hour)}$ 60 (external)	$L_{Aeq(9hour)}$ 55 (external)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq(1hour)}$ 55 (external)	$L_{Aeq(1hour)}$ 50 (external)

4 Methodology

4.1 Noise Modelling Algorithm

Noise modelling for the assessment of the project has been undertaken using the CONCAWE noise modelling calculation algorithm in SoundPLAN noise modelling software. SoundPLAN software conforms to ISO 17534-1:2015 Acoustics – Software for the Calculation of Sound Outdoors – Part 1: Quality Requirements and Quality Assurance.

CONCAWE is an industry standard algorithm and considered suitable for use for industrial noise predictions over medium to large source to receiver distances. CONCAWE has been tested over the range of 100 to 2000 m and for wind speeds of up to 7 m/s (refer to paper *The CONCAWE Mode for Calculating the Propagation of Noise from Open-Air Industrial Plants*, K. J. Marsh, BP Group Engineering and Technical Centre, Applied Acoustics, 1982).

CONCAWE as implemented in SoundPLAN has been used extensively on industrial and mining projects in Australia over several decades with good correlation between predicted levels and measured levels (tending towards conservatism). CONCAWE allows assessment of noise enhancing meteorological conditions, as described in the NPfI, including direct input of site specific weather conditions (see **Section 4.3.5**).

The ISO 9613-2 algorithm, as implemented in SoundPLAN software, was also investigated for use in the assessment of the project. Predicted noise levels at the receivers using ISO 9613-2 were typically around 5 dB lower than the equivalent CONCAWE results. As such, CONCAWE is considered to be more conservative for the project.

4.2 Construction Noise and Vibration Assessment

A SoundPLAN noise model of the study area has been used to predict noise levels from the proposed construction work to all surrounding receivers.

Local terrain, receiver buildings and structures were digitised in the noise model to develop a three-dimensional representation of the construction sites and surrounding areas.

4.2.1 Construction Activities

Representative scenarios have been developed to assess the likely impacts from the various construction phases of the proposal. These scenarios are shown in **Table 15**.

The assessment uses 'realistic worst-case' scenarios to determine the impacts from the noisiest 15-minute period that are likely to occur for each work scenario, as required by the ICNG. The impacts represent construction noise levels without mitigation applied.

The sound power levels for the construction equipment used in each scenario is presented in **Appendix C.**

Table 15 Construction Equipment

Scenario	Works Activity	Equipment
W.01	Vegetation clearing	Chainsaw, chipper, dozer, dump truck, excavator (22 tonne), front end loader, water tanker
W.02	Demolition	Excavator – breaker, dozer, front end loader, truck, water tanker
W.03	Earthworks	Dozer, dump truck, excavator (22 tonne), front end loader, water tanker, grader, vibratory roller
W.04	Excavation of hard rock	Dozer, dump truck, excavator – breaker, excavator (22 tonne), front end loader, water tanker
W.05	Piling	100t mobile crane, excavator (30 tonne), piling rig – bored, concrete pump, concrete mixer truck, truck
W.06	Construction of roads	Vibratory roller, bitumen spray truck, paving machine, line marking plant
W.07	Construction of pads and hardstands	Concrete pump, concrete mixer truck, concrete vibrator
W.08	Construction of Structures	Elevated working platform, truck, hand tools, 100t mobile crane

4.2.2 Hours of Construction

Construction activities for the proposal would only be undertaken during the following hours:

- 7:00 am to 6:00 pm, Mondays to Fridays
- 8:00 am to 1:00 pm on Saturdays
- At no time on Sundays or Public Holidays.

4.3 Operational Noise Assessment

The project is in the early design stages and certain tenants are currently unknown. Several assumptions have been made regarding the future tenants and sources of noise, based on the likely warehouse and distribution uses. These assumptions have been used to develop representative worst-case noise modelling scenarios that reflect the expected highest noise emissions that the development would likely emit.

The potential operational noise levels from the proposal have been predicted to the surrounding receivers using SoundPLAN. The model includes ground topography, ground type (ground absorption modelled 0.5 for residential areas and 0.0 for commercial areas), buildings and representative worst-case noise sources from the proposal.

The potential impacts have been determined by comparing the predicted worst-case noise levels to the NPfI PNTLs in a 15-minute assessment period.

4.3.1 Operational Noise Sources

The development comprises of various tenancies with associated ancillary offices, an access road for heavy (including medium rigid (MRV) and heavy rigid (HRV) and light vehicles, hardstands (at the upper levels) and an external ramp to the Level 1 and internal ramp to Level 2. All vehicles would access the site from Aquatic Drive. MRV would park on Level 1 and Level 2 hardstand loading areas while they are loaded/unloaded. Light vehicle carparking for the development is located externally, along the access road, and would generally be used by staff. HRV would only access carpark and ground floor hardstand.

Internal noise sources would generally be minimal and associated with typical logistical, distribution, warehousing and office space activities. There would be no use of manufacturing equipment within any

warehouses. Roof mounted mechanical plant would be provided for each office. The development would operate 24 hours a day.

The main sources of operational noise at the development are expected to include:

- On-site light and heavy vehicles (MRV and HRV) movements
- Loading dock activities in hardstands
- Mechanical plant
- Off-site vehicle movements.

A summary of the expected noise sources and worst-case assessment scenarios associated with the operation of the development is provided below.

On-Site Traffic

On-site vehicles have been modelled using the data in **Table 16** and

Table 17. The volumes are representative of the expected worst-case 15-minute period for the daytime, evening and night-time. The volumes conservatively assume that light and heavy vehicles concurrently access the various warehouse tenancies during the worst-case 15-minute assessment period. In reality, vehicle access to each warehouse would be unlikely to occur concurrently, particularly during the night-time.

Heavy vehicle deliveries to the warehouses would be via a range of freight vehicles, with the largest vehicles expected to be Rigid Heavy Vehicles. The vehicle routes are shown in **Figure 6** and **Figure 7**.

Table 16 Vehicle Traffic Data – Worst-case 15-Minute Period

Tenancy	Vehicle Type	Number of Vehicles in Worst-case 15-minute Period[1]		
		Daytime (7am to 6pm)	Evening (6pm to 10pm)	Night-time (10pm to 7am)
Warehouse Units (Level 1)	MRV	1	1	1
Warehouse Units (Level 2)	MRV	1	1	1
All tenancies	Light vehicles	15	5	1

Note 1: Total vehicles, includes both inbound and outbound vehicles. Volumes are rounded up to whole numbers for display purposes.

Table 17 Vehicle Sound Power Levels

Vehicle	Movement	Sound Power Level (dBA)	Vehicle Speed (km/h)
Heavy vehicles (HVR)	Access routes	108[1]	25
	On-lot routes and hardstands		10
Heavy vehicles (MRV)	Access routes	102[1]	25
	On-lot routes and hardstands		10
	Ramps	106[1]	20
Light vehicles	Car park	90[2]	20

Note 1: Sound power level for large trucks based on 106 dBA for trucks at slow speed for 80% of the time and 111 dBA for trucks accelerating for 20% of the time and is representative of trucks with three or more axles. Sound power level for medium trucks based on 100 dBA for trucks at slow speed for 80% of the time and 106 dBA for trucks accelerating for 20% of the time and is representative of trucks with two axles and six tires. Sound power levels taken from the Federal Highway Administration's *Traffic Noise Model*.

Note 2: The sound power level for light vehicles is based on SLR measurement data and includes various light vehicle types and models at speeds of up to around 40 km/h, including acceleration.

Hardstands and Loading Docks

Details of the noise sources on the hardstands are shown in **Table 18**. The various sources have been modelled in the locations shown in **Figure 6** and **Figure 7** and are based on the corresponding number of heavy vehicle movements in the worst-case 15-minute periods (see **Table 16**).

Table 18 Typical Hardstand and Loading Dock Noise Sources

Noise Source	Sound Power Level (dBA)[1]	Typical Duration of Use in Worst-case 15-minute Period
All Warehouses		
Truck reversing alarm	107[2,3]	30 seconds
Forklift reversing alarm	102[2,3]	90 seconds
Air brakes	118	1 second
Roller door	94	15 seconds
Electric forklift	84	900 seconds
Cold Storage Warehouses (assumed at 10% of tenancies)		
Refrigeration truck trailer	102[4]	900 seconds

Note 1: SWLs based on measurement data, where appropriate.

Note 2: SWL based on recommendation to use broadband reversing alarms, see **Section 6.2**.

Note 3: SWL includes a -3 dB reduction due to alarms being discrete events.

Note 4: SWL based on measured data and *Sound Power Levels and Directivity Patterns of Refrigerated Transport Trailers*, Roy et al, 2017.

Internal Activities

The future tenants of the warehouses would likely be associated with typical warehousing and distribution uses. Internal noise-generating activities at all warehouses are expected to generally be minimal. A sound power level of 75 dBA has been applied at openings in the facades of each warehouse to cover potential break-out noise from general internal activities, based on observations of loading activities at similar warehouse facilities. Warehouse roller shutter doors are assumed to be open during loading dock activities.

The facade and roof construction of the warehouses would be metal sheeting (Colorbond or similar). The proposed warehouse construction is expected to be sufficient to minimise noise breakout through the facade and roof to a level that results in negligible external noise emissions.

Mechanical Plant

The specific details regarding mechanical plant at the development are not currently known. Reasonable assumptions have been made which includes air-conditioning equipment serving the office buildings and ventilation/extraction fans mounted on the roof of each warehouse. Compressors are expected to be required within the plant rooms of tenancies with cold storage needs, together with external condensers located on the hardstands.

External mechanical plant has been modelled with indicative data for equipment typical to a development of this size, as shown in **Table 19**.

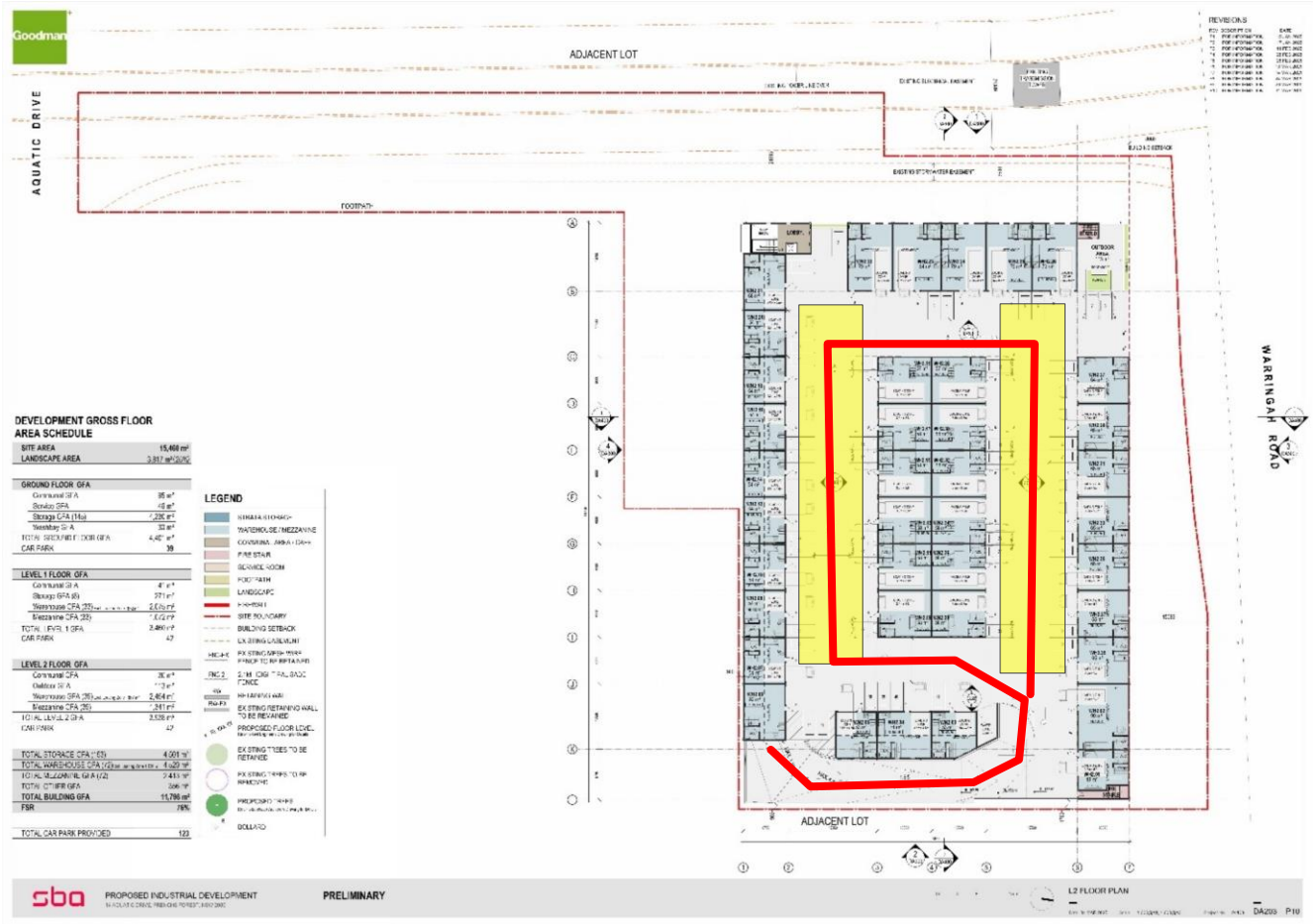
Table 19 Mechanical Plant

Noise Source	Sound Power Level (dBA)	Location and Operational Hours
All Warehouses		
Office air-conditioning units	78 (each unit)	Office and dock offices for all warehouses. Assumed operational hours 24/7.
Warehouse roof fans	90 (cumulative per warehouse)	Roof of all warehouses. Roof fans assumed to potentially operate at any time during a 24/7 period for air purge.
Cold Storage Warehouses (assumed at 10% of warehouses)		
Compressor	98	Assumed to be internal within warehouse plant rooms with pre-cast concrete facade, therefore negligible noise emissions.
Condenser	90[1]	Roof of warehouse plant room. Condenser operational hours 24/7.

Note 1: A limiting SWL of 90 dBA has been used to reduce noise emissions from the proposal. For further discussion on mitigation measures, see **Section 6.2**.

Figure 6 Heavy Vehicle Routes and Loading Areas – Level 1

Figure 7 Heavy Vehicle Routes and Loading Areas – Level 2



4.3.2 Corrections for Annoying Noise Characteristics

The potential annoying noise characteristics and modifying factor corrections relevant to the proposal are:

- **Tonality** – the only source identified with potential tonal characteristics is reversing alarms. However, when considering broadband reversing alarms have been recommended as a noise mitigation measure (see **Section 6.2**), it is unlikely that this noise source would result in tonal noise impacts and no corrections have been applied.
- **Low frequency noise** – previous measurements of sources similar to those operating at the development indicate that no sources are expected to result in low frequency noise impacts.
- **Intermittent noise** – the NPfI defines intermittent noise as noise heard at the receiver where the level suddenly drops or increases several times during the assessment period, with a noticeable change of at least 5 dB, such as where equipment cycles on and off. The intermittent correction does not apply to short-term events that emerge above the general industrial noise level and is therefore not applicable to industrial or commercial sites that have vehicle or plant movements at night, including audible reversing alarms. No sources have been identified with potential intermittent characteristics.

4.3.3 Noise Sources with Potential for Sleep Disturbance

As the development is proposed to operate 24-hours a day, noise emissions during the night-time require assessment for potential sleep disturbance at the nearest residential receivers. The details of typical activities with the potential to cause sleep disturbance are shown in **Table 20**.

Table 20 Sleep Disturbance Noise Events – L_{Amax} Sound Power Levels

Noise Source	Sound Power Level L_{Amax} (dBA)
MRV/HRV movement	111
MRV/HRV airbrake	118
Truck reversing alarm	110
Forklift reversing alarm	105
Roller door	94
Cars	96

4.3.4 Off-site Road Traffic

Development related heavy vehicles would generally travel on Warringah Road, Wakehurst Parkway and Allambie Road before accessing the site via Aquatic Drive.

The traffic assessment report prepared by ASON (Ref: P2072r06 DA TA) indicates that the impact of the development on the broader road network is expected to be minimal, hence potential noise impacts from development related traffic on public roads are expected to be negligible given the surrounding roads are major roads with high existing traffic volumes. As such, no further assessment of off-site traffic noise is required.

4.3.5 Weather Conditions

Certain weather conditions can increase noise levels by focusing noise towards receivers. Noise-enhancing weather conditions can occur where wind blows from the source to the receiver, or where temperature inversions occur.

The NPfI defines 'standard' and 'noise-enhancing' weather conditions as shown in **Table 21**. Noise-enhancing weather should be included in the assessment where it occurs for more than 30% of the daytime, evening or night-time period in any season.

Table 21 Standard and Noise-enhancing Weather Conditions

Weather Conditions	Meteorological Parameters
Standard	Daytime/evening/night-time: stability categories A–D with wind speed up to 0.5 m/s
Noise-enhancing	Daytime/evening: stability categories A–D with light winds up to 3 m/s Night-time: stability categories A–D with light winds up to 3 m/s and/or stability category F with winds up to 2 m/s

The weather conditions used in the assessment are shown in **Table 22**. As per the NPfI, noise-enhancing meteorological conditions have been conservatively assumed for all assessment periods. The assessment considers source-to-receiver wind vectors for all receivers and F class temperature inversions with wind speeds up to 2 m/s at night.

Table 22 Modelled Weather Conditions

Period	Weather Condition	Meteorological Parameters used in Assessment
Daytime	Noise-enhancing	Stability categories A–D with light winds up to 3 m/s
Evening	Noise-enhancing	Stability categories A–D with light winds up to 3 m/s
Night-time	Noise-enhancing	Stability category F with source to receiver wind up to 2 m/s

5 Assessment of Impacts

5.1 Construction Noise

The predicted construction noise levels at the most-affected sensitive receivers surrounding the site are shown in **Table 23** and exceedances of the NMLs are shown in **Table 24**.

The predictions represent a realistic worst-case scenario where the equipment in each scenario is working concurrently and the nearest location to each receiver. It is expected that noise levels would frequently be lower than the worst-case levels presented.

Table 23 Predicted Construction Noise Levels at Nearest Receivers

Receiver	NML (Day)	Predicted Noise Level – $L_{Aeq(15minute)}$ (dBA)							
		W.01 Vegetation clearing	W.02 Demolition	W.03 Earthworks	W.04 Excavation of hard rock	W.05 Piling	W.06 Construction of roads	W.07 Construction of pads and hardstands	W.08 Construction of structures
West Residential	58	61	56	57	59	50	51	44	41
South East Residential	58	67	61	63	65	55	57	49	46
North Residential	49	57	55	53	55	49	47	43	40
Child Care Centre	50	77	61	73	75	55	67	49	46
Place of Worship	55	60	53	56	58	47	50	41	38
Hospital (Northern Beaches Hospital)	65	58	56	54	56	50	48	44	41
NBMHH		90	84	86	88	78	80	72	69
Education	55	48	44	44	46	38	38	32	29
Commercial	70	88	84	84	86	78	78	72	69

Table 24 Predicted Exceedances at Nearest Receivers

Receiver Type	NML (Day)	Predicted Exceedance(dB)							
		W.01 Vegetation clearing	W.02 Demolition	W.03 Earthworks	W.04 Excavation of hard rock	W.05 Piling	W.06 Construction of roads	W.07 Construction of pads and hardstands	W.08 Construction of structures
West Residential	58	3	-	-	1	-	-	-	-
South East Residential	58	9	3	5	7	-	-	-	-
North Residential	49	8	6	4	6	-	-	-	-
Child Care Centre	50	27	11	23	25	5	17	-	-
Place of Worship	55	5	-	1	3	-	-	-	-
Hospital (Northern Beaches Hospital)	65	-	-	-	-	-	-	-	-
NBMHH		25	19	21	23	13	15	7	4
Educational	55	-	-	-	-	-	-	-	-
Commercial	70	18	14	14	16	8	8	2	-
Legend (NML exceedances)		= Minor to marginal (1 to 10 dB exceedance)		= Moderate (11 to 20 dB exceedance)		= High (>20 dB exceedance)			

The above worst-case predictions show the following:

- Noise levels predicted at the nearest residential receivers are generally expected to comply with the NMLs during most work scenarios. Exceedances are predicted during some of the noisier work scenarios, however these are relatively minor and are limited to the nearest receivers.
- The highest impacts on the residential receivers are seen during work that uses noise intensive equipment such as chainsaws or rockbreakers during early stages of the works (*W.01 – Vegetation clearing or W.04 Excavation of hard rock*), where exceedances of up to 9 dB are predicted at the nearest residential receivers. These items of equipment are, however, expected to only be required infrequently, with noise levels and corresponding impacts being much lower when they are not in use.
- Exceedances of up to 27 dB are predicted at the nearest child care receivers during noisy work scenarios. This is primarily due to the proximity of this receiver to work areas and the conservative assumption that the child care centre is located on the most affected facade of the building and has windows open. Impacts during less noise intensive work would range from minor to moderate.
- Exceedances of up to 25 dB are predicted at the proposed NBMHH during noisy work scenarios. This is primarily due to the proximity of this receiver to the work areas.
- Moderate exceedances of up to 18 dB are predicted at the nearest commercial receivers during noisy work scenarios. This is primarily due to the proximity of these receivers to the site.
- Noise levels predicted at the Frenchs Forest Anglican Church are generally expected to comply with the NMLs during most work scenarios. Exceedances are predicted during some of the noisier work scenarios, however these exceedances are generally relatively minor and would likely only occur when works are conducted near the site boundary.

- Noise levels at the Northern Beaches Hospital, The Forest High School and the Arranounbai School are predicted to comply with their respective NMLs.
- Works would only occur during Standard Daytime Construction Hours. There is no expectation for evening or night-time work to be required.

The presented worst-case impacts would only be expected to occur when noisy work is being completed close to the site boundaries, relative to each receiver. When work is in central areas of the site, or when less noise-intensive equipment is being used, the noise levels would be lower.

Feasible and reasonable construction noise mitigation measures should be applied where exceedances of the NMLs are predicted. Construction noise mitigation and management measures are discussed in **Section 6.1**.

5.2 Construction Vibration

The major potential sources of vibration from the proposed construction activities would likely be during:

- 'Demolition' and 'Excavation of hard rock' when rock breakers (hydraulic hammers) are being used.
- 'Earthworks' when vibratory rollers are being used

Vibration offset distances have been determined from the CNVG minimum working distances for cosmetic damage and human comfort (see **Table 8**) and the assessment is summarised in **Figure 8** and **Figure 9** for a large hydraulic hammer and a 12 T vibratory roller, respectively. Buildings within the minimum working distances are shown in the figure.

Figure 8 Construction Vibration – Large Hydraulic Hammer

Figure 9 Construction Vibration – 12 T Vibratory Roller

Cosmetic Damage Assessment

The above figures show that the distance between the construction work and the nearest sensitive receivers is generally sufficient for most receiver buildings to the east and north to be outside of the cosmetic damage minimum working distance for vibration intensive equipment. However, the NBMHH to the west and some of the nearest commercial buildings to the west and east are likely to be within the minimum working distance for cosmetic damage when vibration intensive works are being completed adjacent to the site boundary. All residential buildings are sufficiently distant from the site and cosmetic damage impacts are not considered likely.

Human Comfort Assessment

The above figure shows that the NBMHH and some of the nearest commercial buildings are within the human comfort minimum working distance for a large hydraulic hammer and a 12 T vibratory roller. Occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use. Where impacts are perceptible, they would likely only be apparent for relatively short durations when vibration intensive equipment is nearby.

Feasible and reasonable construction vibration mitigation measures should be applied where vibration intensive works are required within the minimum working distances. Construction mitigation and management measures are discussed further in **Section 6.1**.

Vibration Sensitive Medical Equipment

Northern Beaches Endocrinology is located around 15 m from the development at 10 Tilley Lane, Frenchs Forest and would likely have vibration sensitive imaging equipment. There is also potential for sensitive equipment at the Northern Beaches Mental Health Hub, however, it is noted that this receiver is not currently approved and unlikely to be constructed and operational before construction of the proposal. Further assessment of the potential impacts of vibration intensive construction activities on equipment within this building should be completed when detailed information regarding construction activities for the proposal are available.

5.3 Operational Noise

5.3.1 Predicted Operational Noise Levels

A summary of the predicted operational noise assessment at the receivers surrounding the proposal is shown in **Table 25**. Impacts have been predicted to all floors of the receivers. The predictions represent worst-case noise levels from the entire development and are compared to the Project Noise Trigger Levels to determine the potential impact of the proposal.

A detailed assessment of all potential feasible and reasonable mitigation measures that could be applied to the development to minimise the impacts has been completed and is summarised in **Section 6.2**. The following predictions include the recommended mitigation measures, where appropriate. Noise contours of the predicted worst-case operational noise impacts are in **Appendix D.**

Table 25 Operational Noise Assessment

Receiver Location	Period	Noise Level $L_{Aeq(15minute)}$ (dB)			Expected Outcome
		Noise Criteria	Predicted[1]	Exceedance	
West Residential	Day	53	37	-	Compliance
	Evening	43	32	-	Compliance
	Night	38	32	-	Compliance
South Residential	Day	53	45	-	Compliance
	Evening	43	41	-	Compliance
	Night	38	38	-	Compliance
North Residential	Day	44	34	-	Compliance
	Evening	40	27	-	Compliance
	Night	38	26	-	Compliance
Place of Worship	When in use	48	33	-	Compliance
Hospital (Northern Beaches Hospital)	Noisiest 1-hour	48	40	-	Compliance
NBMHH		35	28[2]	-	Compliance
Educational	When in use	48	27	-	Compliance
Commercial	When in use	63	60	-	Compliance

Note 1: Predicted level shown for the most-affected receiver type in that area.

Note 2: Internal noise levels within the NBMHH building have been calculated using the proposed glazing specifications from the JHA report (See **Section 1.1.2**)

The above assessment indicates that the proposed mitigation is expected to reduce noise levels to comply with the criteria at all receivers.

5.3.2 Sleep Disturbance

The predicted night-time maximum noise levels at the nearest residential receivers are shown in **Table 26**. These include the mitigation measures specified in **Section 6.2**, where appropriate.

Table 26 Sleep Disturbance Assessment

Receiver Location	Source	Maximum Noise Level L_{Amax} (dBA)			Below Screening Level
		Sleep Dist. Screening Level	Predicted	Exceedance	
West Residential	Truck reversing alarm	52	42	-	Yes
	Forklift reversing alarm		47	-	Yes
	HRV/MRV airbrake		57	5	**No**
	HRV/MRV movements – Access routes		51	-	Yes
	MRV movements – Up-ramp		50	-	Yes
	Cars		39	-	Yes
	Roller door		34	-	Yes
South Residential	HRV/MRV reversing alarm	52	51	-	Yes
	Forklift reversing alarm		56	4	**No**
	HRV/MRV airbrake		65	13	**No**
	HRV/MRV movements – Access routes		59	7	**No**
	MRV movements – Up-ramp		59	7	**No**
	Cars		45	-	Yes
	Roller door		40	-	Yes
North Residential	Truck reversing alarm	52	42	-	Yes
	Forklift reversing alarm		47	-	Yes
	HRV/MRV airbrake		57	5	**No**
	HRV/MRV movements – Access routes		49	-	Yes
	MRV movements – Up-ramp		41	-	Yes
	Cars		32	-	Yes
	Roller door		36	-	Yes
NBMHH	Truck reversing alarm	52	63	11	**No**
	Forklift reversing alarm		68	16	**No**
	HRV/MRV airbrake		76	24	**No**
	HRV/MRV movements – Access routes		75	23	**No**
	MRV movements – Up-ramp		72	20	**No**
	Cars		64	12	**No**
	Roller door		49	-	Yes

The assessment above indicates the following:

- Maximum noise levels are generally expected to comply with the sleep disturbance screening level in the residential areas except for when heavy vehicles access the site and truck airbrakes are used.
- Maximum noise levels at the proposed NBMHH are expected to exceed the sleep disturbance screening level for most sources. This results from the close proximity of the NBMHH to the site.
- It is noted that heavy vehicle delivery during the night-time would be infrequent, and it is likely that many of the night-time heavy vehicles would be rigid trucks (or similar) which generally do not use airbrakes. Deliveries during the night-time are also likely to be in the morning shoulder period (ie between 6 am and 7 am), which is generally less sensitive to potential sleep disturbance.

The NPfI requires a detailed maximum noise level assessment to be completed where night-time noise levels exceed the screening level.

5.3.2.1 Detailed Maximum Noise Level Assessment

The detailed maximum noise level assessment is summarised in **Table 27** for residential receivers and **Table 28** for the NBMHH.

Table 27 Detailed Maximum Noise Level Assessment – Residential Receivers

Receiver	Maximum Noise Level L_{Amax} (dBA)					Comments
	Sleep Disturbance Goals (dBA)		Development Related Maximum Noise Events		Existing Maximum Noise Levels	
	Awakening Response[1]	Good Sleep[2]	Predicted	Frequency of Occurrence		
West Residential	65	Around 55 (10 to 15 times per night)	34 to 57	Infrequent	55 – 65	**Awakening Response:** maximum noise levels are predicted to be below the 'awakening response' level at all residential receivers.
South East Residential	65	Around 55 (10 to 15 times per night)	40 to 65	Infrequent	65 – 75	

Receiver	Maximum Noise Level L_{Amax} (dBA)					Comments
	Sleep Disturbance Goals (dBA)		Development Related Maximum Noise Events		Existing Maximum Noise Levels	
	Awakening Response[1]	Good Sleep[2]	Predicted	Frequency of Occurrence		
North Residential	65	Around 55 (10 to 15 times per night)	32 to 57	Infrequent	60 – 70	**Good Sleep:** noise from truck movements and truck air brakes are predicted to potentially exceed 55 dBA externally at the nearest residential areas, mostly when heavy vehicles the site. Truck access during the night-time is, however, expected to be infrequent. Where it does occur during the night it is likely to be in the morning shoulder period (ie between 6 am and 7 am), which is generally less sensitive to potential sleep disturbance impacts. As such, infrequent maximum noise events from trucks are not expected to adversely affect 'good sleep' (ie they not expected to occur more than 10 to 15 times per night) **Existing maximum noise levels:** the unattended noise monitoring showed that existing maximum noise levels were measured to frequently be in the order of 55 to 65 dBA at L01 (West Residential area) and 65 to 75 dBA at L02 (South East Residential area). Historical noise measurements conducted on Frenchs Forest Road indicate existing maximum noise levels at the most-impacted receivers in the North Residential area are frequently between 60 – 70 dBA. As such, development related maximum noise levels are expected to be lower in magnitude than existing maximum noise levels in all residential areas.

Note 1: Based on RNP guidance that maximum internal noise levels below 50 dBA to 55 dBA are unlikely to awaken people from sleep. This equates to an external noise level of 65 dBA when assuming a 10 dB loss for partially open windows for ventilation.

Note 2: Based on RNP guidance that for a good sleep over eight hours the indoor L_{Amax} sound pressure level should not exceed around 45 dBA more than 10 or 15 times per night. This equates to an external noise level of around 55 dBA when assuming a 10 dB loss for partially open windows for ventilation.

Table 28 Detailed Maximum Noise Level Assessment – Northern Beaches Mental Health Hub

Receiver	Maximum Noise Level L_{Amax} (dBA)					Comments
	Sleep Disturbance Goals (dBA)		Development Related Maximum Noise Events		Existing Maximum Noise Levels	
	Awakening Response[1]	Good Sleep[2]	Predicted	Frequency of Occurrence		
NBMHH	55 (internal)	45 (internal) (10 to 15 times per night)	17 to 44 (Internal)[3]	Infrequent	n/a[4]	**Awakening Response:** maximum internal noise levels the proposed NBMHH, from on-site truck movements, airbrake releases, reversing alarms and loading activities on the hardstands are expected to be below 55 dBA due to the reduction that would be provided by the proposed recommended 6.38 mm laminated glass windows. **Good Sleep:** maximum internal noise within the proposed NBMHH, from on-site truck movements, airbrakes releases, reversing alarms and loading activities on the hardstands are predicted to marginally exceed 45 dBA by 1 dB. Truck access during the night-time is, however, expected to be infrequent. Where it does occur during the night it is likely to be in the morning shoulder period (ie between 6 am and 7 am), which is generally less sensitive to potential sleep disturbance impacts. As such, infrequent maximum noise events from trucks are not expected to adversely affect 'good sleep' (ie they not expected to occur more than 10 to 15 times per night).

Note 1: Based on RNP guidance that maximum internal noise levels below 50 dBA to 55 dBA are unlikely to awaken people from sleep.

Note 2: Based on RNP guidance that for a good sleep over eight hours the indoor L_{Amax} sound pressure level should not exceed around 45 dBA more than 10 or 15 times per night. T

Note 3: Internal noise levels within the NBMHH building have been calculated using the proposed glazing specifications from the JHA report (See **Section 1.1.2**)

Note 4: NBMHH is proposed and not currently approved for development.

The predicted maximum noise levels during truck deliveries are not expected to result in noise levels or impacts that would result in potential sleep disturbance at the residential receivers. Additionally, maximum noise levels from the development are predicted to be lower than existing maximum noise levels in the residential areas which are from existing vehicles on the surrounding roads in all residential areas.

The SSDA NIA for the proposed NBMHH includes 6.38 mm fixed laminated glazed windows on the eastern facade of the development. Internal noise levels have been predicted at the NBMHH assuming this glazing and the assessment concludes that internal noise levels at the NBMHH are also not expected result in potential sleep disturbance.

Based on the above, the predicted sleep disturbance exceedances are considered of relatively low significance and do not warrant any specific mitigation measures.

6 Mitigation and Management Measures

6.1 Construction Impacts

The impacts during construction of the project are predicted to be typical of major construction works near to sensitive receivers. No works outside of standard construction hours are currently proposed.

The use of standard mitigation measures to minimise the impacts is considered sufficient to control the majority of the impacts. Examples of measures which could be applied to the work are provided in the Roads and Maritime (now Transport for NSW) *Construction Noise and Vibration Guideline* (see **Appendix E**).

A Construction Noise and Vibration Management Plan (CNVMP) would be prepared before any work begins. This would identify all potentially impacted receivers, assess the potential noise and vibration impacts from the project and provide details regarding how the impacts would be minimised through the use of all feasible and reasonable mitigation measures. The CNVMP would also contain procedures for handling complaints, should they occur, and detail any compliance monitoring requirements.

6.2 Operational Noise Impacts

Where operational noise impacts from the site are predicted to exceed the relevant noise criteria, feasible and reasonable operational noise mitigation and management measures should be considered, with the aim of reducing noise emissions to the relevant criteria.

The typical hierarchy for mitigation and management of industrial noise sources is as follows:

- Reducing noise emissions at the source (ie noise source control)
- Reducing noise in transmission to the receiver (ie noise path control)
- Reducing noise at the receiver (ie at-receiver control).

A detailed assessment of all potential feasible and reasonable mitigation measures that could be applied to the development to minimise the impacts has been completed and is summarised in **Table 29**.

The measures should be regarded as indicative and would be further refined during detailed design when more details regarding specific tenants are known.

Table 29 Operational Noise Mitigation Options

Ref.	Mitigation Option	Noise Impact/Benefit	Feasible and Reasonable to Apply
Source Control			
S1	Optimised site layout to minimise noise emissions from the site	Where possible, the site layout has been designed so that the warehouse buildings screen the noisier areas of the development (ie hardstands and truck routes) from the nearest receivers.	Yes – applied during design of the concept.
S2	Limit vehicle movements	A reduction in concurrent vehicle movements across the site by staggering delivery/pickup times and/or employee shift change times could reduce noise emissions. In practice, this would occur naturally across the estate due to operational requirements of the different tenants.	No – vehicle volumes used in this assessment are likely needed to meet tenant's requirements. Placing restrictions on allowable vehicle movements across the different tenancies is unlikely to be feasible and reasonable.
S3	Hardstand/external equipment use	Minimising the concurrent use of forklifts or other mobile plant outside the warehouses and/or limiting their use to the less sensitive day and evening periods. In practice, this would occur naturally across the estate due to operational requirements of the different tenants.	No – placing restrictions on allowable external use of forklifts and equipment across the different tenancies is unlikely to be feasible and reasonable.
S4	Use broadband and/or ambient sensing alarms on trucks and forklifts where they are required to reverse during the night-time.	Reduce potential for annoying noise emissions during the night-time.	Yes – use broadband and/or ambient sensing alarms on forklifts and trucks where they are required to reverse during the night-time.
S5	Appropriate specification and location of mechanical plant during detailed design.	If noise impacts from mechanical plant are identified during detailed design, quieter plant could be selected, or the plant could be relocated to a location screened from view of the nearest receivers, where appropriate.	Yes – noise impacts from mechanical plant would be investigated further during detailed design or construction certificate stages when specific plant requirements are identified. While a limiting sound power level of 90 dBA has been used for the cold storage condensers on the Level 1 hardstand for indicative purposes, alternative forms of mitigation measures could be used to achieve compliance, such as using an increased specification of acoustic enclosure/louvres to house the condensers. The final design of this equipment would be completed as the project progresses.

Ref.	Mitigation Option	Noise Impact/Benefit	Feasible and Reasonable to Apply
S6	Appropriate design of warehouses during detailed design.	Appropriate warehouse materials to minimise noise break-out from internal activities would be selected during detailed design.	Yes – noise impacts from internal equipment would be investigated further during detailed design or construction certificate stages if tenant requires manufacturing plant or other noisy equipment.
S7	Roller doors kept closed when loading/unloading is not occurring to minimise noise breakout.	Roller doors should be kept closed when not in use for loading/unloading trucks.	Yes.
Path Control			
P1	Not required	n/a	n/a
Receiver Control			
R1	Not required	n/a	n/a

The project is a speculative development without any tenants committed and the exact operational procedures of the site are not known at this time. Several assumptions have been made regarding the likely future sources of noise. The noise predictions in this report should be regarded as indicative for planning purposes and are required to be confirmed at a later stage when detailed information is available.

7 Conclusion

SLR has been engaged to assess the potential construction and operational noise emissions from the proposed multistorey warehouse facility at 14 Aquatic Drive, Frenchs Forest. The proposal includes the operation of a multi level warehouses.

The potential impacts from the proposal have been assessed against the noise and vibration specific Secretary's Environmental Assessment Requirements.

Construction noise levels are generally predicted to comply with the management levels at the nearest sensitive receivers. Exceedances are predicted at some of the nearest sensitive receivers during some of the noisy work activities. Mitigation measures have been recommended to address the potential construction impacts.

Operational noise levels are expected to comply with the trigger levels at the nearest receivers. A range of feasible and reasonable mitigation measures have been recommended to control the impacts.

Based on the predicted levels and indicative mitigation measures, the proposal is considered appropriate from an acoustic standpoint.

Appendix A:

Acoustic terminology

1. Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that 'noise' often refers to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure. The human ear responds to changes in sound pressure over a very wide range with the loudest sound pressure to which the human ear can respond being ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2×10^{-5} Pa.

2. 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4,000 Hz), and less sensitive at lower and higher frequencies. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

3. Sound Power Level

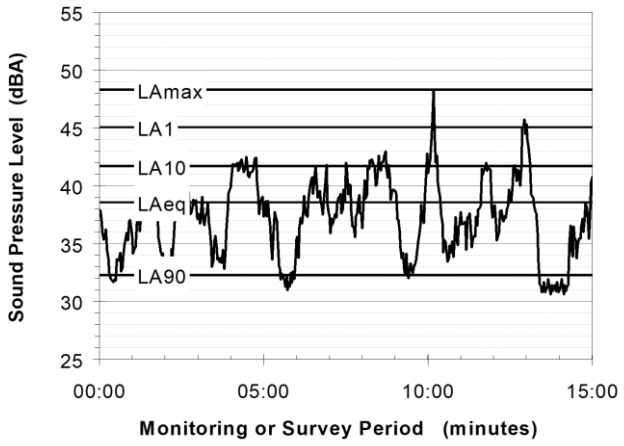
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure is similar to the effect of an electric radiator, which is characterised by a power rating but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4. Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels LAN, where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time, LA10 the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

LA1 The noise level exceeded for 1% of the 15 minute interval.

LA10 The noise level exceeded for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

LA90 The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

LAeq The A-weighted equivalent noise level (basically, the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

5. Frequency Analysis

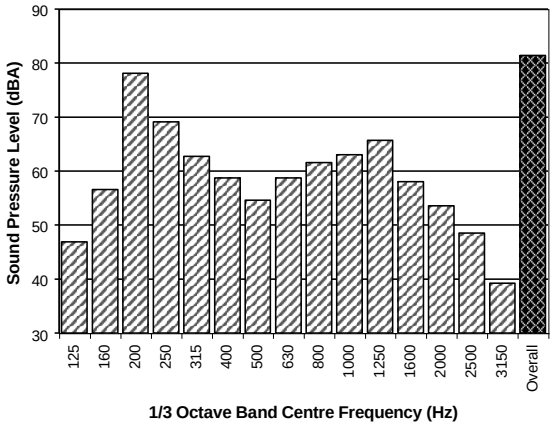
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (three bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



6. Annoying Noise (Special Audible Characteristics)

A louder noise will generally be more annoying to nearby receivers than a quieter one. However, noise is often also found to be more annoying and result in larger impacts where the following characteristics are apparent:

- **Tonality** - tonal noise contains one or more prominent tones (ie differences in distinct frequency components between adjoining octave or 1/3 octave bands), and is normally regarded as more annoying than 'broad band' noise.
- **Impulsiveness** - an impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.
- **Intermittency** - intermittent noise varies in level with the change in level being clearly audible. An example would include mechanical plant cycling on and off.
- **Low Frequency Noise** - low frequency noise contains significant energy in the lower frequency bands, which are typically taken to be in the 10 to 160 Hz region.

7. Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements (ie vertical, longitudinal and transverse).

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/Vo), where Vo is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used.

8. Human Perception of Vibration

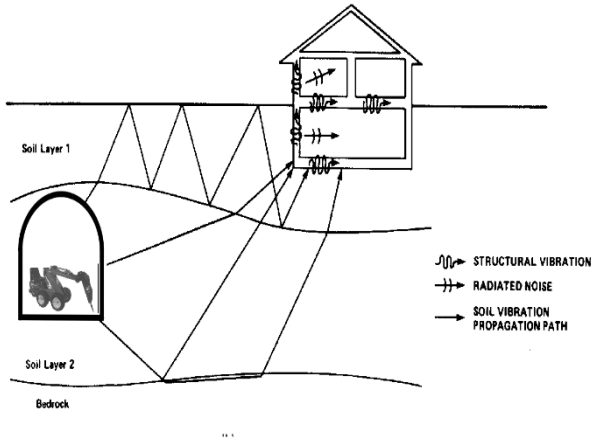
People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience 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.

9. Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents an example of the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise.

Appendix B:

Noise Monitoring Summary

Noise Monitoring Location	L.01	Map of Noise Monitoring Location
Noise Monitoring Address	**67 Bantry Bay Road, Frenchs Forest**	

Logger Device Type: Svantek 977, Logger Serial No: 28070
Sound Level Meter Device Type: Brüel and Kjær 2270, Sound Level Meter Serial No: 3029485

Ambient noise logger deployed adjacent to the property boundary of 67 Bantry Bay Road, Frenchs Forest. Logger located with view of Wakehurst Parkway to the east.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Wakehurst Parkway and road traffic noise from Bantry Bay Road. Noise from road traffic on the surrounding road network influences the background noise at this location.

Recorded Noise Levels (LAmax):
11/11/2022: Light-vehicle traffic Wakehurst Parkway: 55-60 dBA, Heavy-vehicle traffic Wakehurst Parkway: 58-64 dBA, Heavy-vehicle traffic Bantry Bay Road: 58-60 dBA, Birds: 56-68 dBA

Ambient Noise Logging Results – ICNG Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	LAeq	L10	L1
Daytime	48	54	55	59
Evening	44	52	53	58
Night-time	34	46	46	52

Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	Noise Level (dBA)	
	LAeq(period)	LAeq(1hour)
Daytime (7am-10pm)	53	54
Night-time (10pm-7am)	47	50

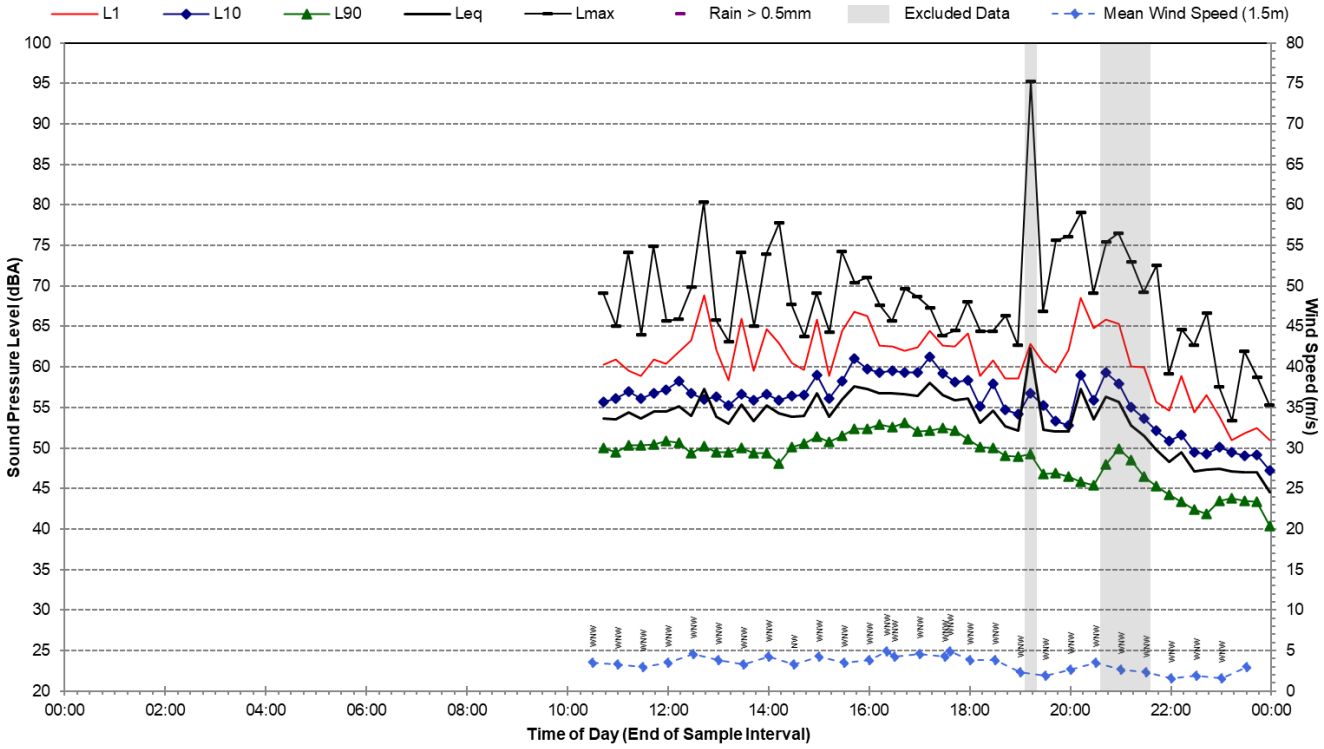
Attended Noise Measurement Results

Date	Start Time	Measured Noise Level (dBA)		
		LA90	LAeq	LAmax
11/11/2022	10:04	50	53	69

Photo of Noise Monitoring Location **10.2 width**

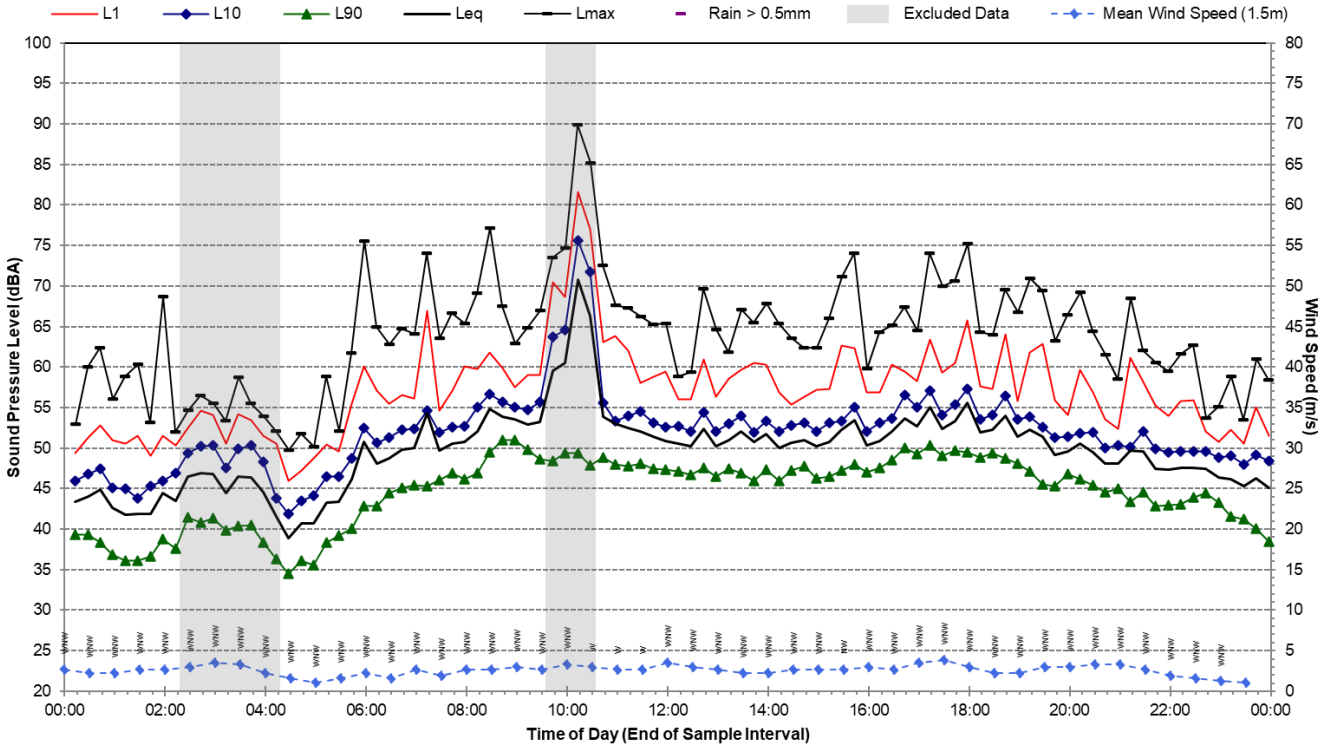
Statistical Ambient Noise Levels

L01 - 67 Bantry Bay Road, Frenchs Forest - Friday, 28 October 2022



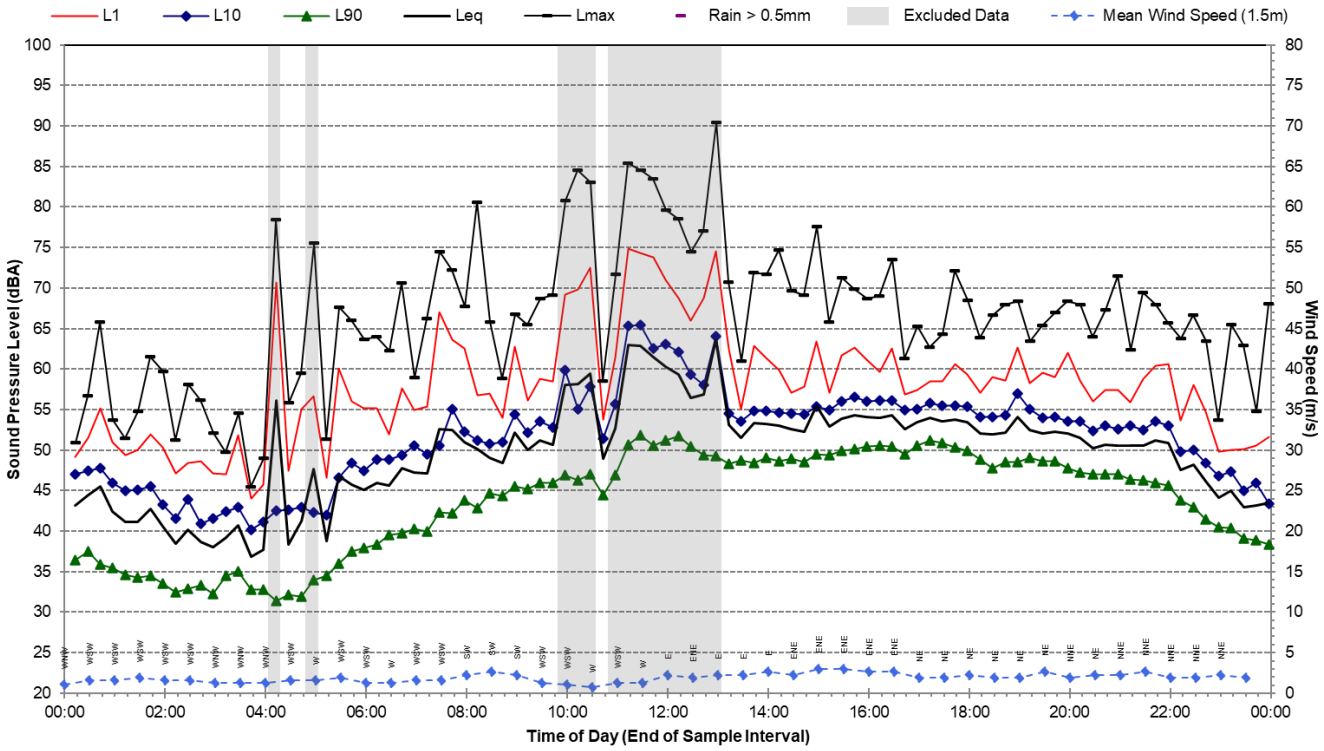
Statistical Ambient Noise Levels

L01 - 67 Bantry Bay Road, Frenchs Forest - Saturday, 29 October 2022



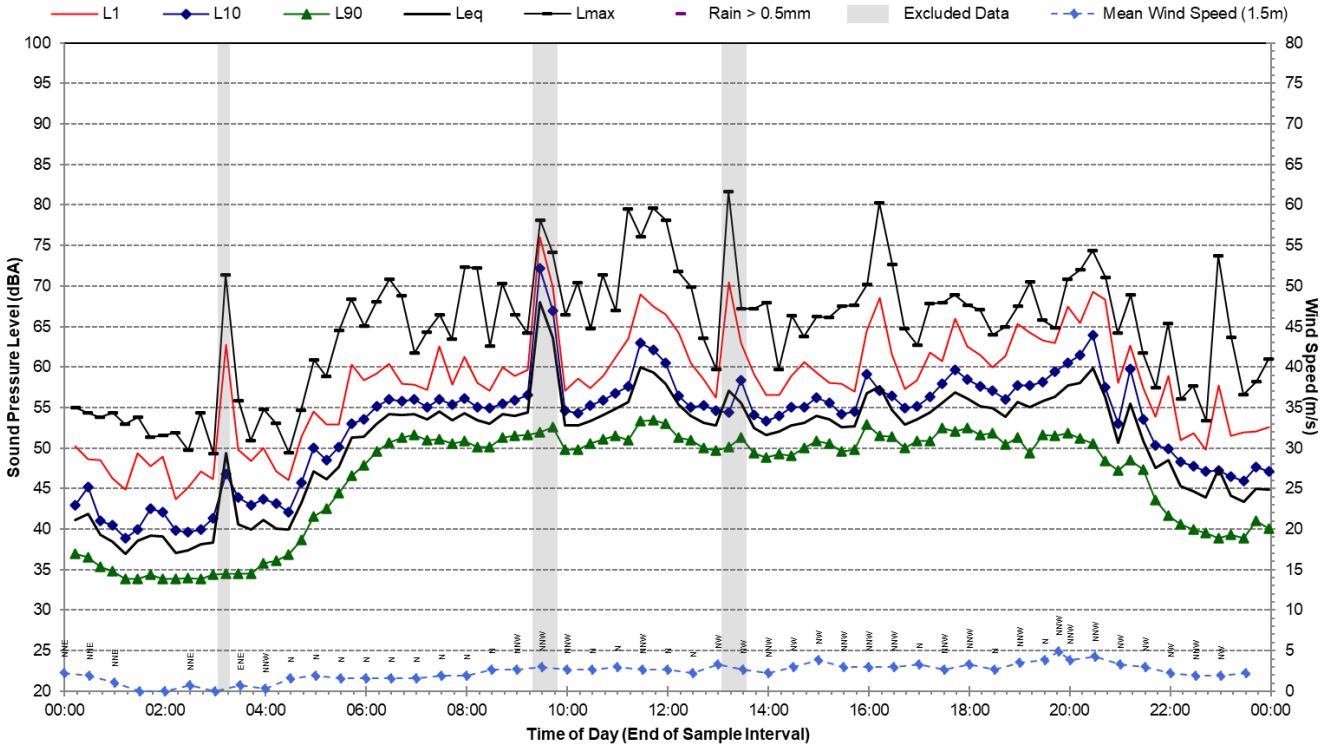
Statistical Ambient Noise Levels

L01 - 67 Bantry Bay Road, Frenchs Forest - Sunday, 30 October 2022



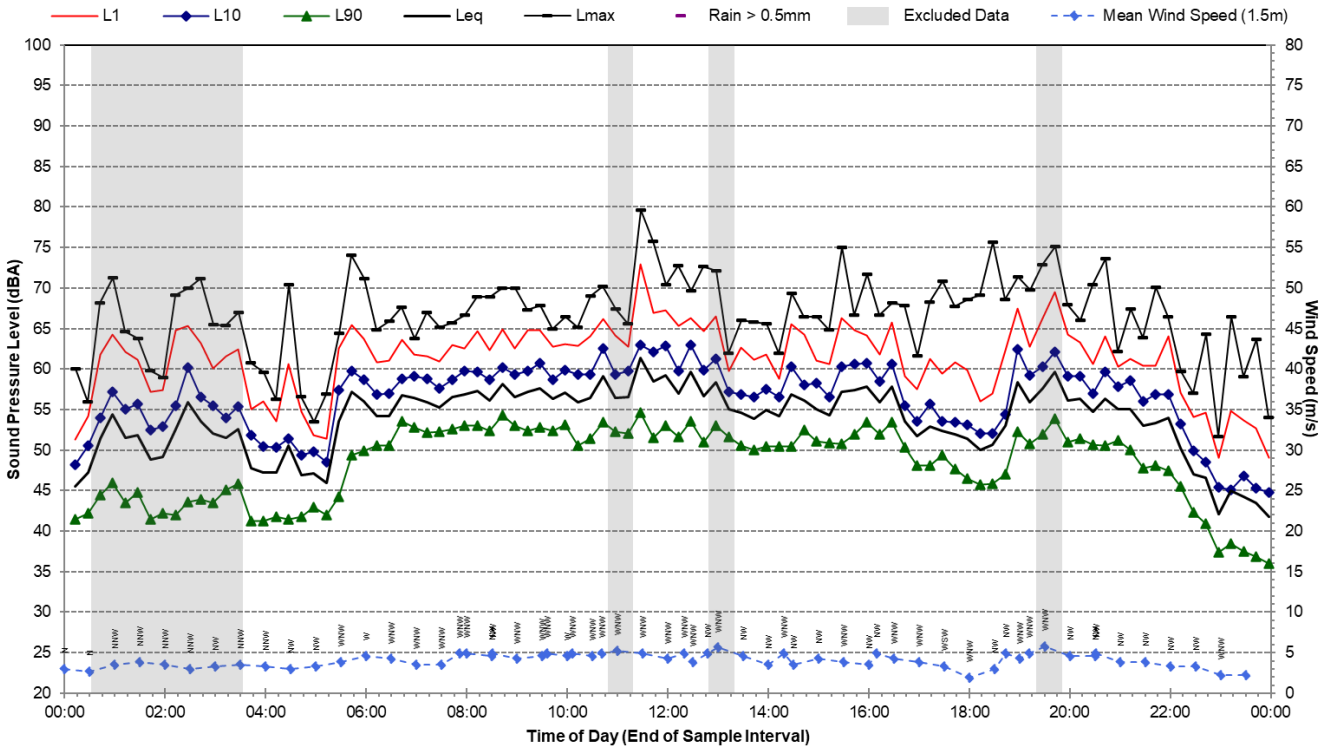
Statistical Ambient Noise Levels

L01 - 67 Bantry Bay Road, Frenchs Forest - Monday, 31 October 2022



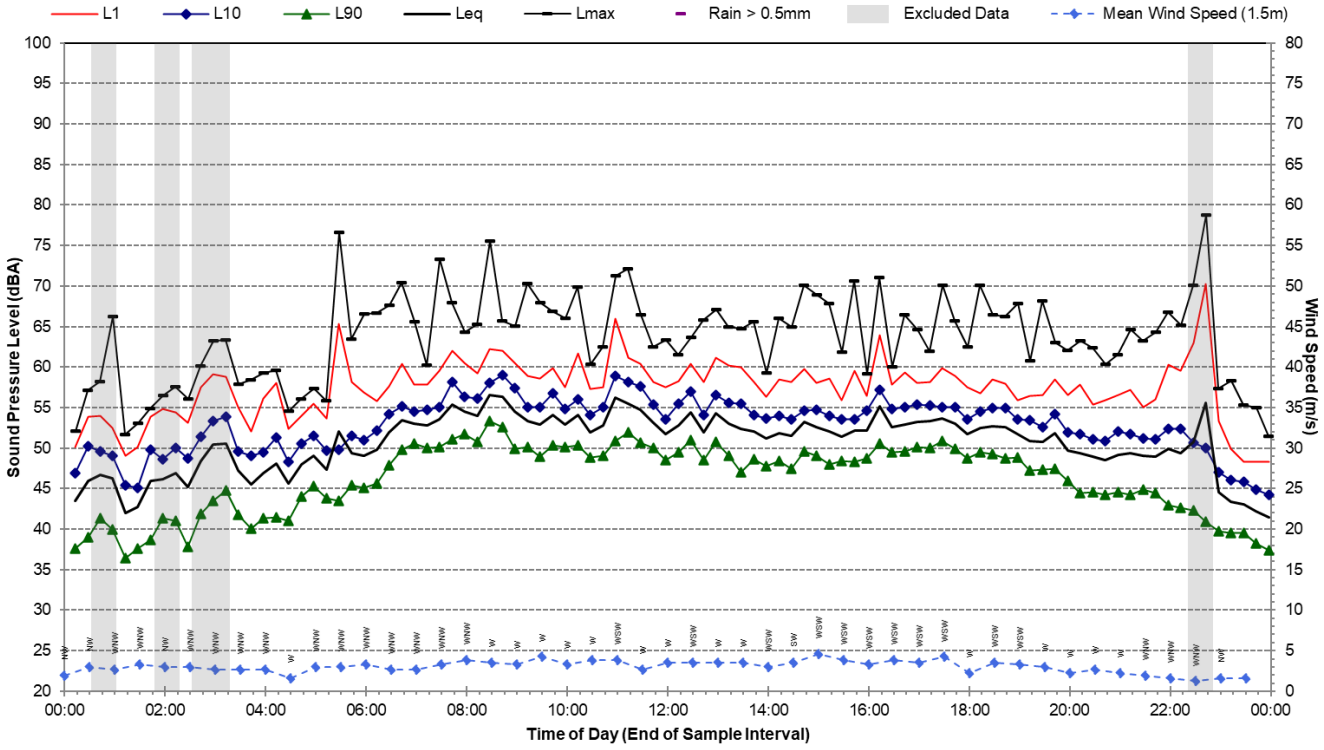
Statistical Ambient Noise Levels

L01 - 67 Bantry Bay Road, Frenchs Forest - Tuesday, 1 November 2022



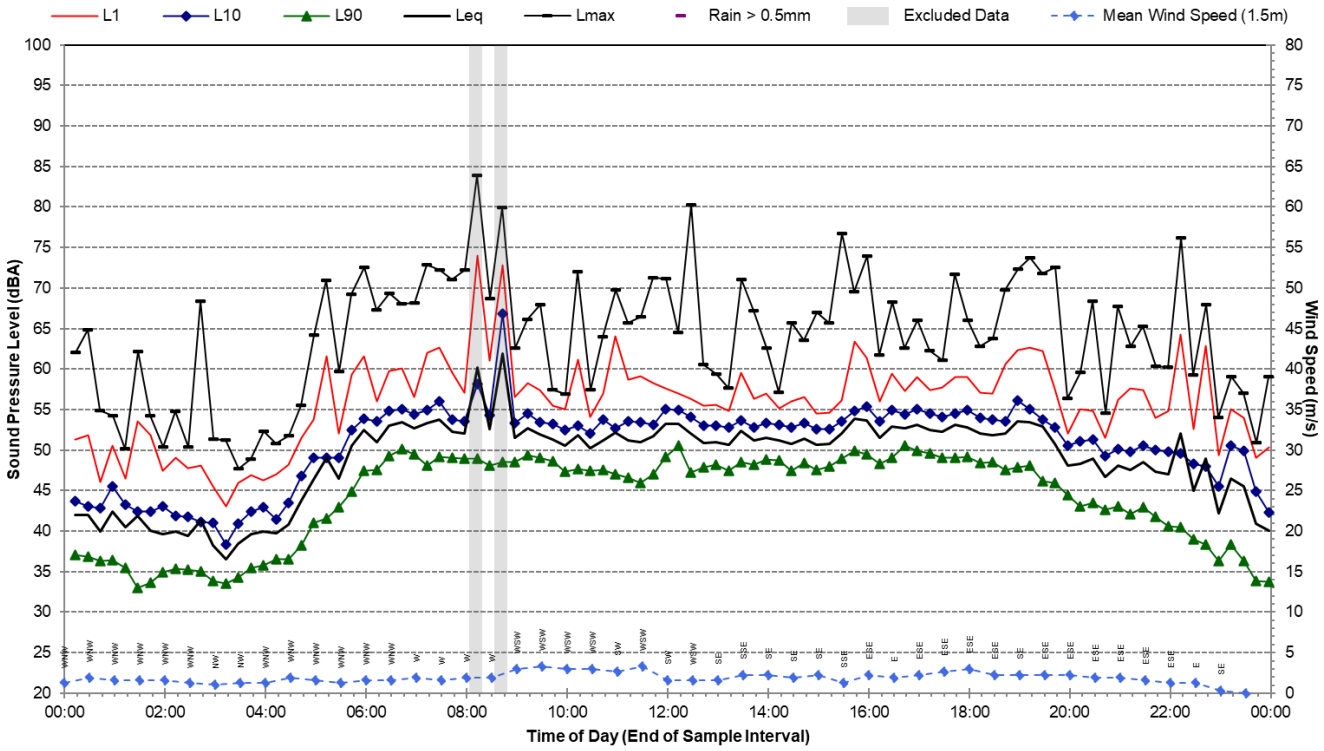
Statistical Ambient Noise Levels

L01 - 67 Bantry Bay Road, Frenchs Forest - Wednesday, 2 November 2022



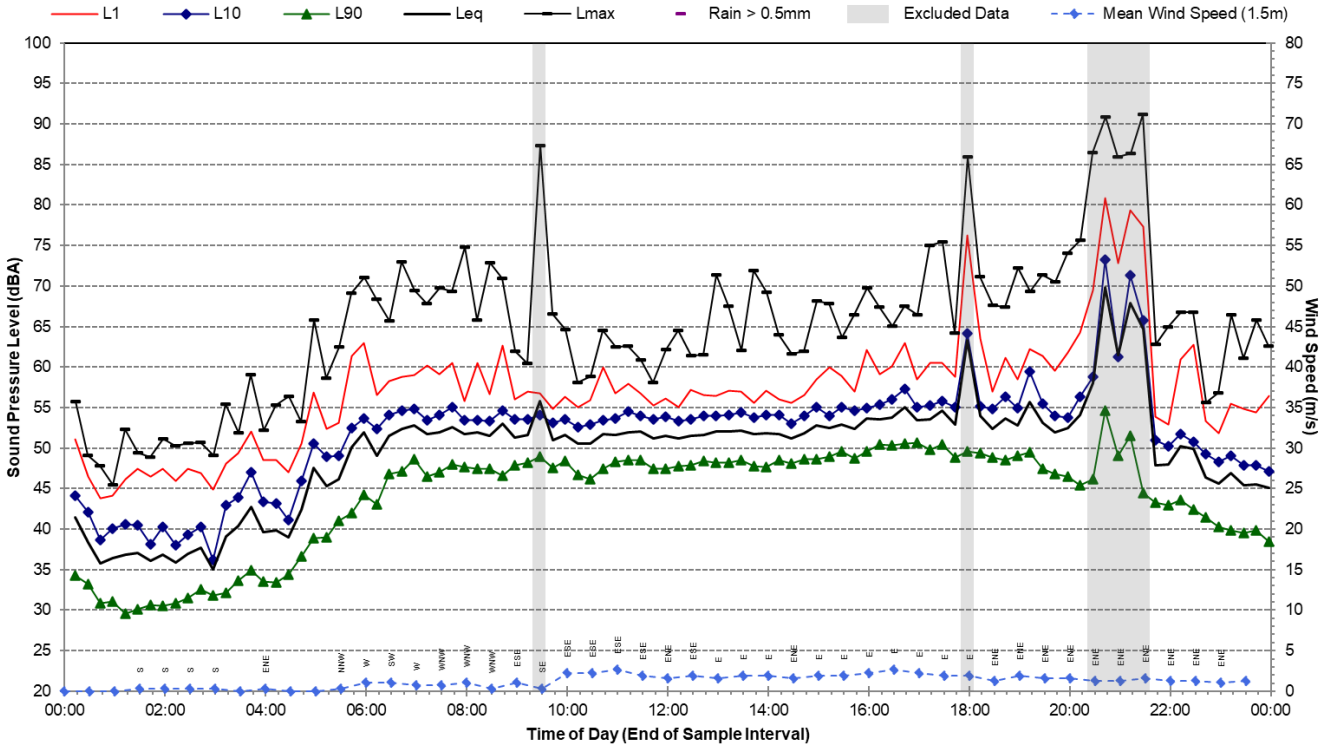
Statistical Ambient Noise Levels

L01 - 67 Bantry Bay Road, Frenchs Forest - Thursday, 3 November 2022



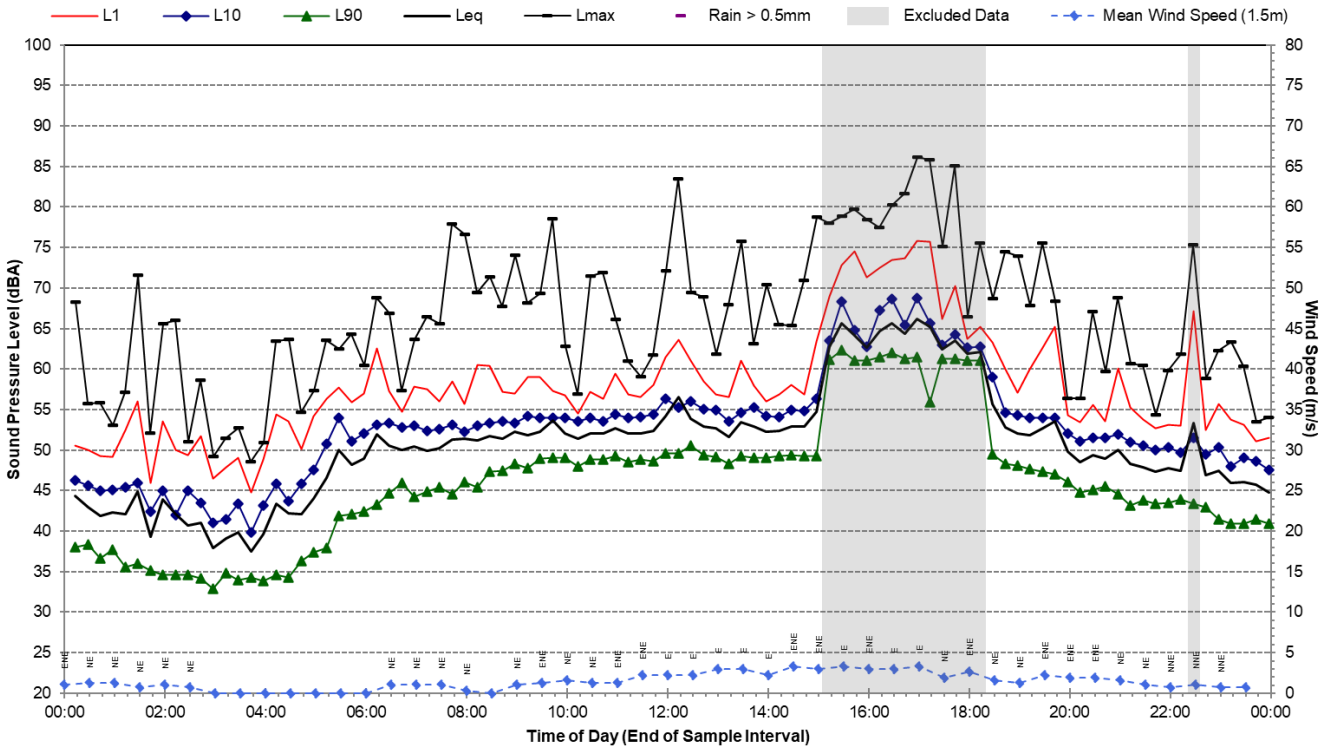
Statistical Ambient Noise Levels

L01 - 67 Bantry Bay Road, Frenchs Forest - Friday, 4 November 2022



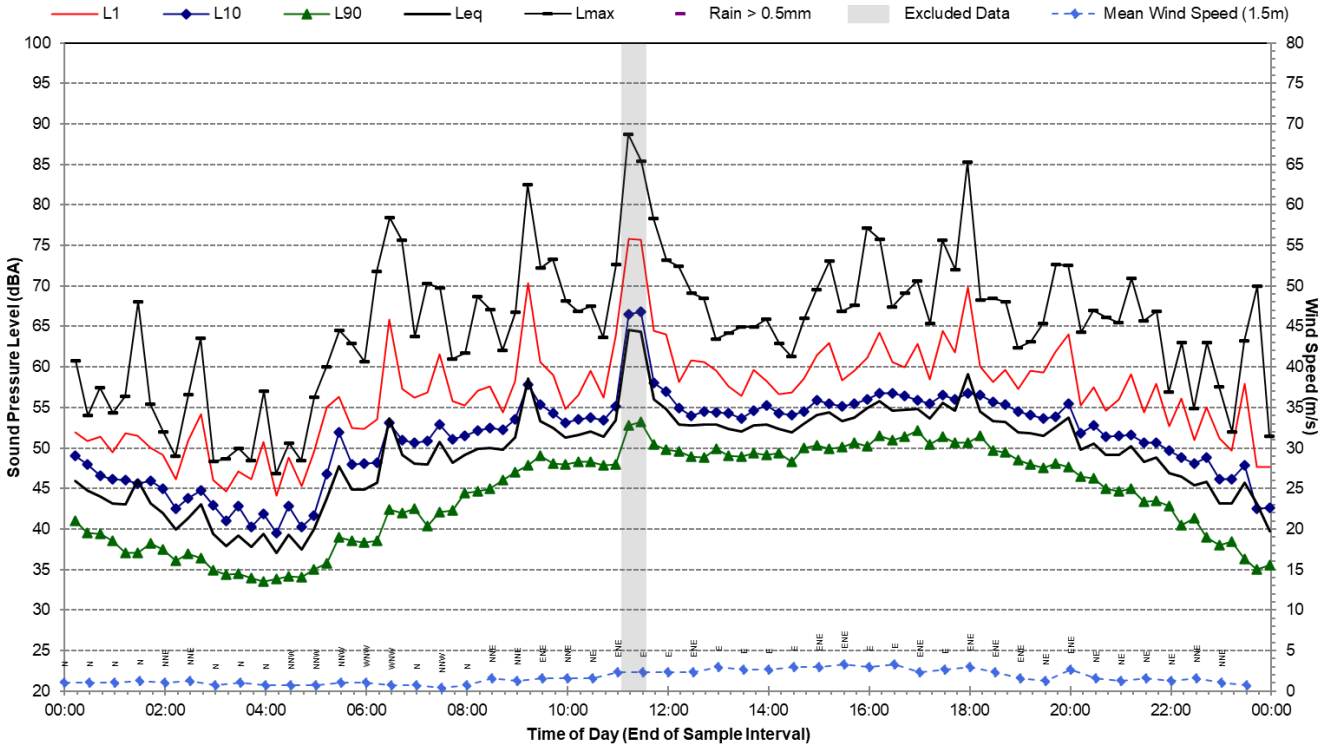
Statistical Ambient Noise Levels

L01 - 67 Bantry Bay Road, Frenchs Forest - Saturday, 5 November 2022



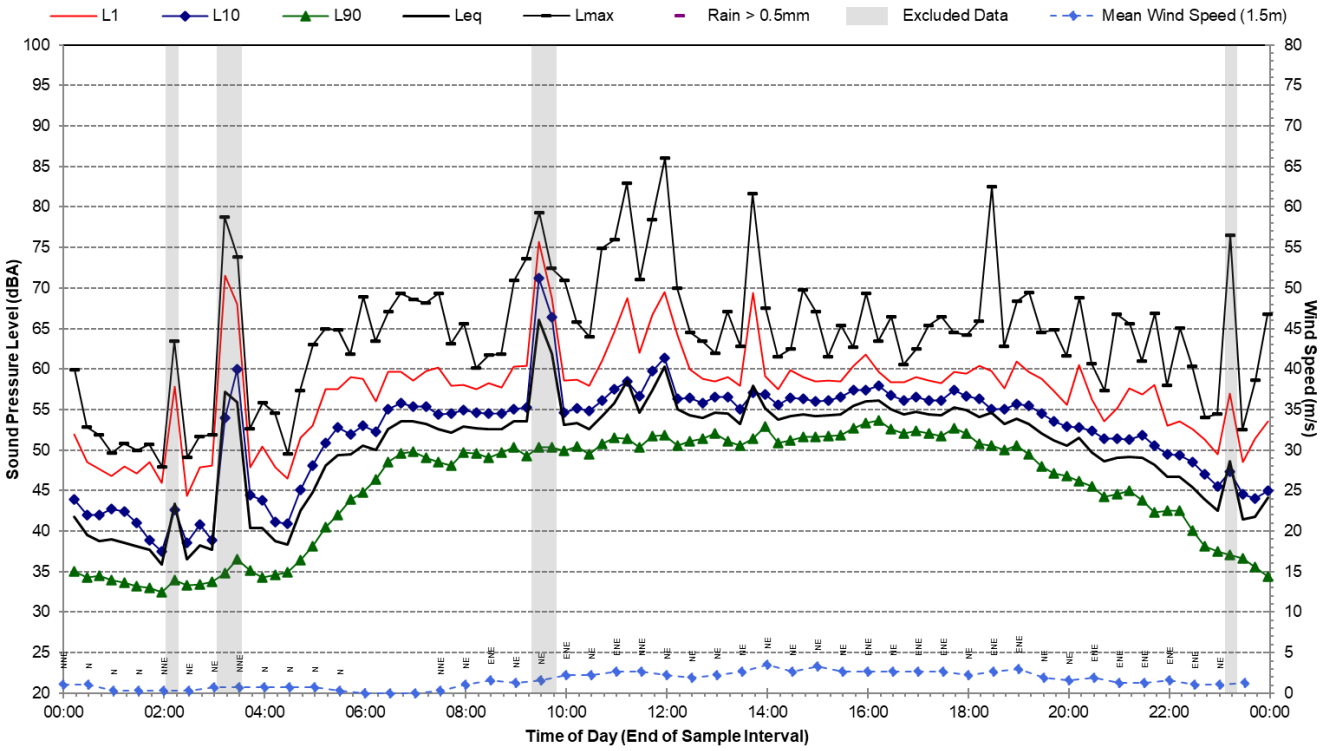
Statistical Ambient Noise Levels

L01 - 67 Bantry Bay Road, Frenchs Forest - Sunday, 6 November 2022



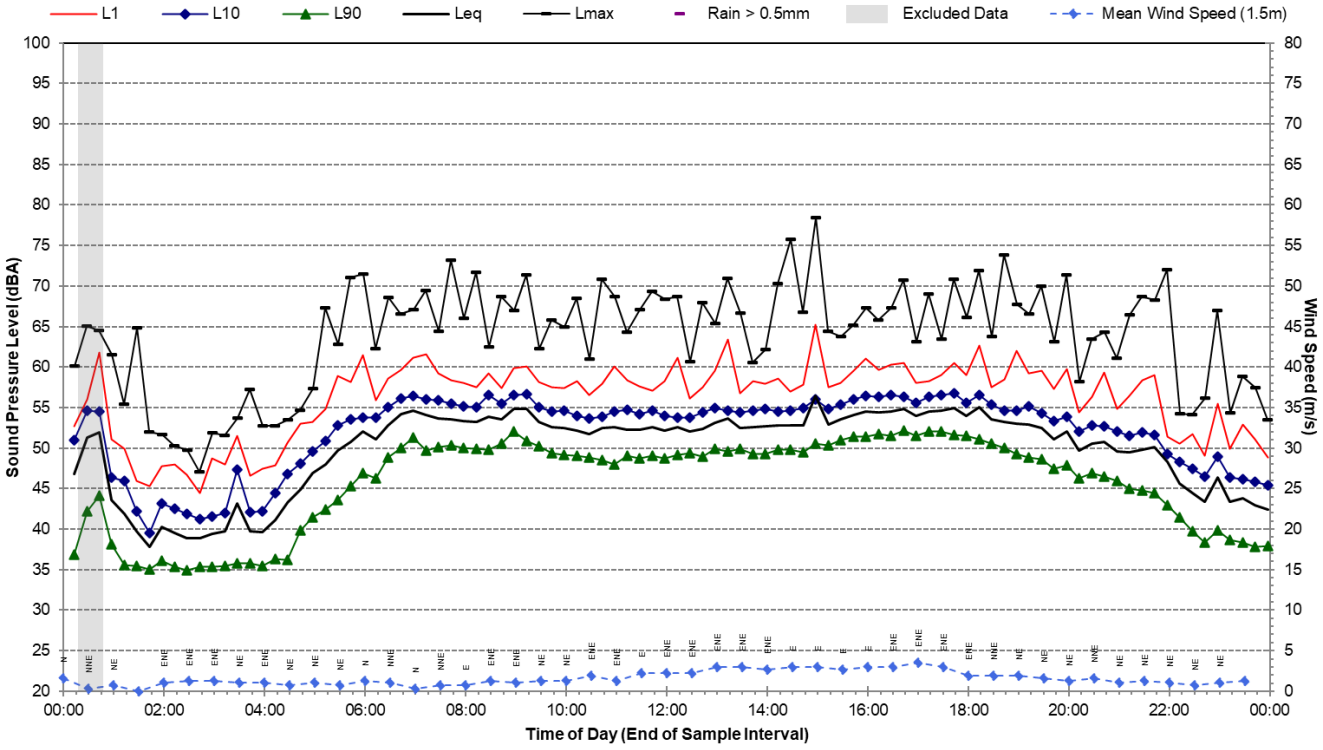
Statistical Ambient Noise Levels

L01 - 67 Bantry Bay Road, Frenchs Forest - Monday, 7 November 2022



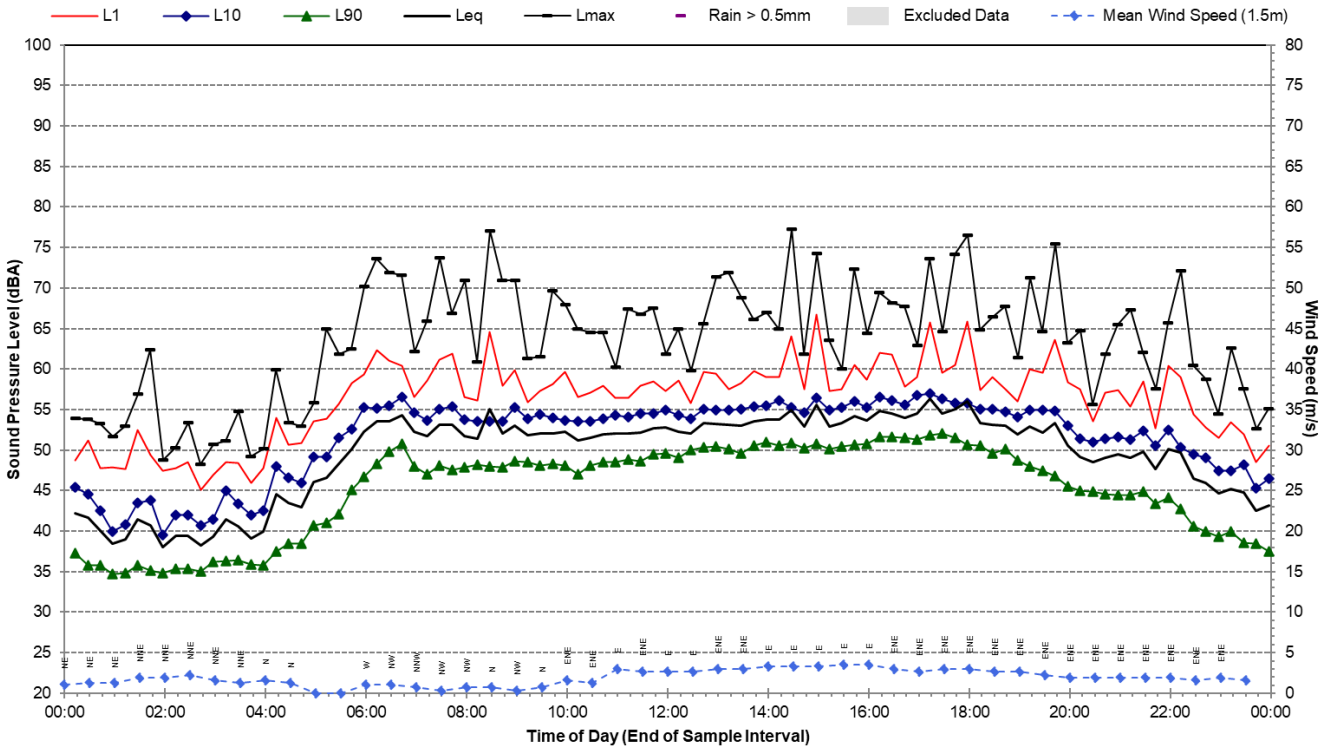
Statistical Ambient Noise Levels

L01 - 67 Bantry Bay Road, Frenchs Forest - Tuesday, 8 November 2022



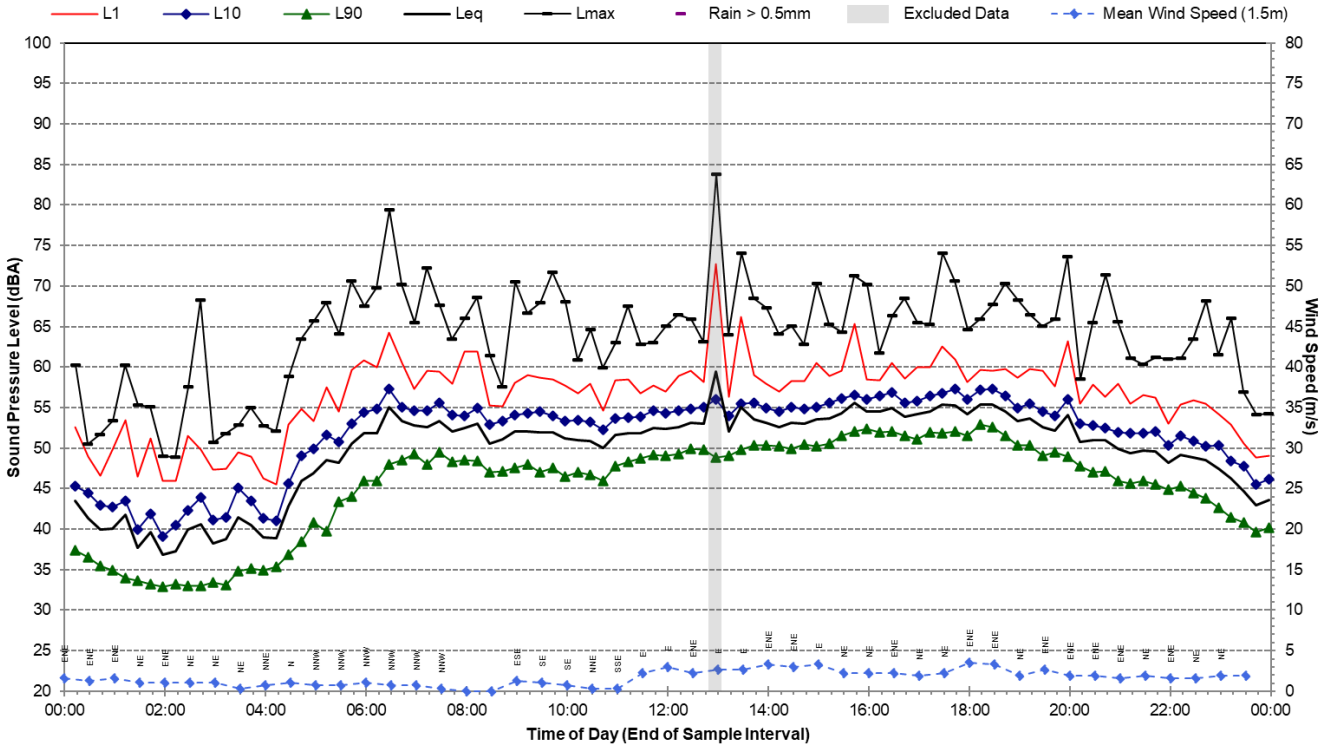
Statistical Ambient Noise Levels

L01 - 67 Bantry Bay Road, Frenchs Forest - Wednesday, 9 November 2022



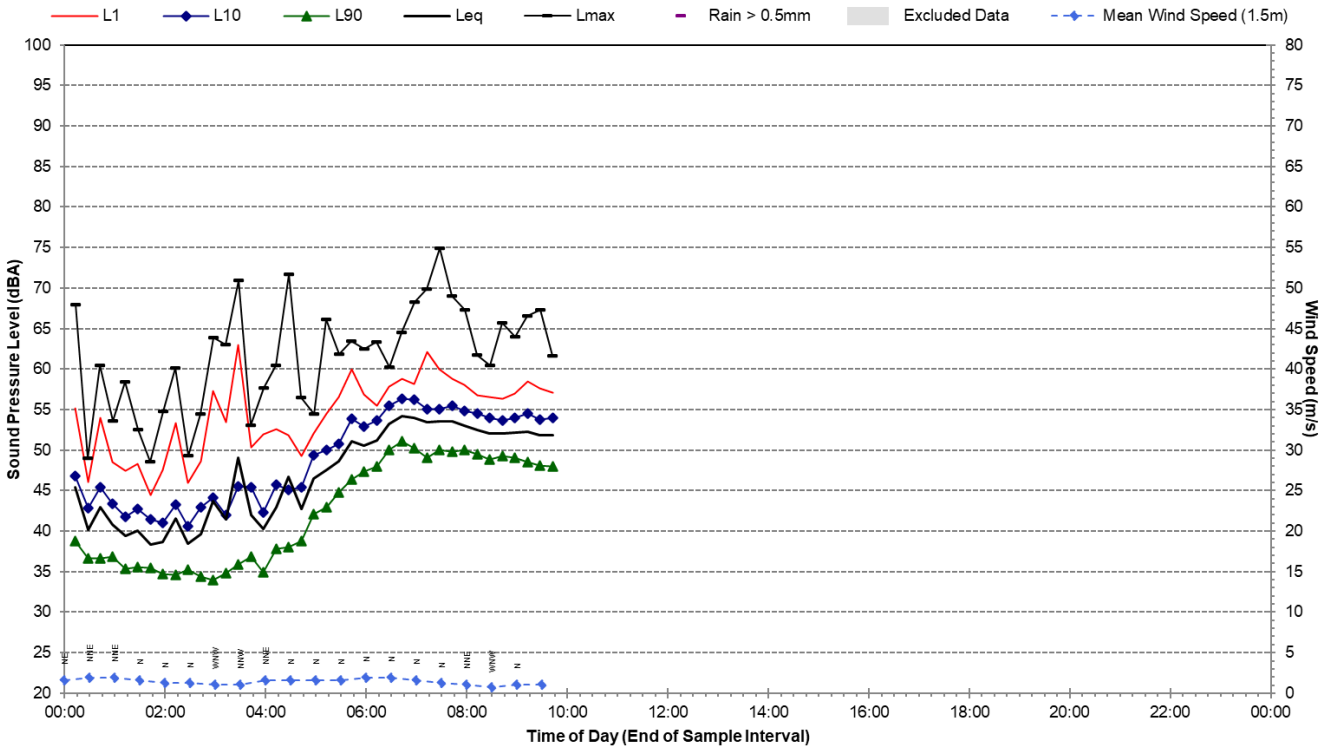
Statistical Ambient Noise Levels

L01 - 67 Bantry Bay Road, Frenchs Forest - Thursday, 10 November 2022



Statistical Ambient Noise Levels

L01 - 67 Bantry Bay Road, Frenchs Forest - Friday, 11 November 2022



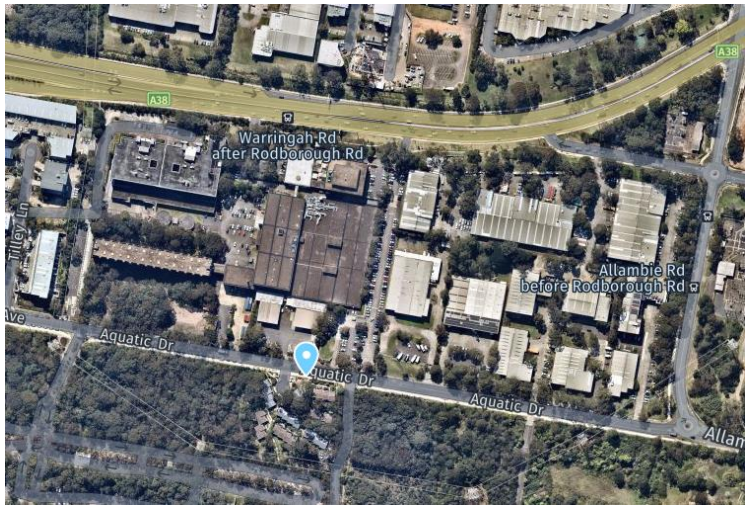
Noise Monitoring Location	L.02	Map of Noise Monitoring Location
Noise Monitoring Address	**11 Aquatic Drive, Frenchs Forest**	

Logger Device Type: Svantek 957, Logger Serial No: 20666
Sound Level Meter Device Type: Brüel and Kjær 2270, Sound Level Meter Serial No: 3029485

Ambient noise logger deployed at residential address 11 Aquatic Drive, Frenchs Forest. Logger located with view of Aquatic Drive to the north.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Aquatic Drive and operational activities associated with the commercial developments north of Aquatic drive. Noise from road traffic on the surrounding road network and mechanical plant from the commercial developments to the north influences the background noise at this location.

Recorded Noise Levels (LAmax):
28/10/2022: Light-vehicle traffic Aquatic Drive: 62-69 dBA, Heavy-vehicle traffic Aquatic Drive: 72 dBA, Industrial operations: 61-66 dBA, Heavy-vehicle accessing in industrial hardstand: 70 dBA



Ambient Noise Logging Results – ICNG Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	LAeq	L10	L1
Daytime	48	60	63	68
Evening	44	57	61	66
Night-time	33	53	46	61

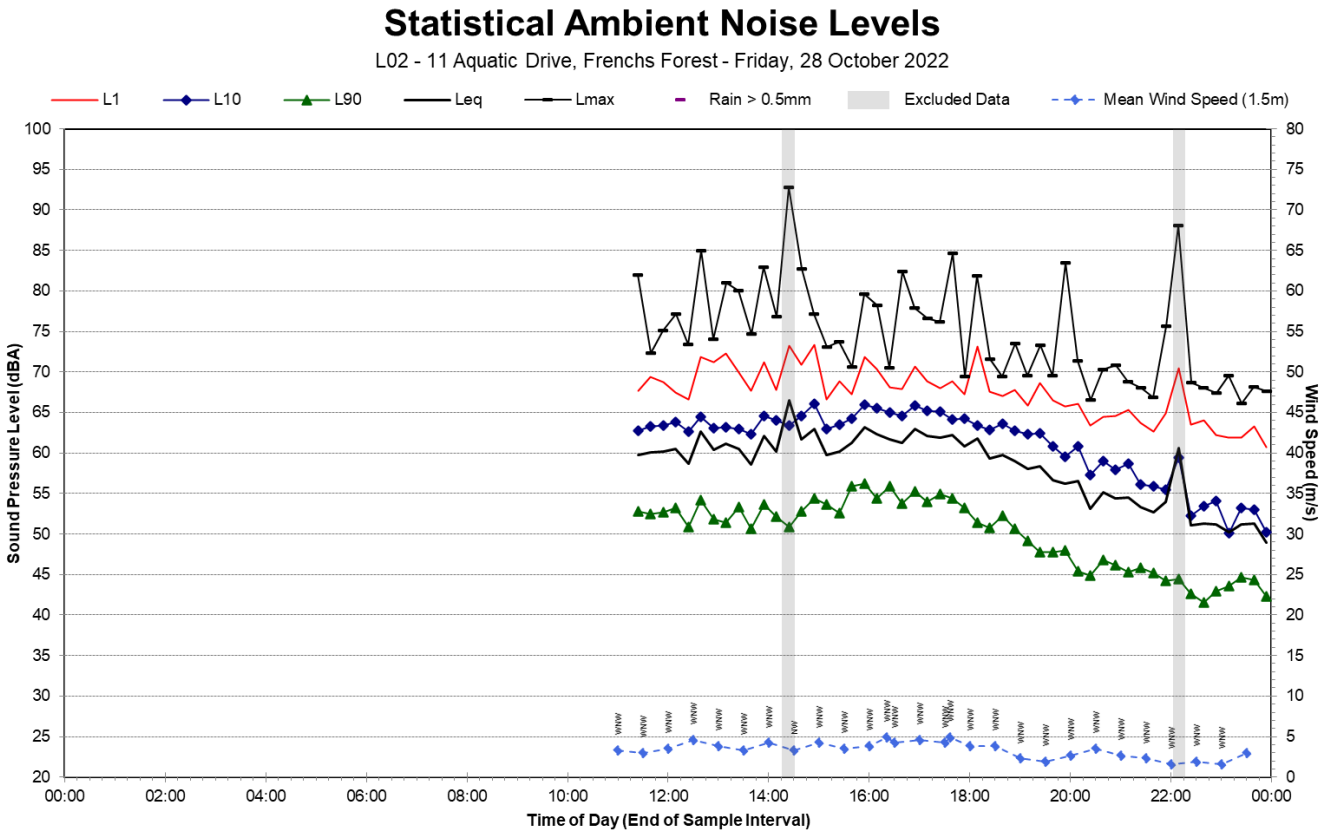
Ambient Noise Logging Results – RNP Defined Time Periods

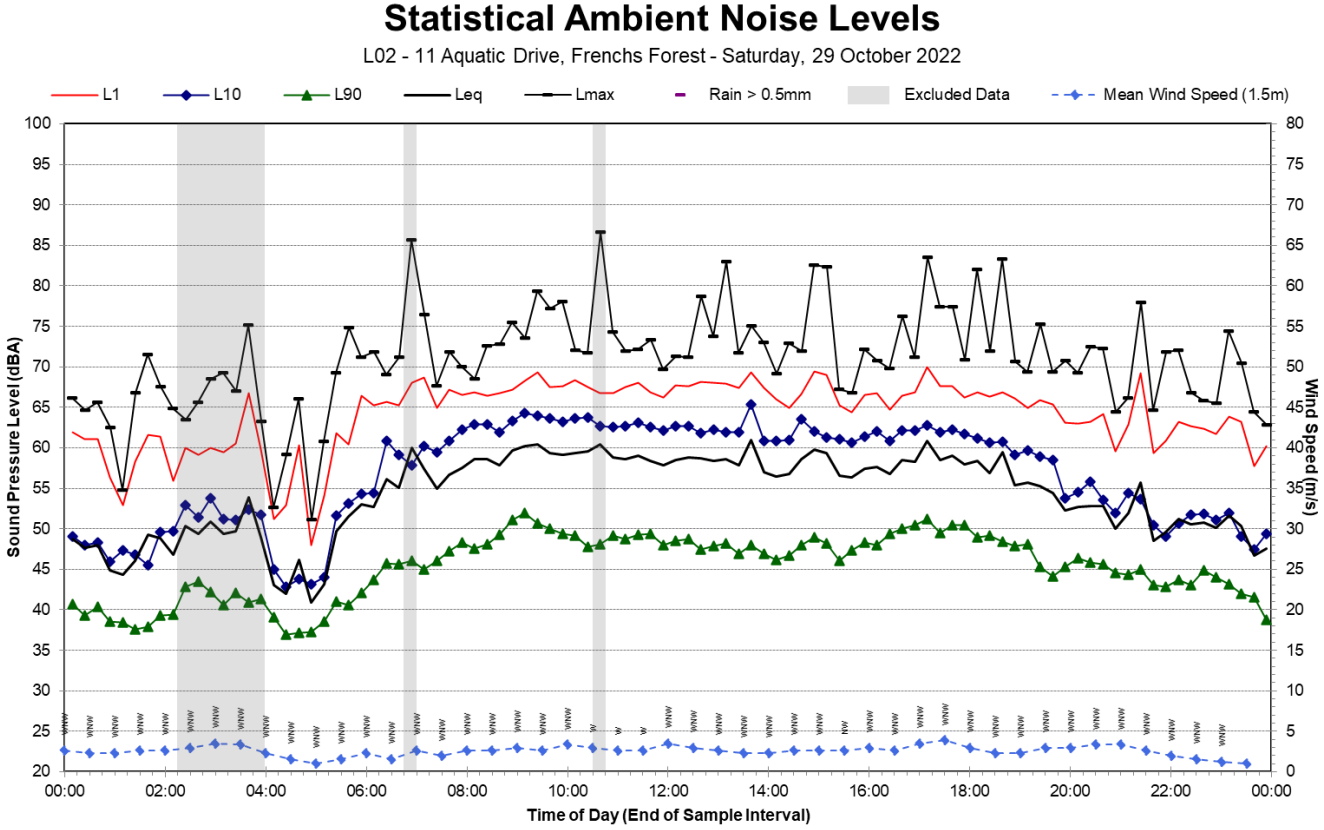
Monitoring Period	Noise Level (dBA)	
	LAeq(period)	LAeq(1hour)
Daytime (7am-10pm)	59	61
Night-time (10pm-7am)	53	57

Attended Noise Measurement Results

Date	Start Time	Measured Noise Level (dBA)		
		LA90	LAeq	LAmax
28/10/2022	11:01	53	60	72

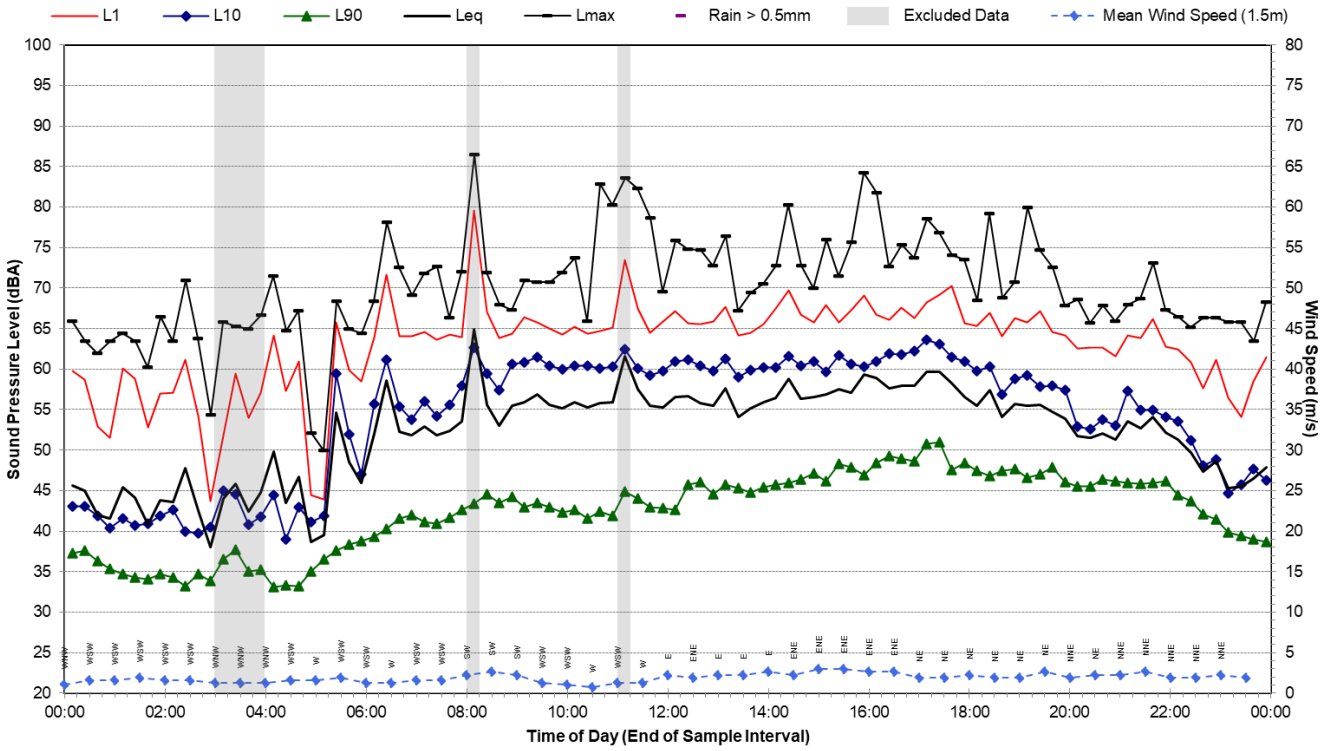
Photo of Noise Monitoring Location


Statistical Ambient Noise Levels
L02 - 11 Aquatic Drive, Frenchs Forest - Friday, 28 October 2022
L1
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
L02 - 11 Aquatic Drive, Frenchs Forest - Saturday, 29 October 2022
L1
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

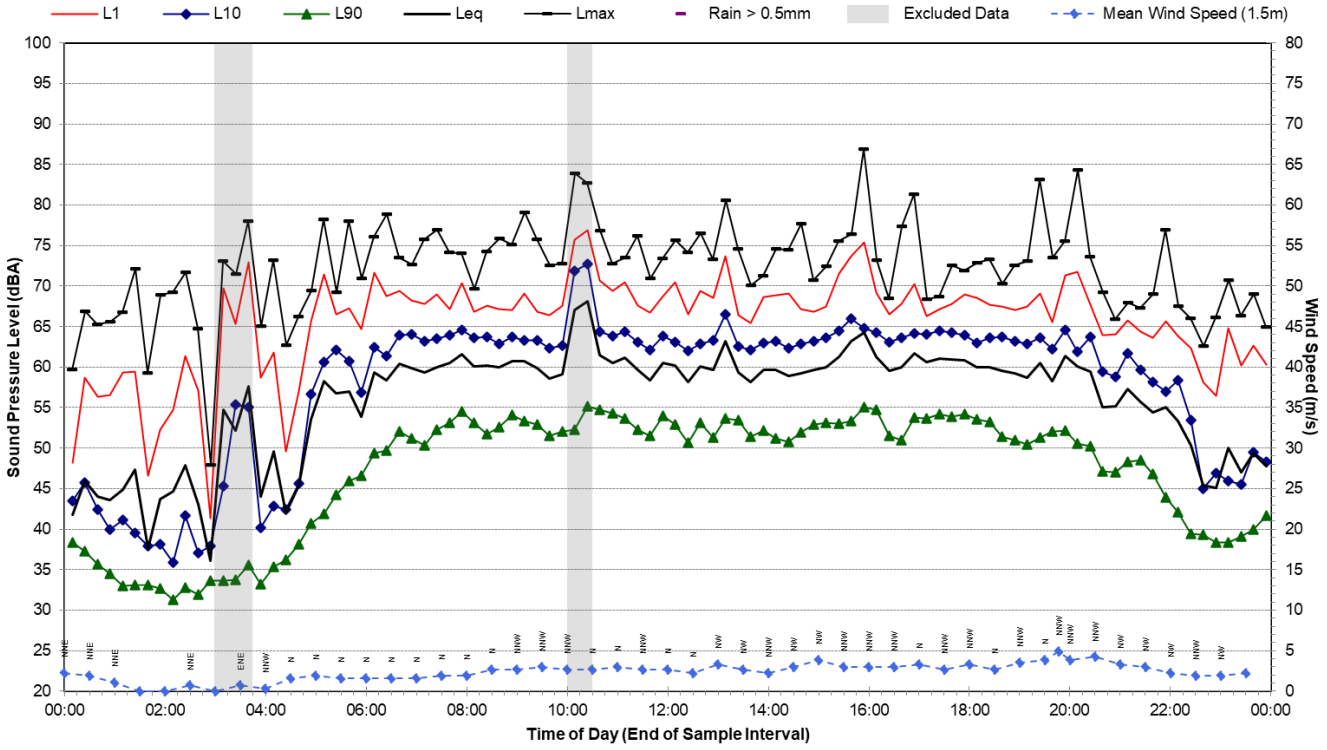
Statistical Ambient Noise Levels

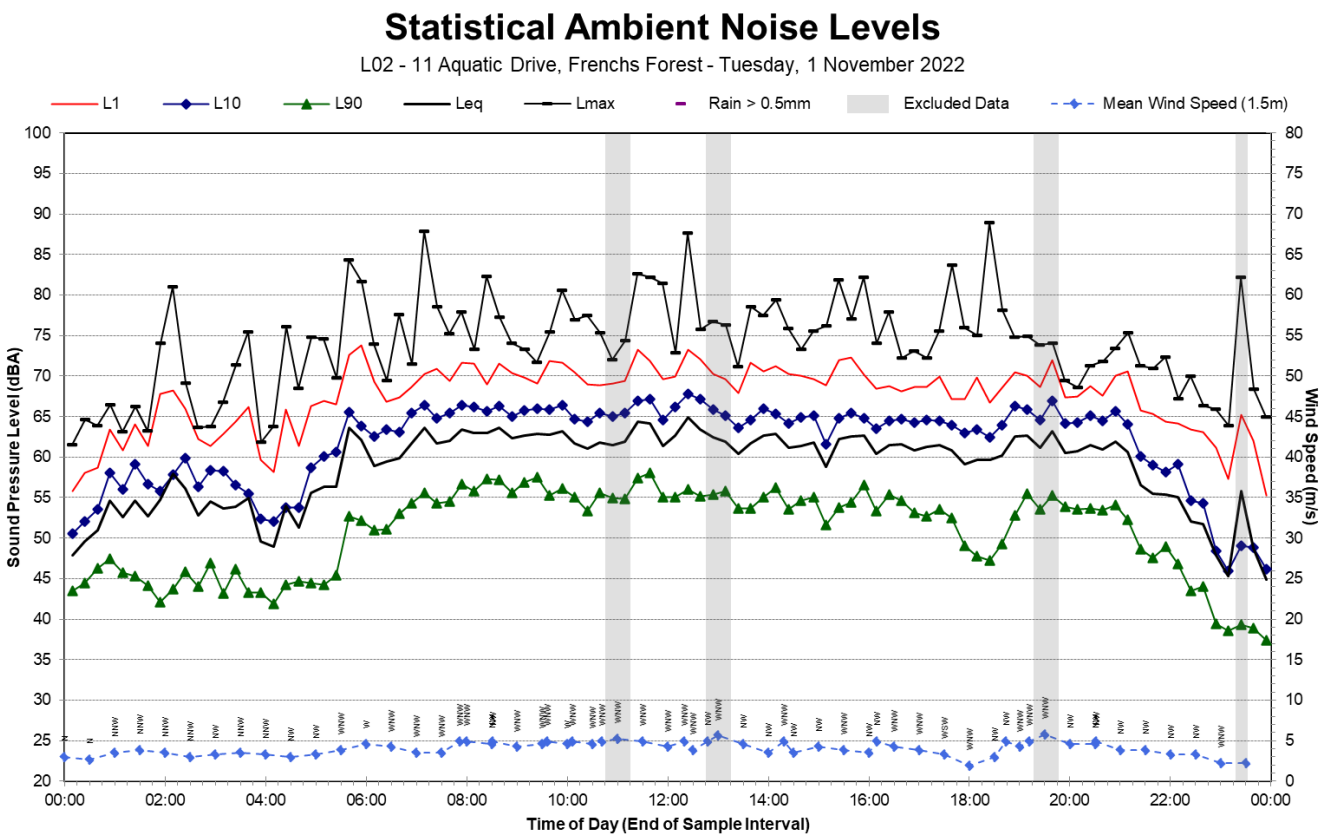
L02 - 11 Aquatic Drive, Frenchs Forest - Sunday, 30 October 2022

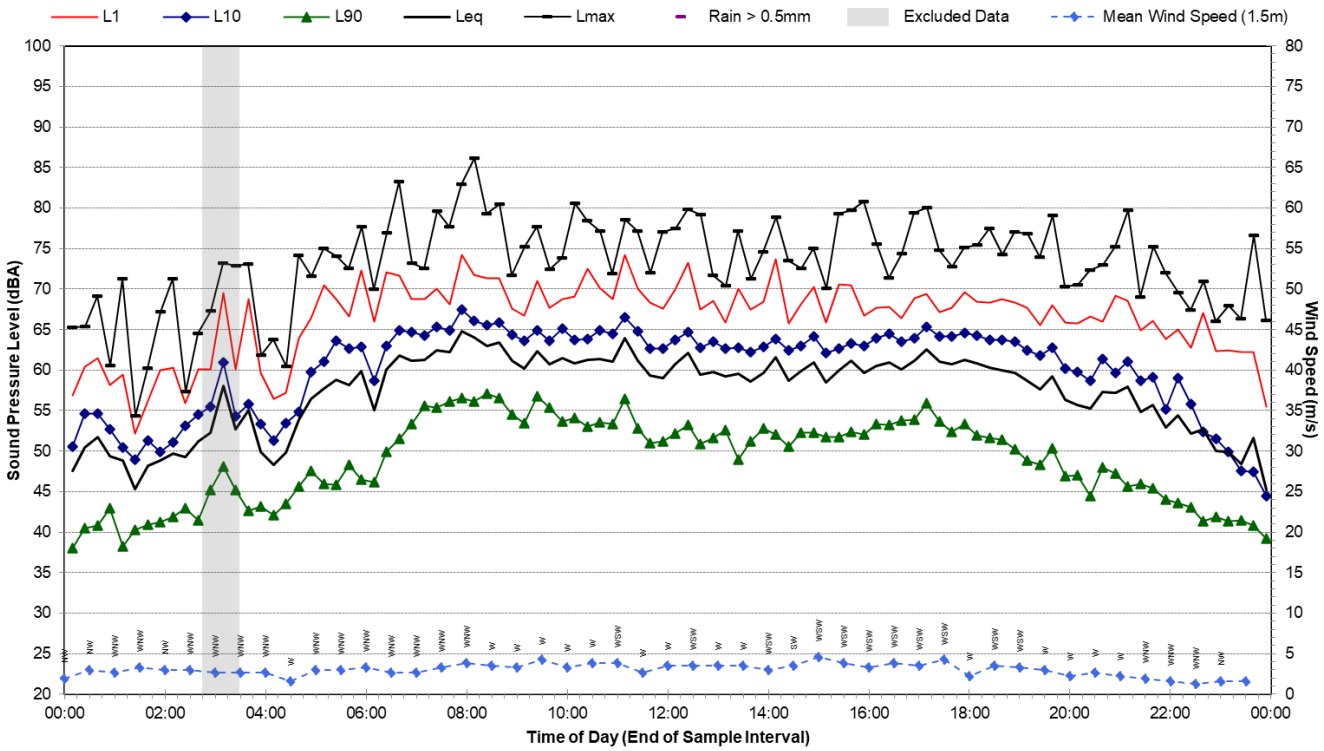


Statistical Ambient Noise Levels

L02 - 11 Aquatic Drive, Frenchs Forest - Monday, 31 October 2022

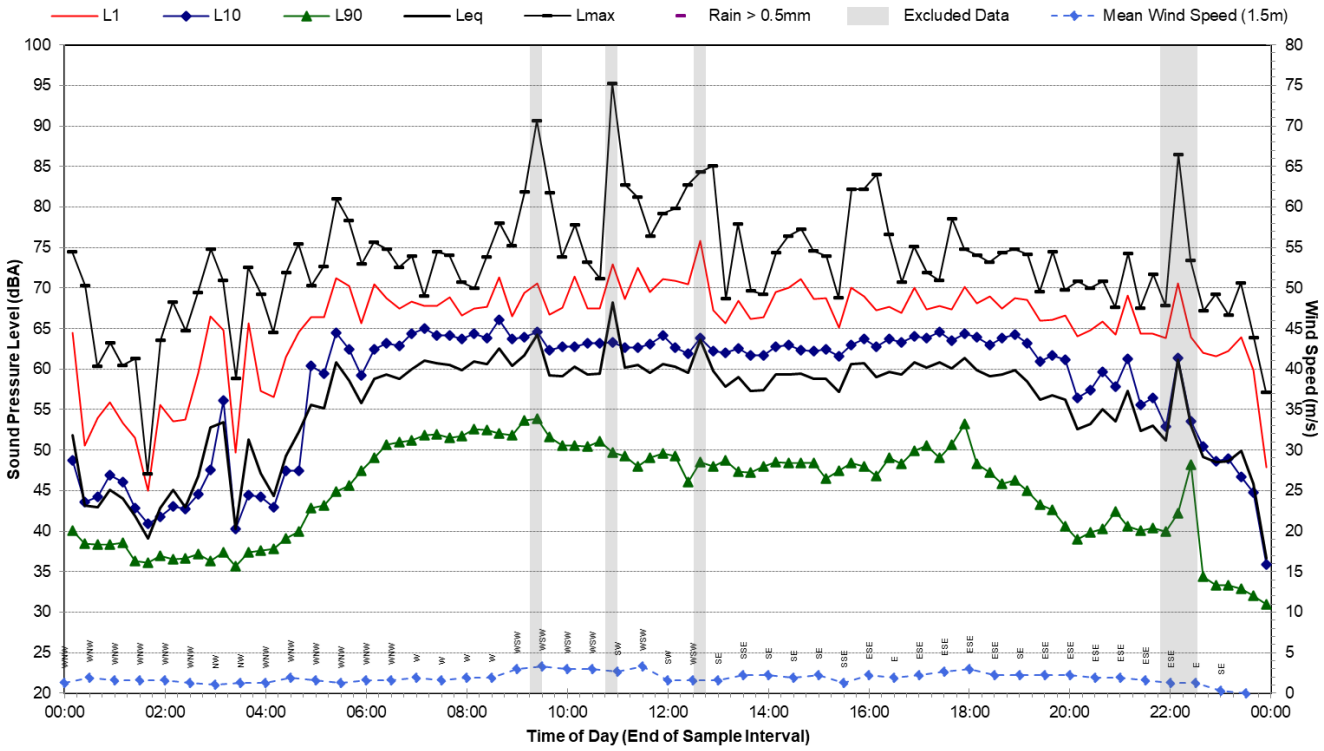



Statistical Ambient Noise Levels
L02 - 11 Aquatic Drive, Frenchs Forest - Tuesday, 1 November 2022
L1
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
L02 - 11 Aquatic Drive, Frenchs Forest - Wednesday, 2 November 2022
L1
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

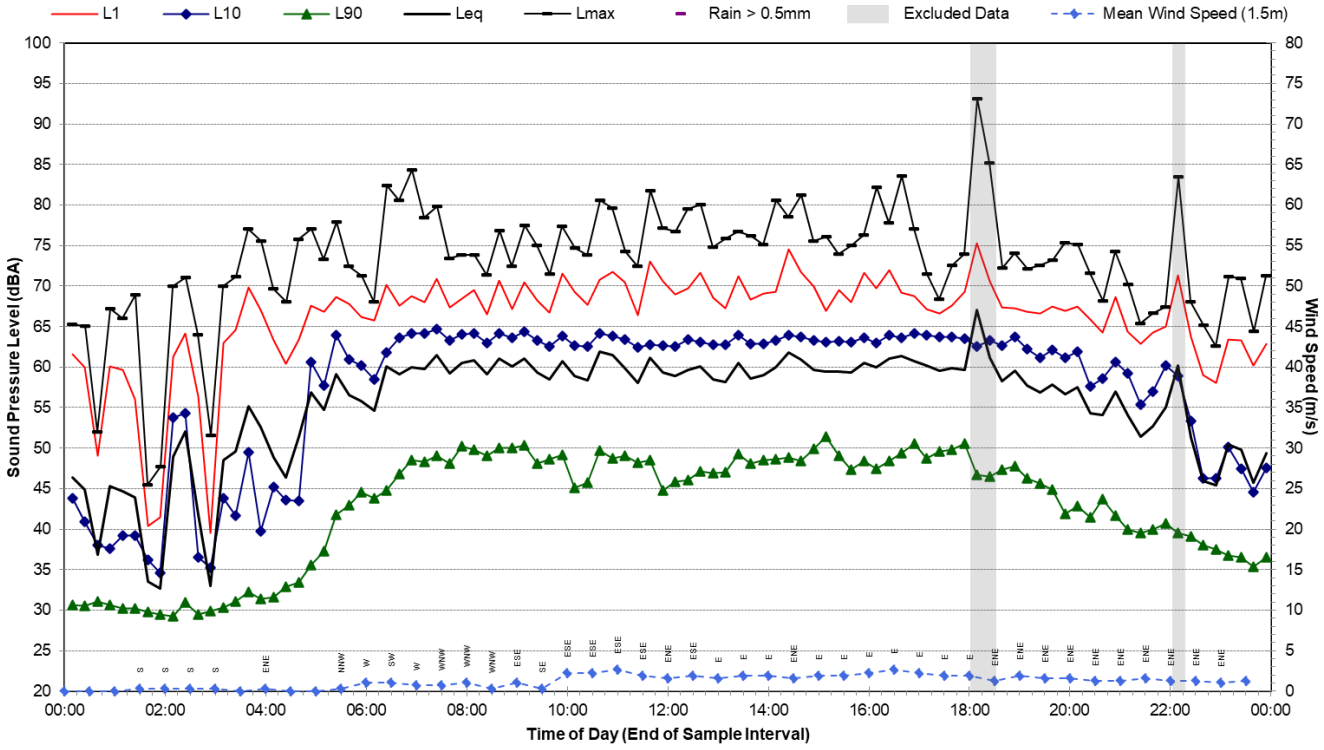
Statistical Ambient Noise Levels

L02 - 11 Aquatic Drive, Frenchs Forest - Thursday, 3 November 2022



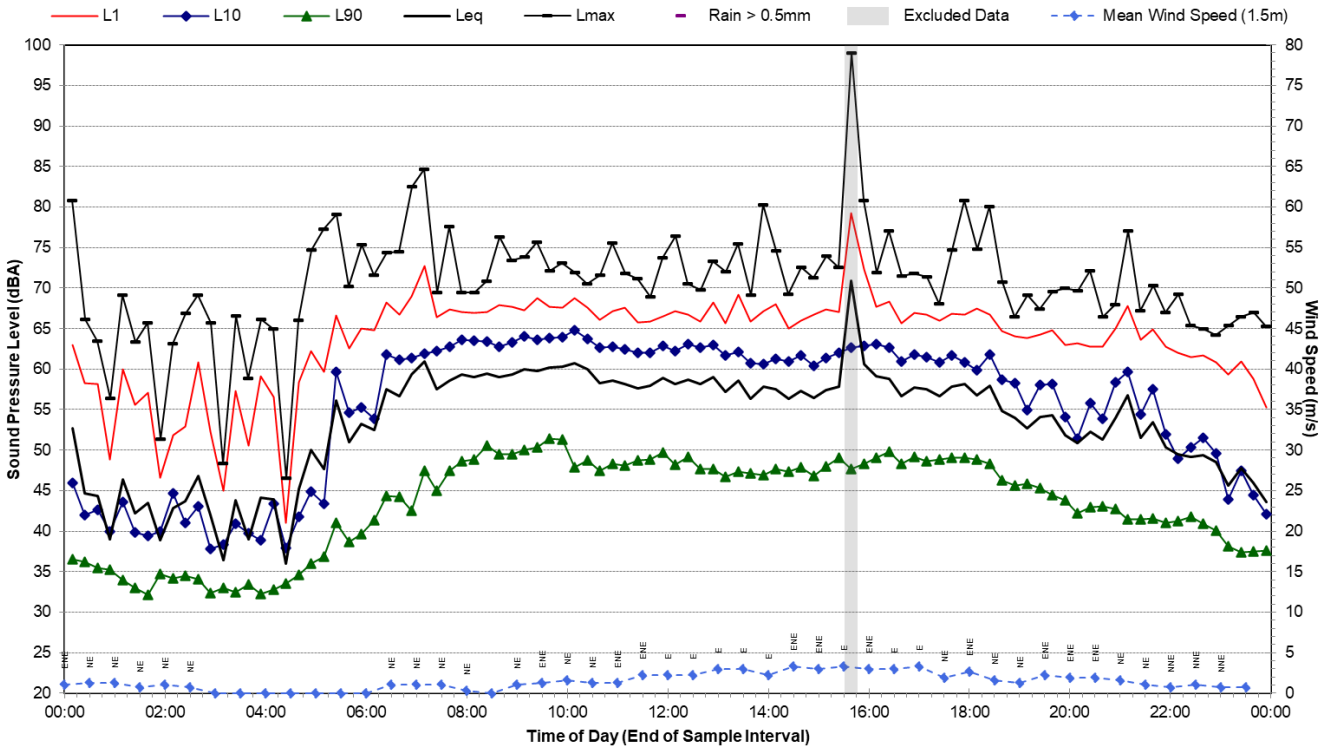
Statistical Ambient Noise Levels

L02 - 11 Aquatic Drive, Frenchs Forest - Friday, 4 November 2022



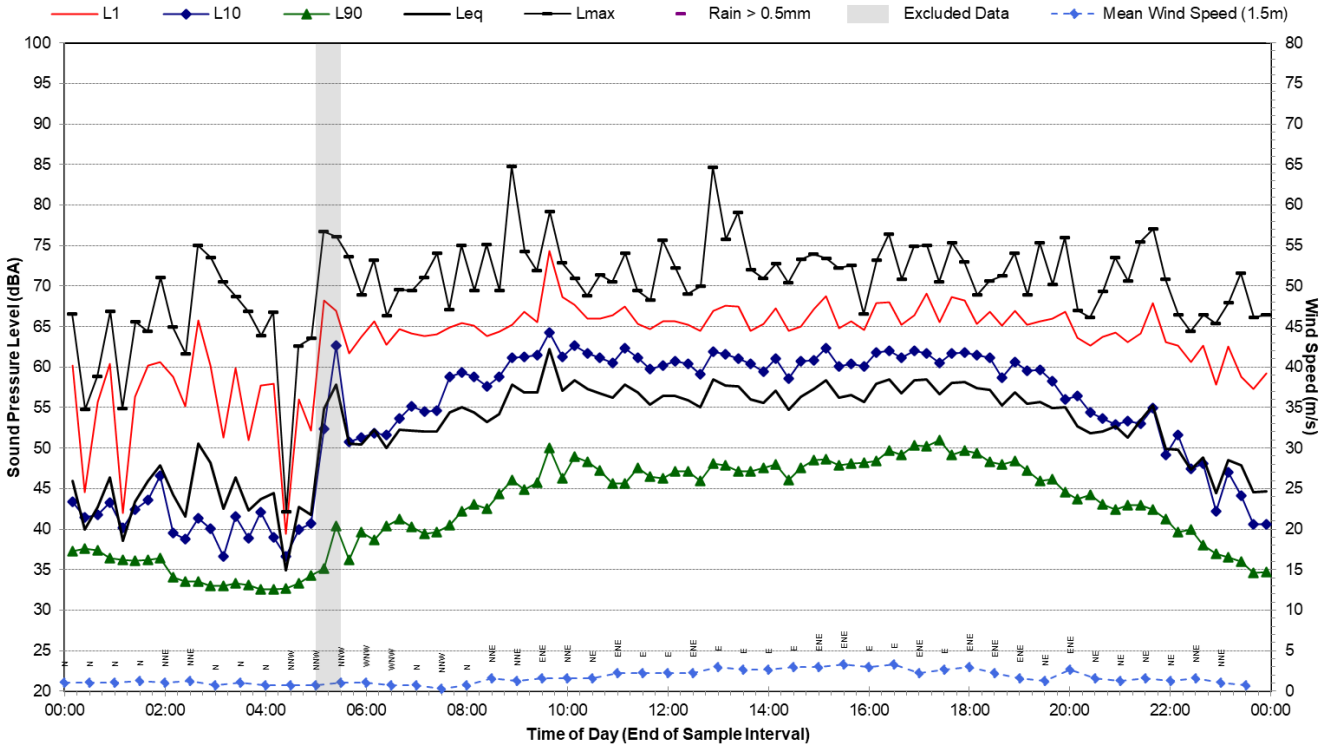
Statistical Ambient Noise Levels

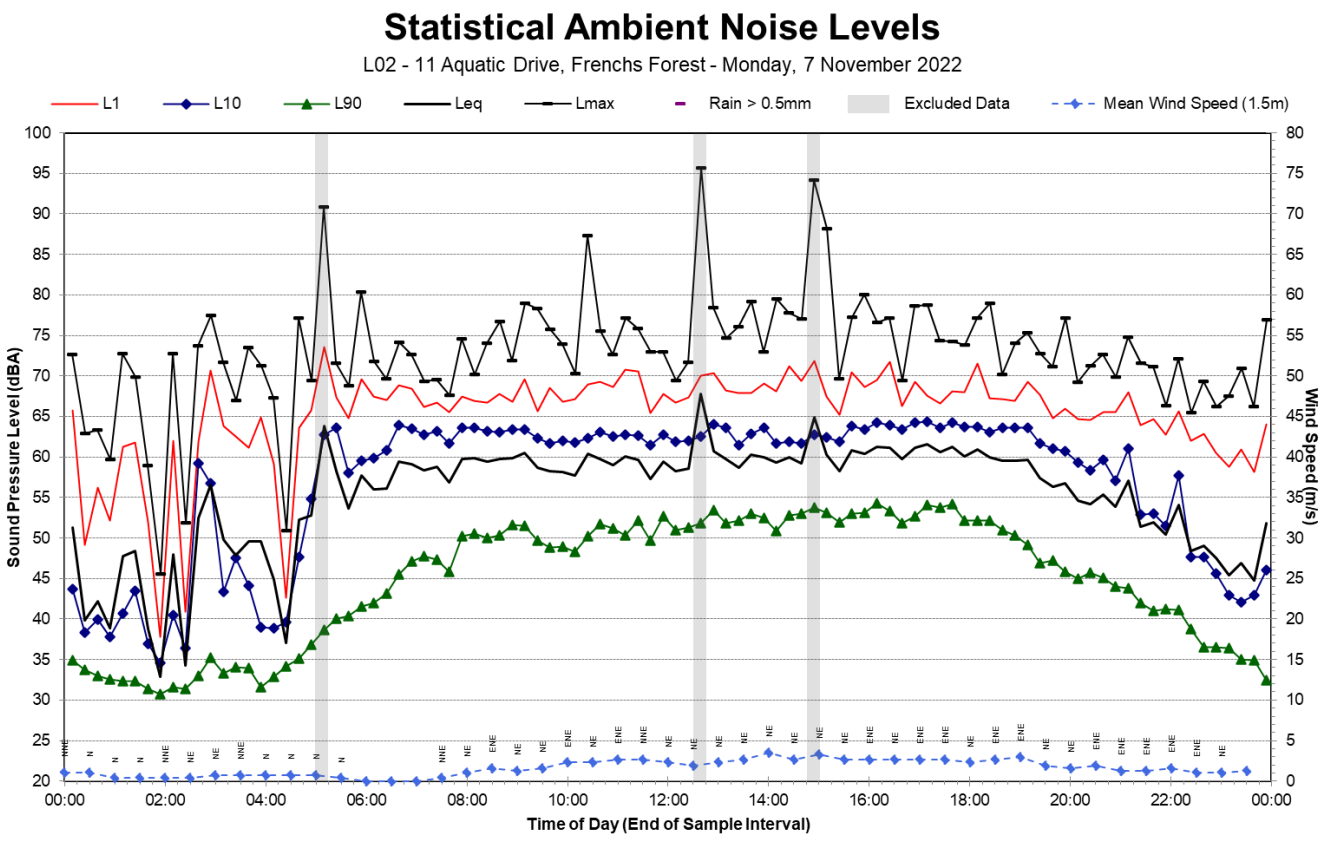
L02 - 11 Aquatic Drive, Frenchs Forest - Saturday, 5 November 2022

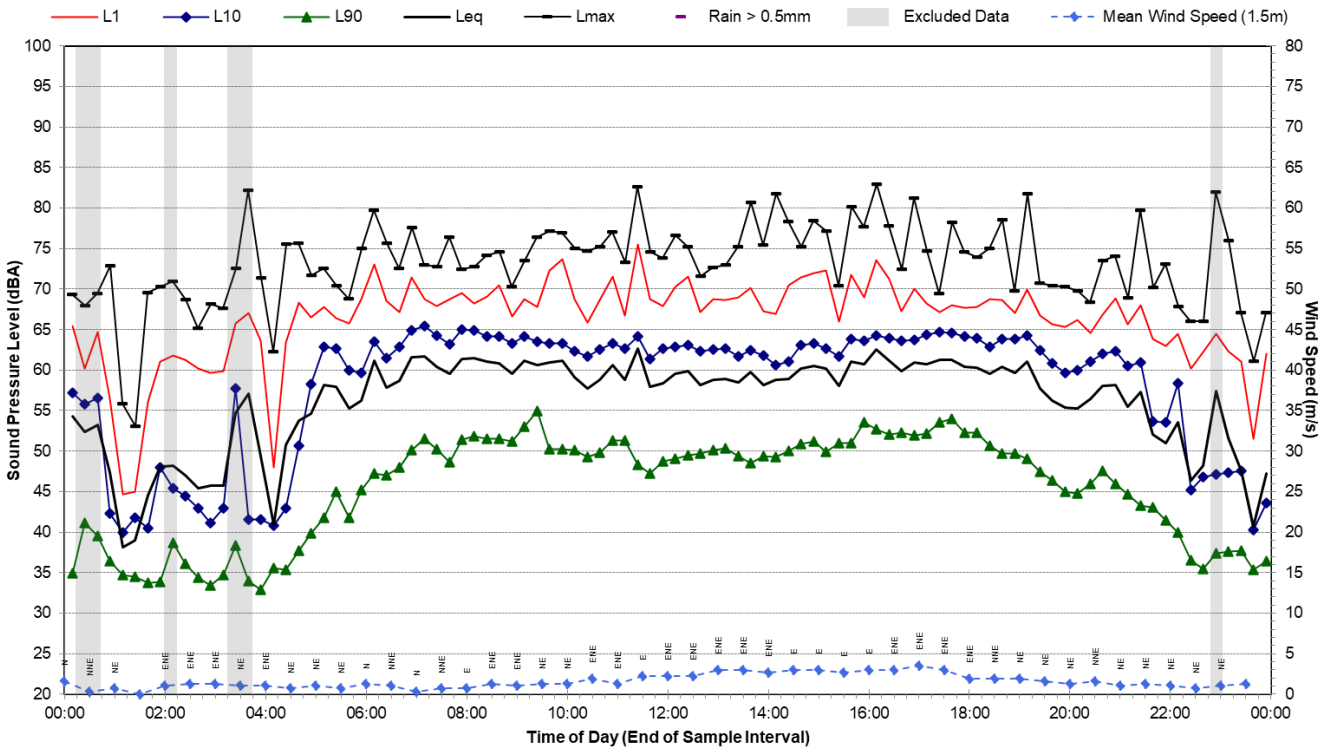


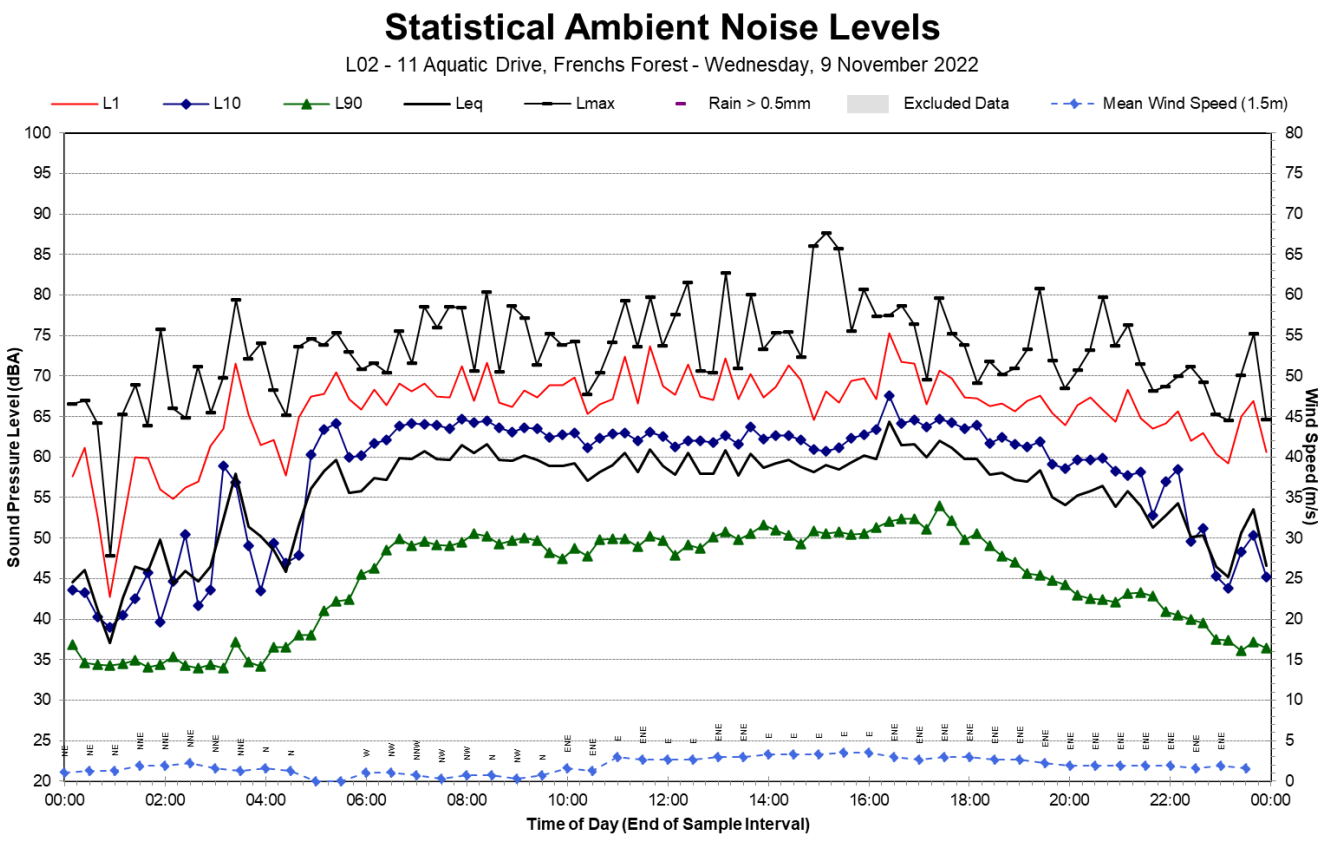
Statistical Ambient Noise Levels

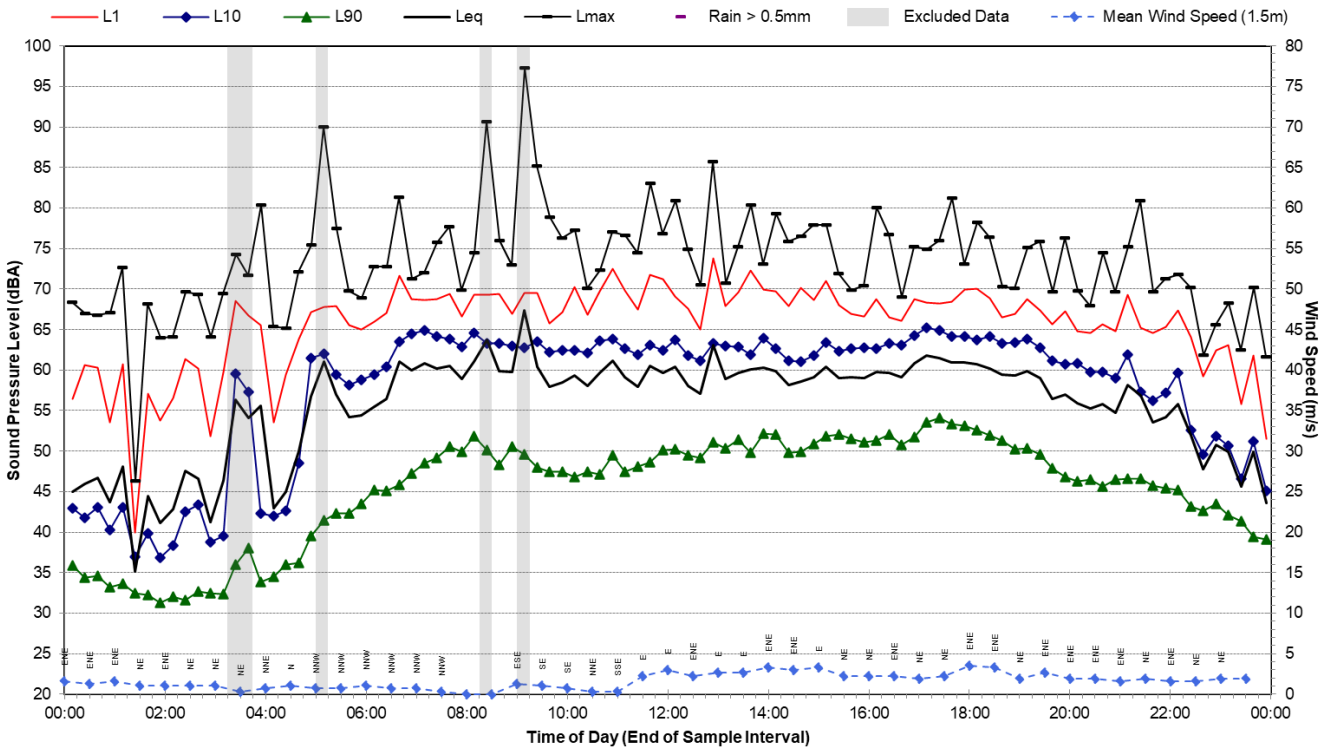
L02 - 11 Aquatic Drive, Frenchs Forest - Sunday, 6 November 2022




Statistical Ambient Noise Levels
L02 - 11 Aquatic Drive, Frenchs Forest - Monday, 7 November 2022
L1
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

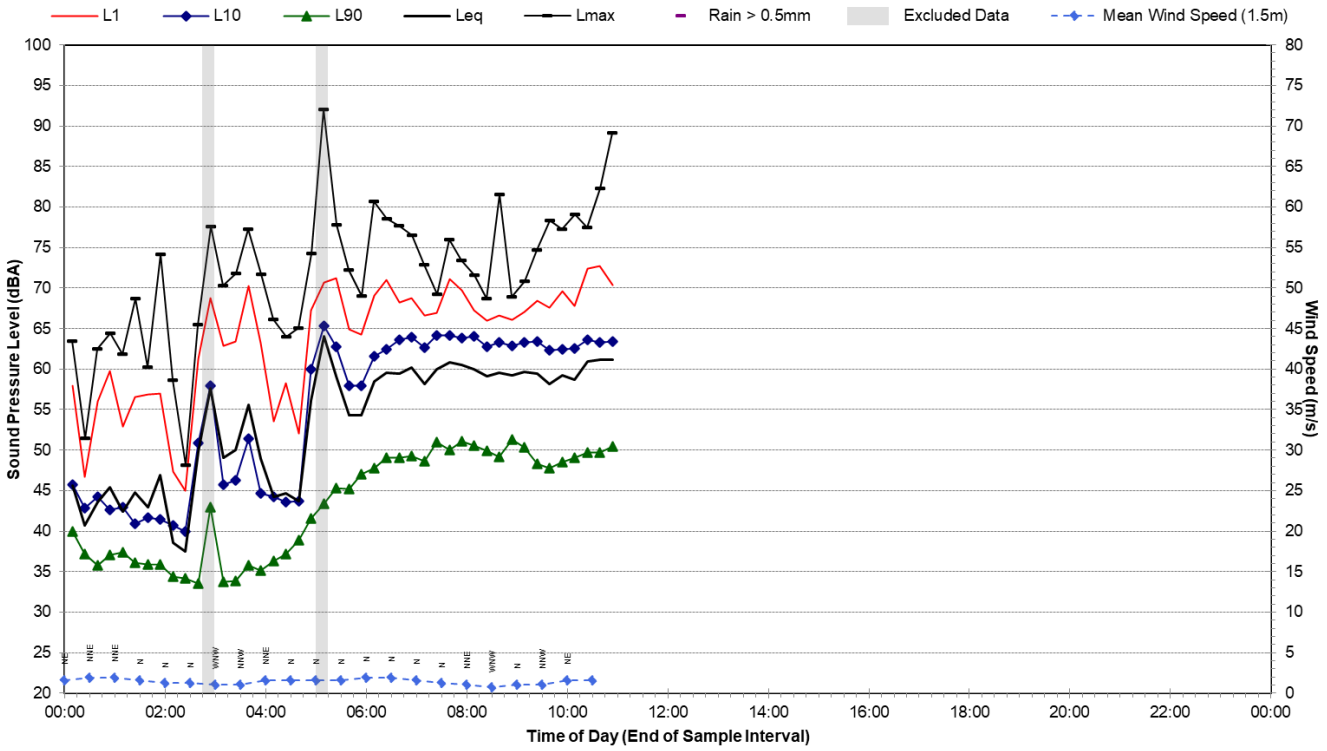

Statistical Ambient Noise Levels
L02 - 11 Aquatic Drive, Frenchs Forest - Tuesday, 8 November 2022
L1
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
L02 - 11 Aquatic Drive, Frenchs Forest - Wednesday, 9 November 2022
L1
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
L02 - 11 Aquatic Drive, Frenchs Forest - Thursday, 10 November 2022
L1
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

Statistical Ambient Noise Levels

L02 - 11 Aquatic Drive, Frenchs Forest - Friday, 11 November 2022



Noise Monitoring Location	L.03	Map of Noise Monitoring Location
Noise Monitoring Address	**18 Bimbadeen Crescent, Frenchs Forest**	

Logger Device Type: Brüel and Kjær 2250L, Logger Serial No: 3004636
Sound Level Meter Device Type: Brüel and Kjær 2270, Sound Level Meter Serial No: 3029485

Ambient noise logger deployed at the residential address 18 Bimbadeen Crescent, Frenchs Forest. Logger located on the with view of Bimbadeen Crescent to the south.

Attended noise measurements indicate the ambient noise environment at this location is dominated by noise from vehicles on Bimbadeen Crescent and local flora and fauna. Road traffic noise from Frenchs Forest Road East and noise from mechanical plant associated with commercial developments south of Frenchs Forest Road East also influence the background noise at this location.

Recorded Noise Levels (LAmax):
20/10/2022: Light-vehicles on Bimbadeen Crescent: 63- dBA, Traffic on Frenchs Forest Road East and commercial operations: 45-48 dBA, Birds: 68 dBA

Ambient Noise Logging Results – ICNG Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	LAeq	L10	L1
Daytime	39	49	50	57
Evening	35	46	47	54
Night-time	24	42	38	45

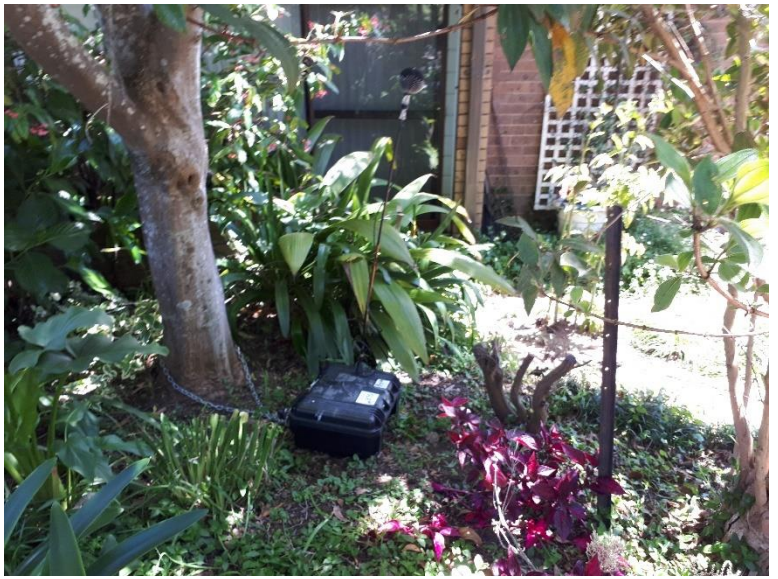
Ambient Noise Logging Results – RNP Defined Time Periods

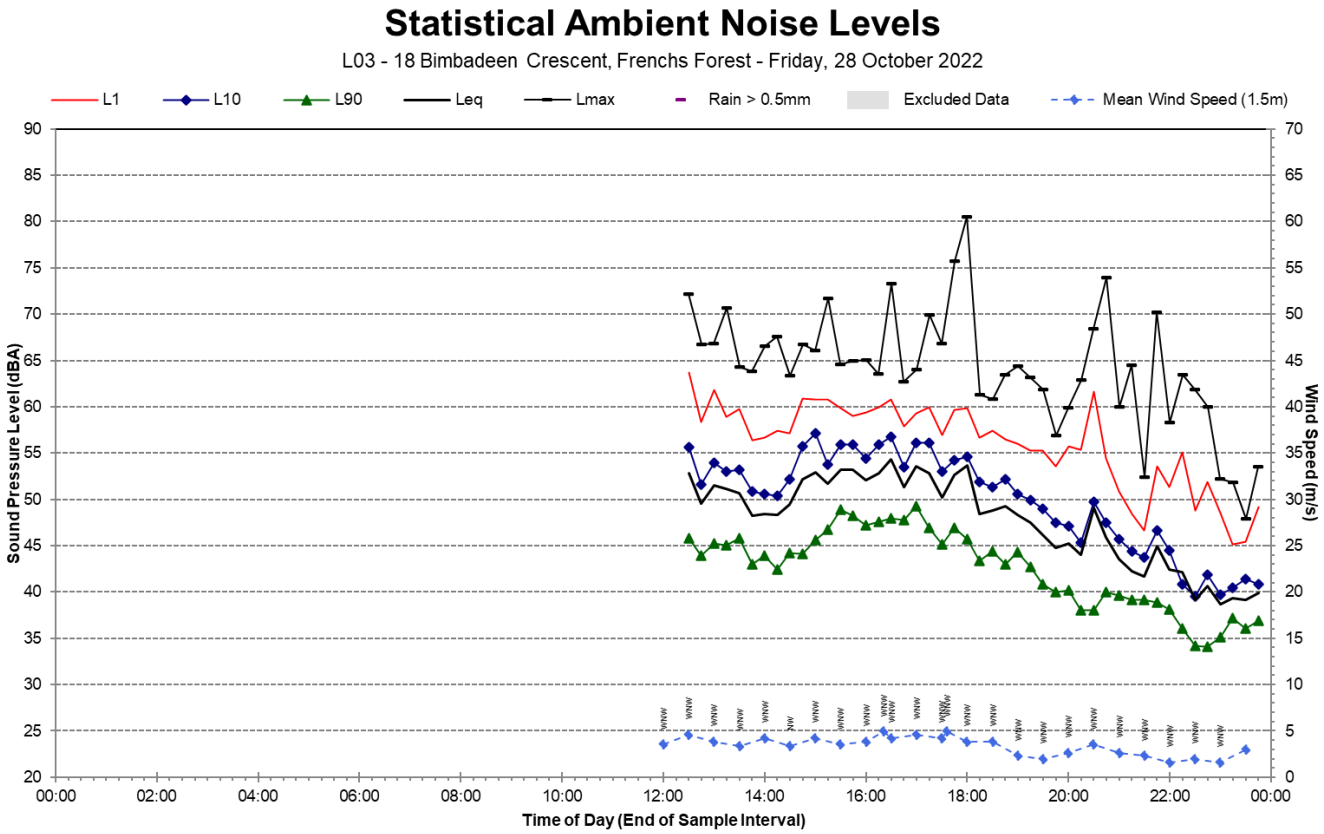
Monitoring Period	Noise Level (dBA)	
	LAeq(period)	LAeq(1hour)
Daytime (7am-10pm)	49	50
Night-time (10pm-7am)	43	46

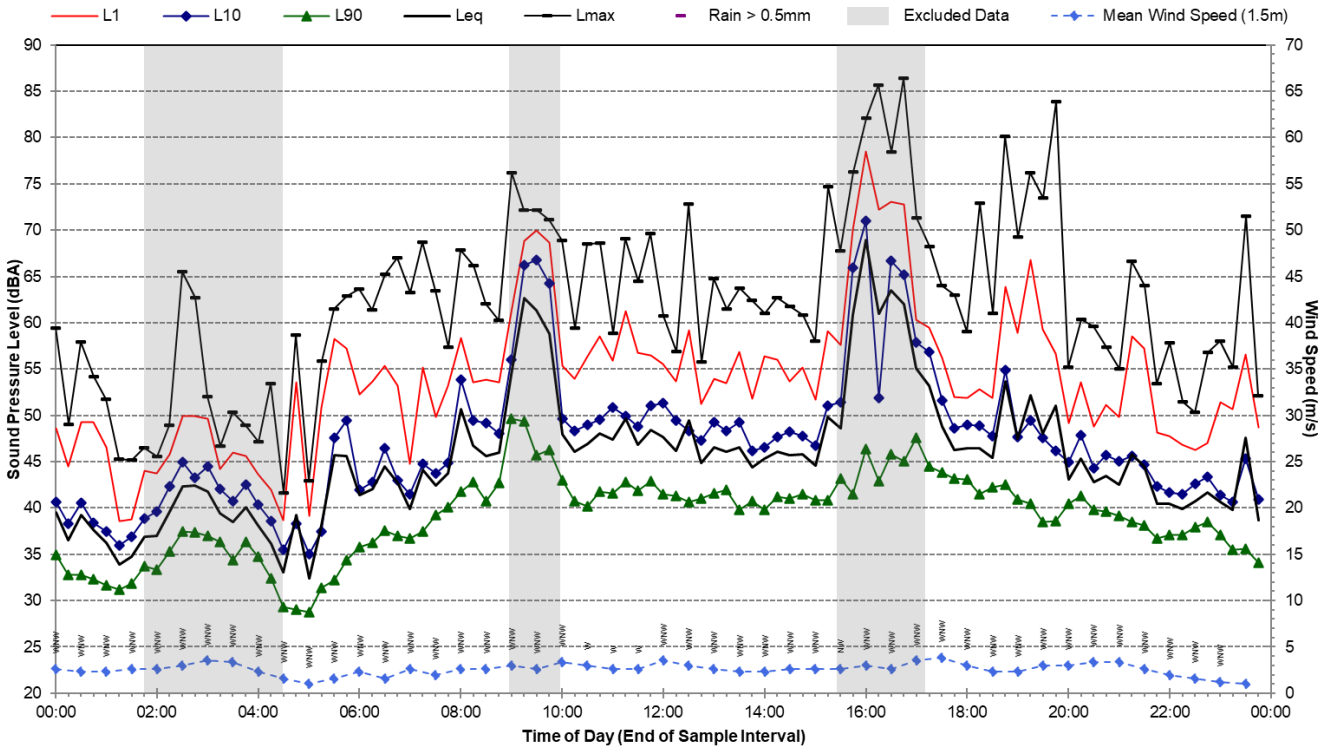
Attended Noise Measurement Results

Date	Start Time	Measured Noise Level (dBA)		
		LA90	LAeq	LAmax
28/10/2022	10:43	48	54	68

Photo of Noise Monitoring Location

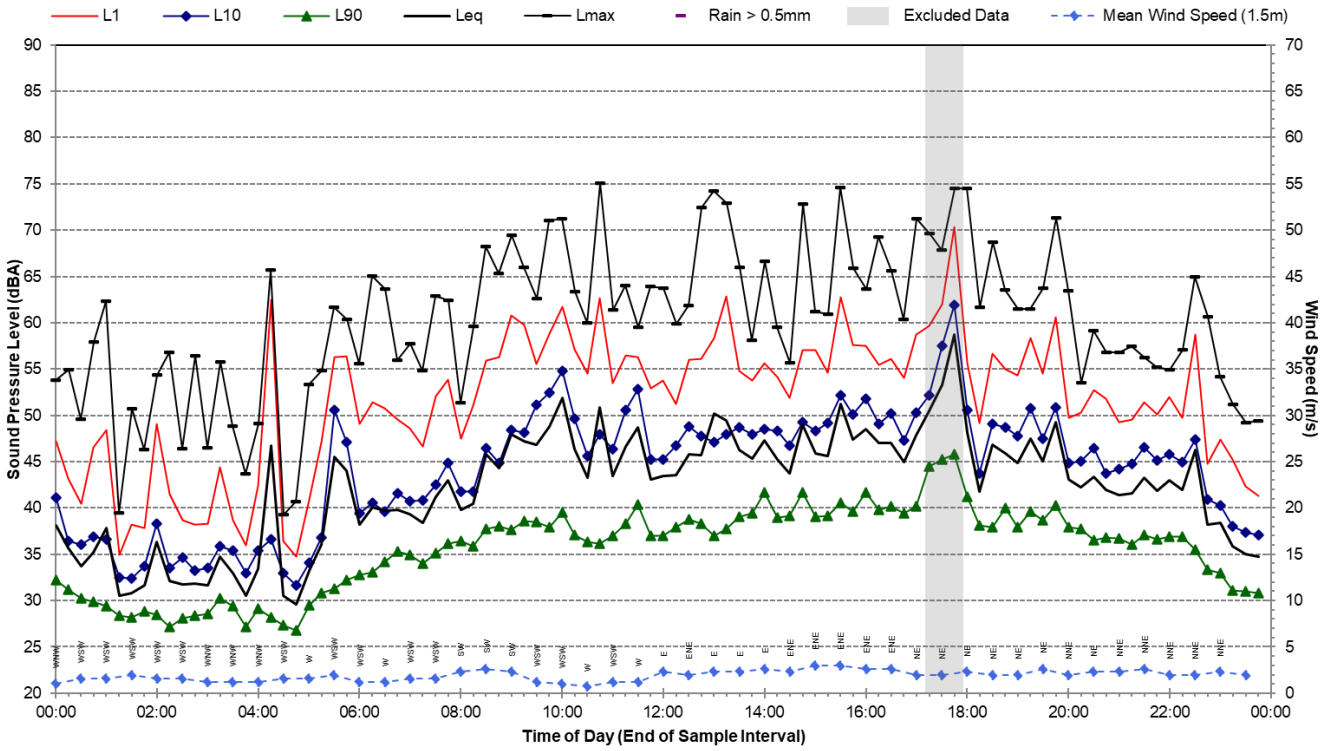



Statistical Ambient Noise Levels
L03 - 18 Bimbadeen Crescent, Frenchs Forest - Friday, 28 October 2022
L1
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
L03 - 18 Bimbadeen Crescent, Frenchs Forest - Saturday, 29 October 2022
L1
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

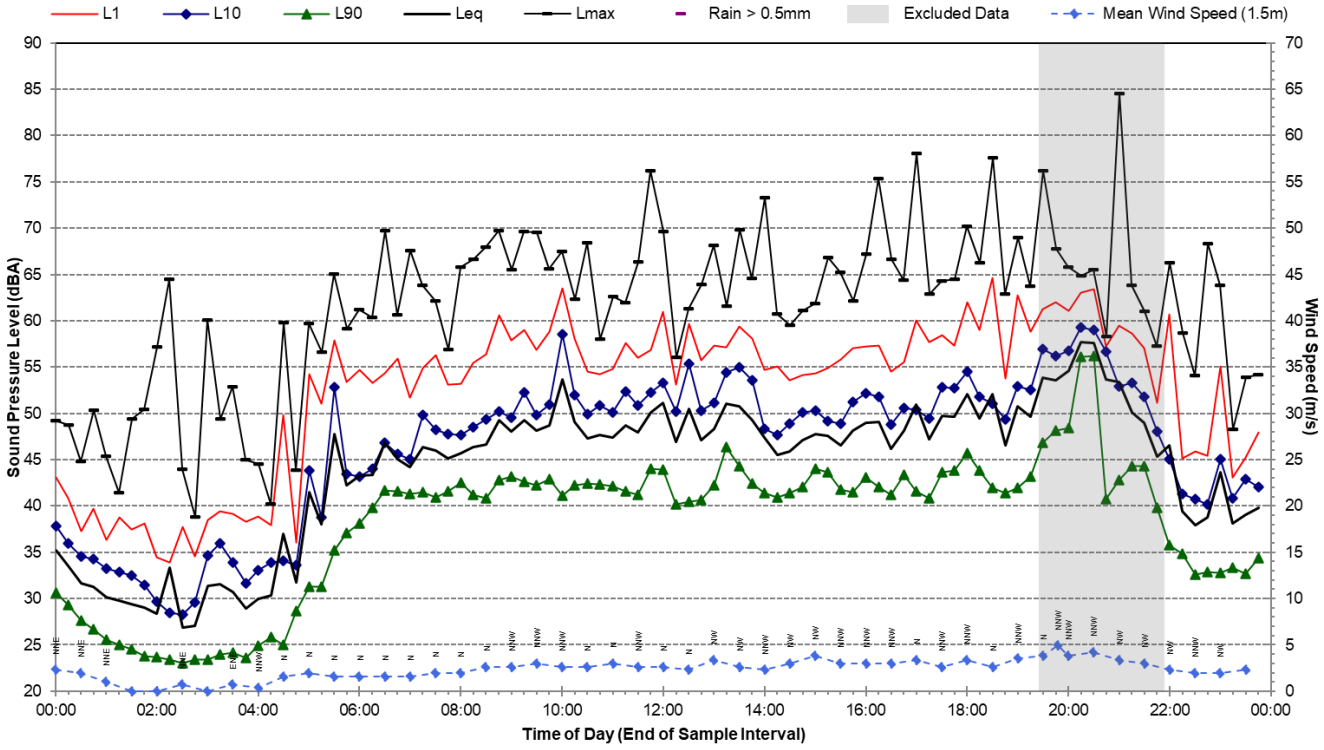
Statistical Ambient Noise Levels

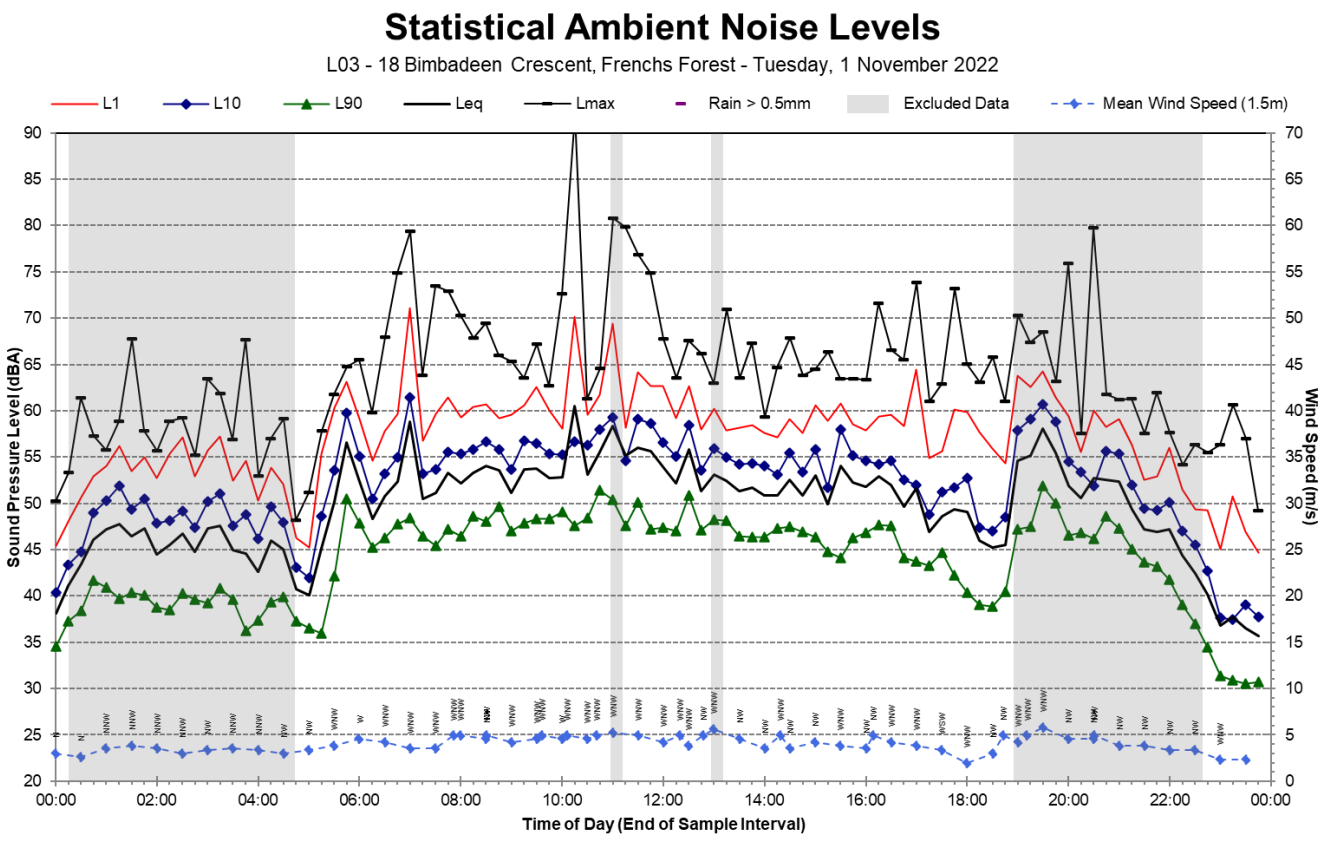
L03 - 18 Bimbadeen Crescent, Frenchs Forest - Sunday, 30 October 2022

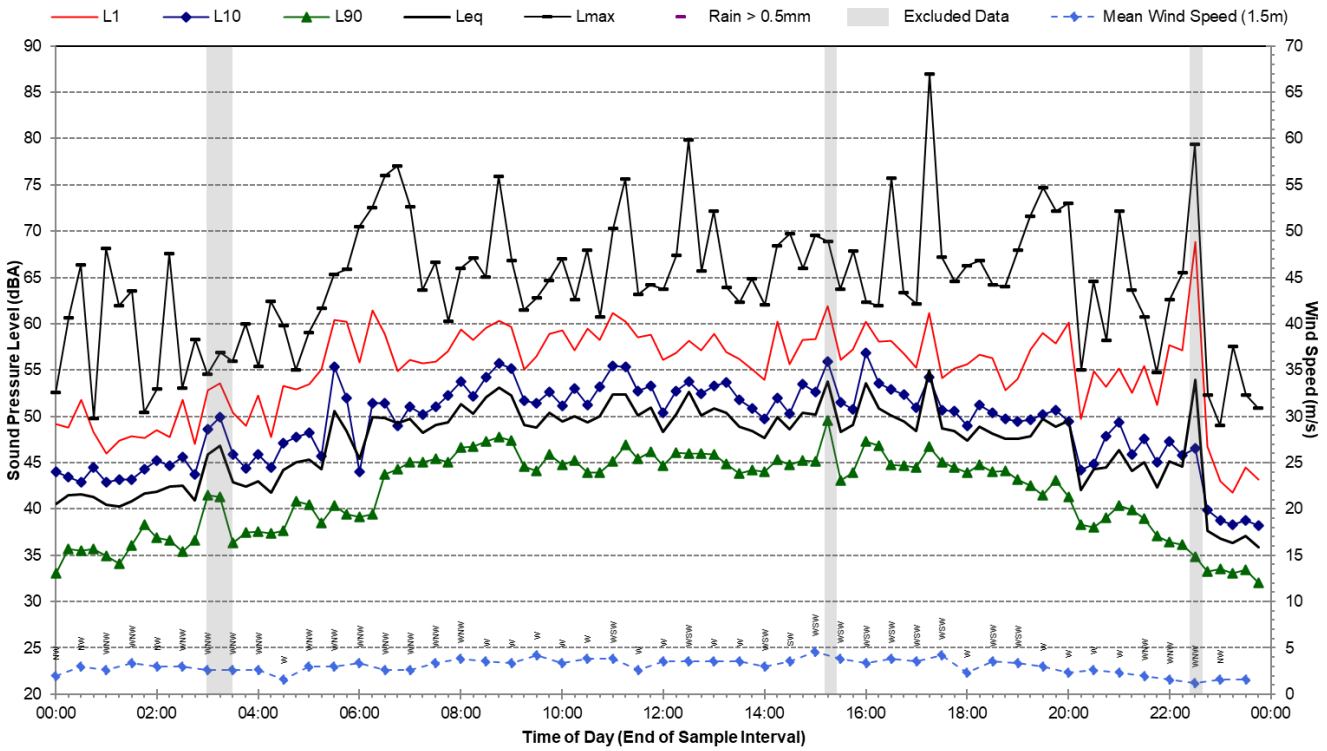


Statistical Ambient Noise Levels

L03 - 18 Bimbadeen Crescent, Frenchs Forest - Monday, 31 October 2022

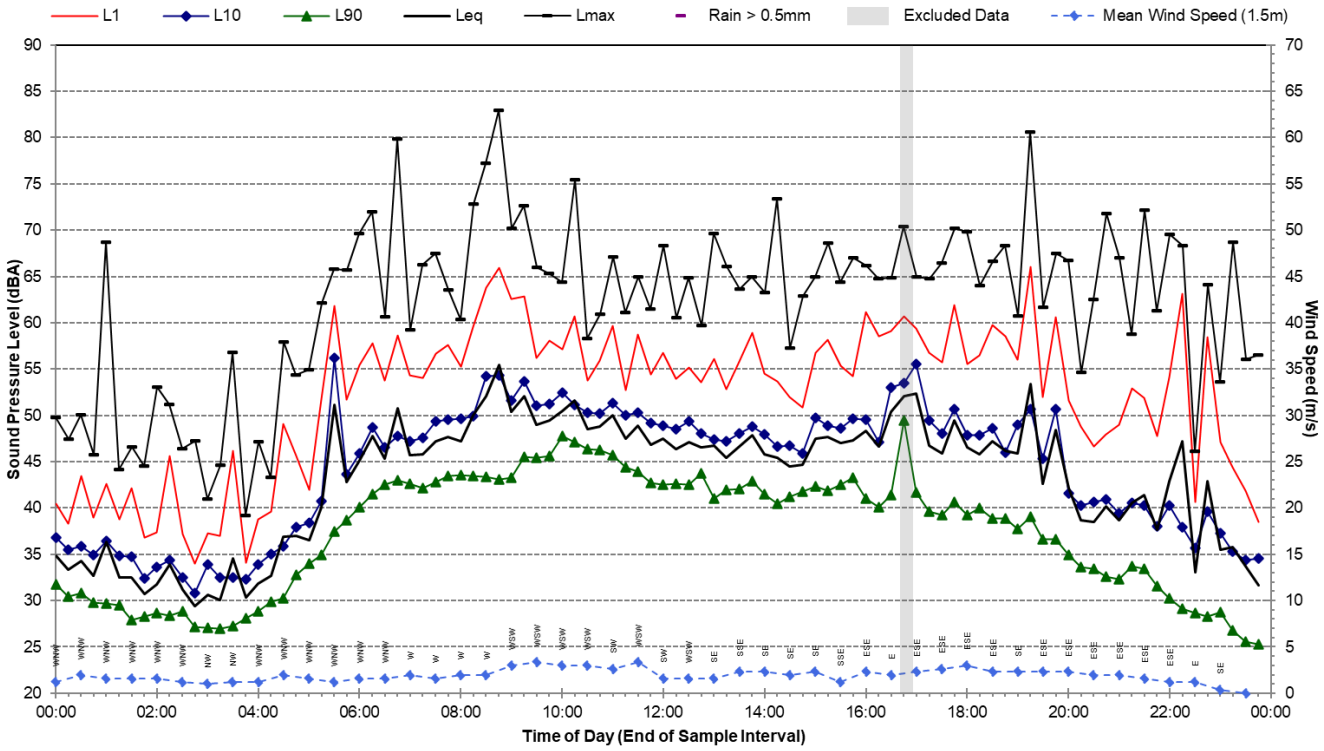



Statistical Ambient Noise Levels
L03 - 18 Bimbadeen Crescent, Frenchs Forest - Tuesday, 1 November 2022
L1
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
L03 - 18 Bimbadeen Crescent, Frenchs Forest - Wednesday, 2 November 2022
L1
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

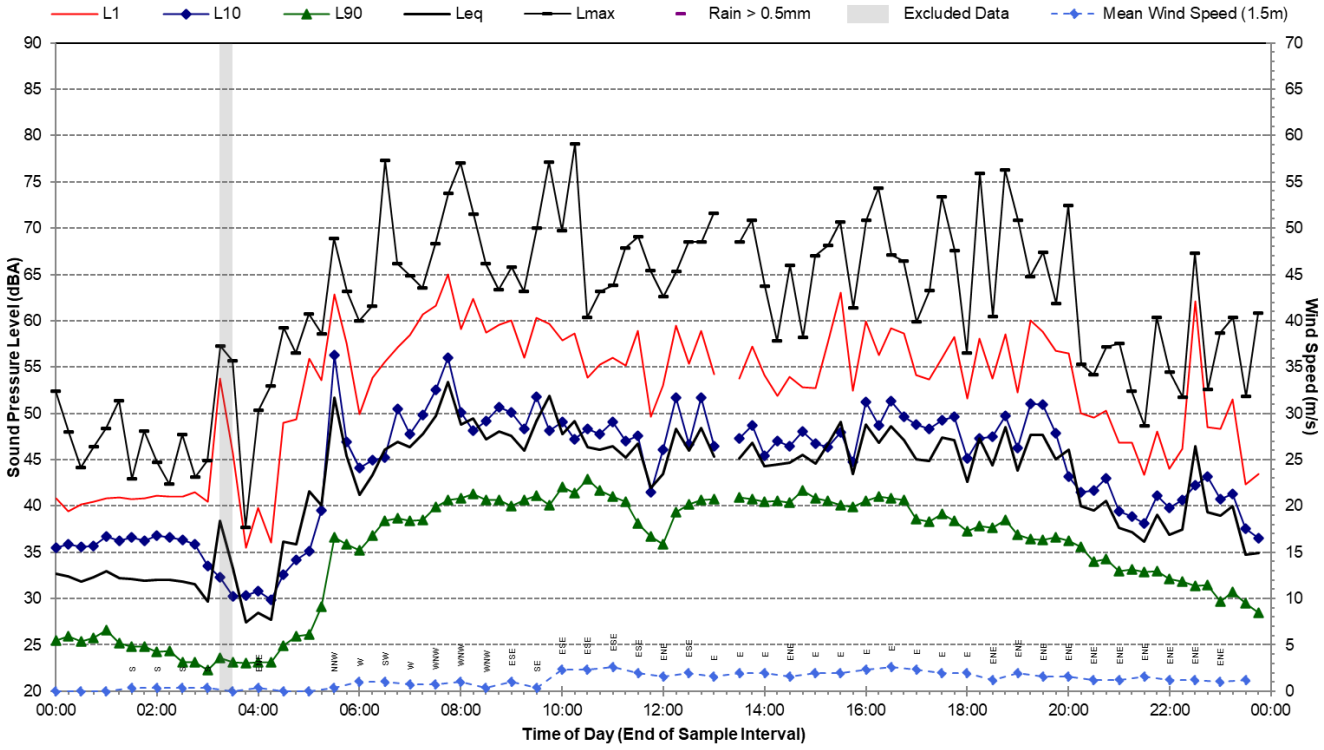
Statistical Ambient Noise Levels

L03 - 18 Bimbadeen Crescent, Frenchs Forest - Thursday, 3 November 2022



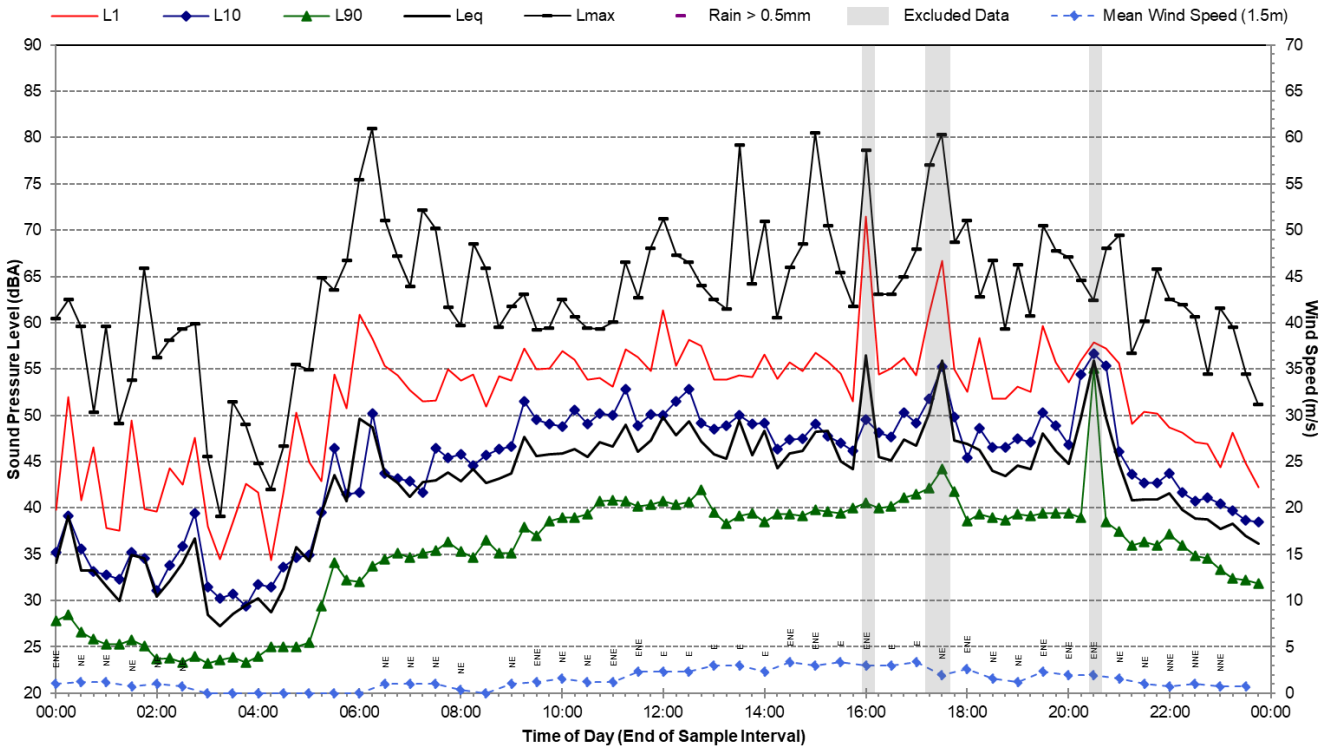
Statistical Ambient Noise Levels

L03 - 18 Bimbadeen Crescent, Frenchs Forest - Friday, 4 November 2022



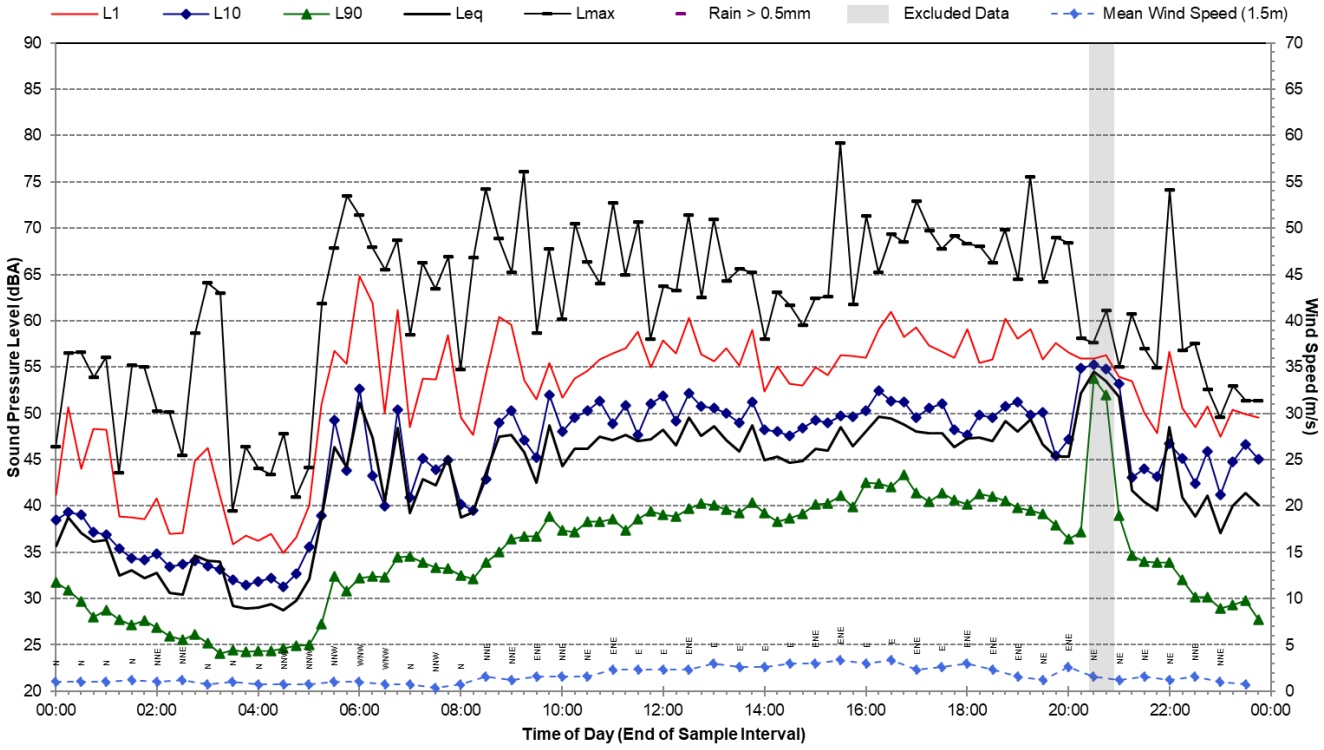
Statistical Ambient Noise Levels

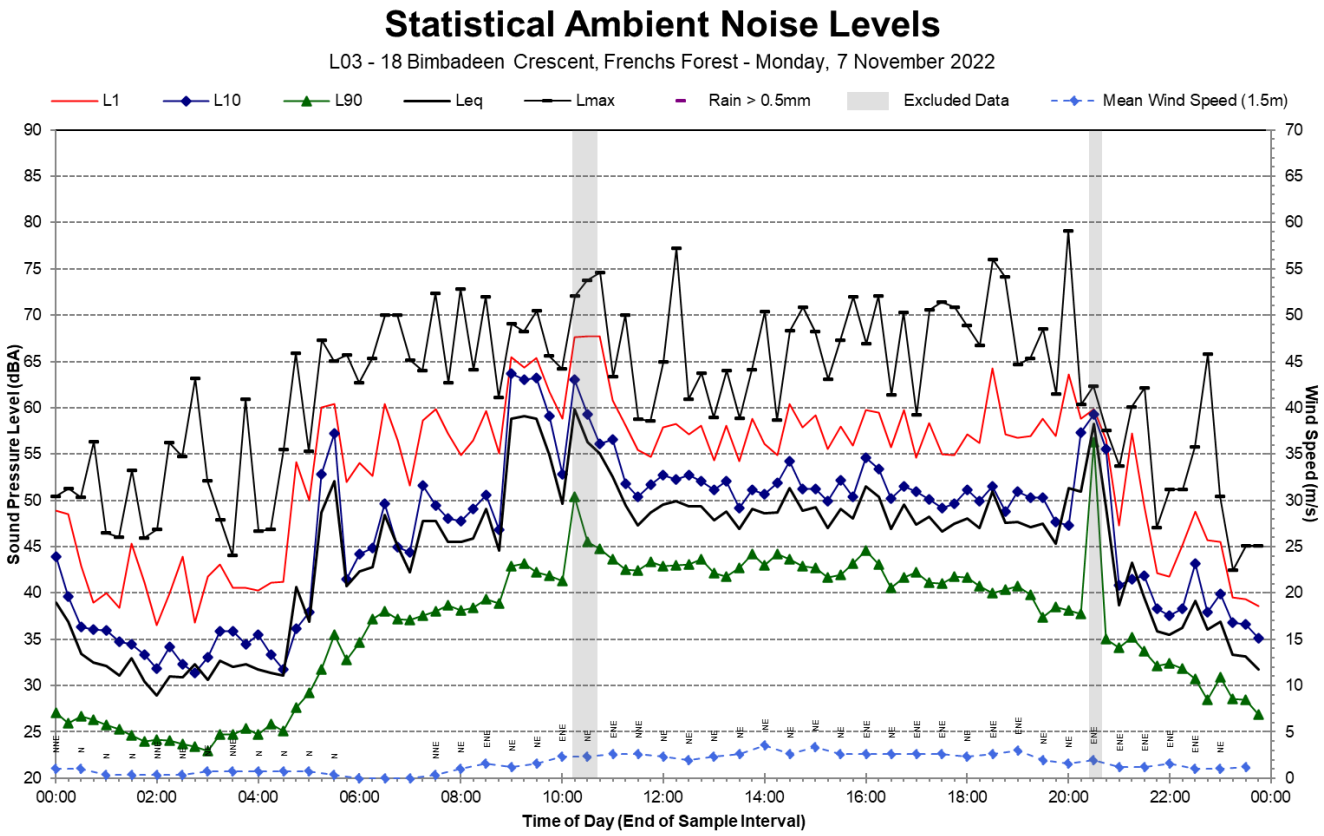
L03 - 18 Bimbadeen Crescent, Frenchs Forest - Saturday, 5 November 2022

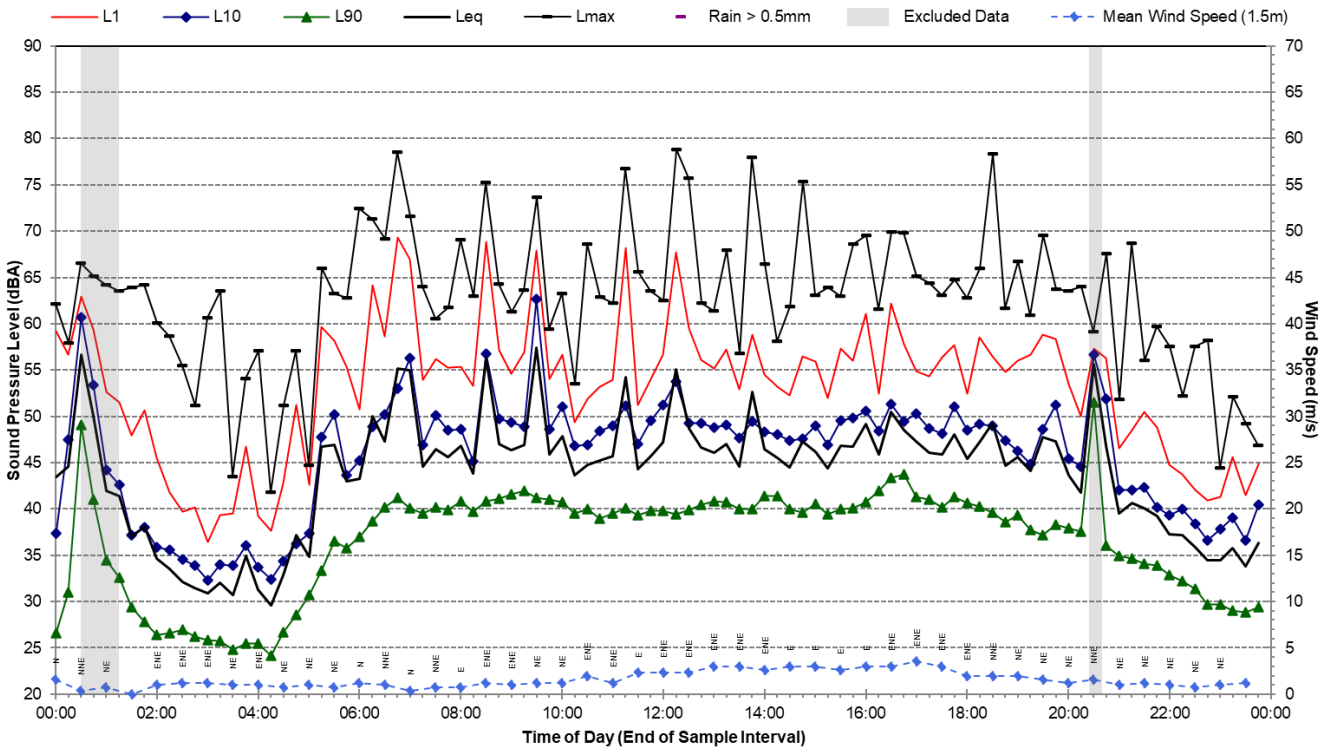


Statistical Ambient Noise Levels

L03 - 18 Bimbadeen Crescent, Frenchs Forest - Sunday, 6 November 2022

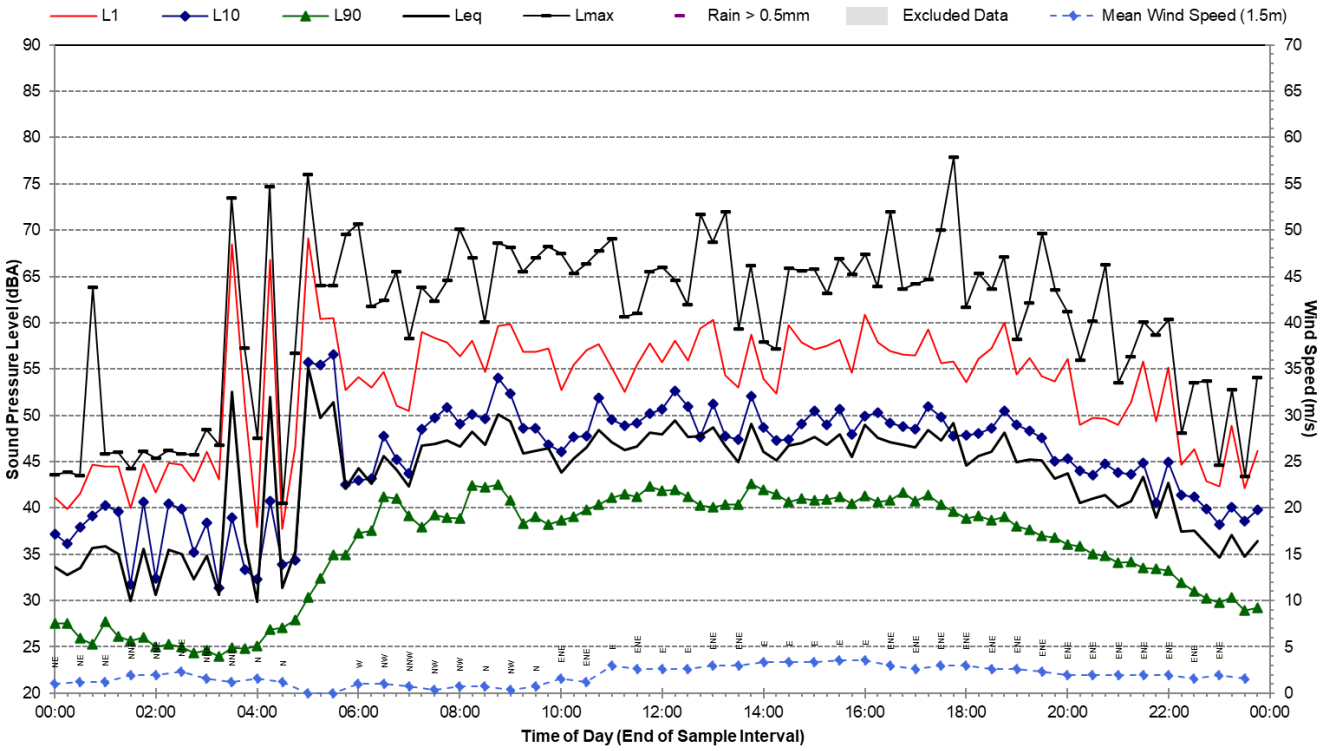



Statistical Ambient Noise Levels
L03 - 18 Bimbadeen Crescent, Frenchs Forest - Monday, 7 November 2022
L1
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
L03 - 18 Bimbadeen Crescent, Frenchs Forest - Tuesday, 8 November 2022
L1
L10
L90
Leq
Lmax
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

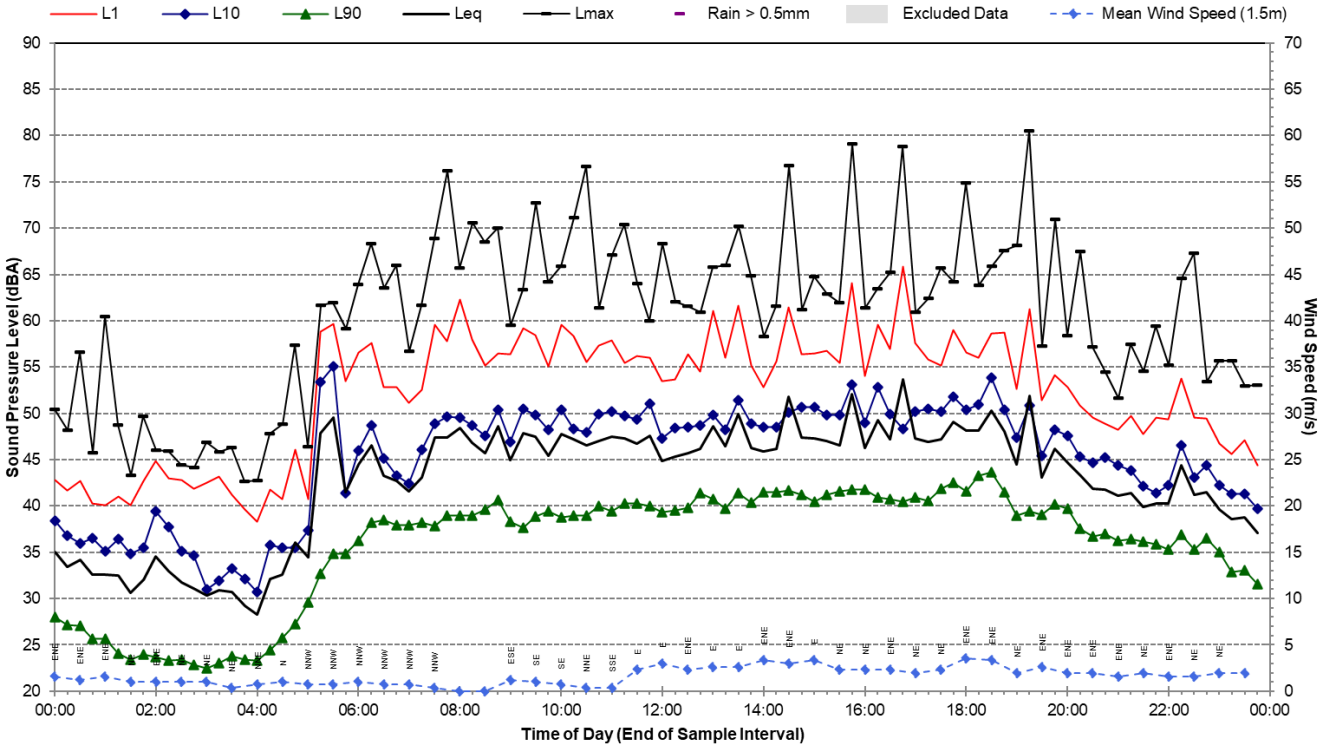
Statistical Ambient Noise Levels

L03 - 18 Bimbadeen Crescent, Frenchs Forest - Wednesday, 9 November 2022



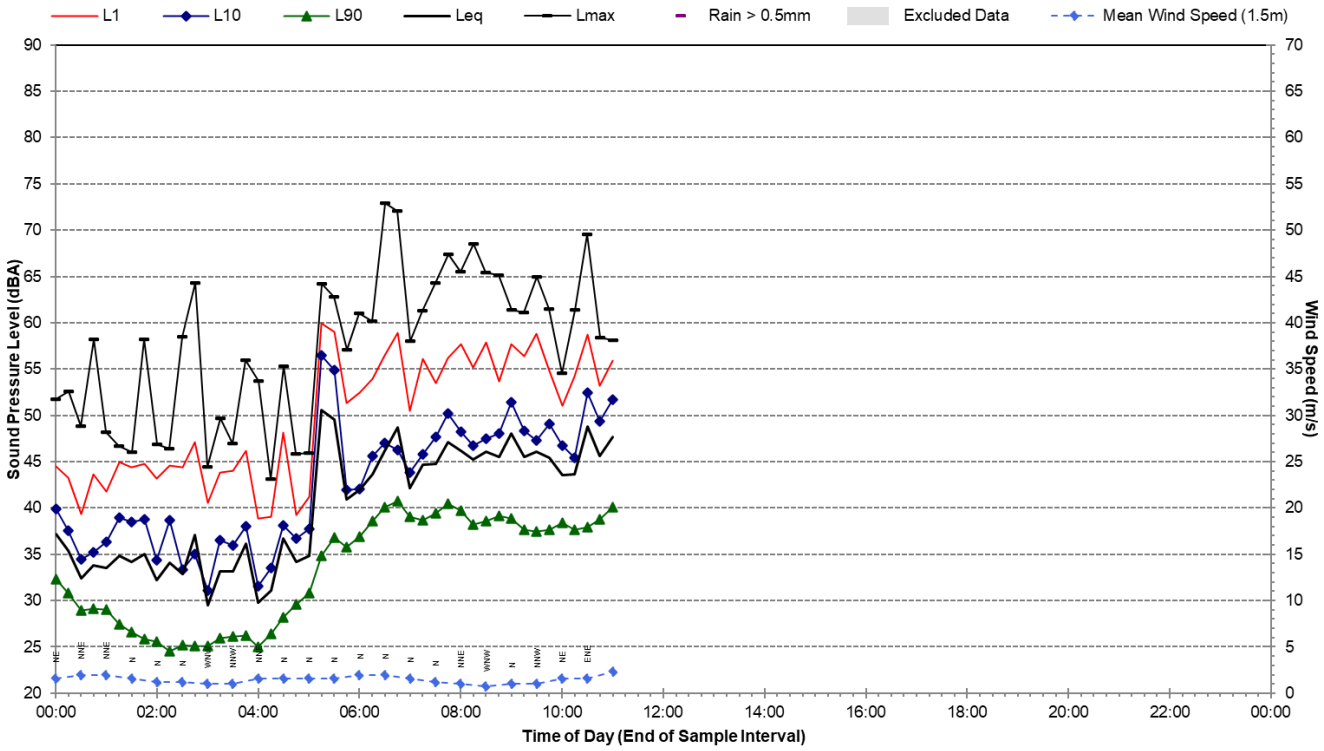
Statistical Ambient Noise Levels

L03 - 18 Bimbadeen Crescent, Frenchs Forest - Thursday, 10 November 2022



Statistical Ambient Noise Levels

L03 - 18 Bimbadeen Crescent, Frenchs Forest - Friday, 11 November 2022



Appendix C:

Construction Noise Sources

Works ID	Scenario	Sound Power Level (L_{Aeq} dBA)																					
		Bitumen Spray Truck	Chainsaw[1]	Chipper	Concrete Mixer Truck	Concrete Pump	Concrete Vibrator	Dozer	Dump Truck (approx. 15 tonne)	Elevated Working Platform	Excavator - Breaker[1]	Excavator (22 tonne)	Flatbed Truck	Front End Loader	Grader	Hand Tools	Line Marking Plant	Mobile Crane (100 tonne)	Paving Machine	Piling - Bored	Roller - Vibratory (12 tonne)1	Truck	Water Tanker (8000 litre)	Excavator 30T
SWL[2]		100	100	114	120	103	106	102	114	100	97	121	99	100	104	108	94	98	100	105	111	109	107	107
Estimated on-time in any 15-min		15	15	5	15	7.5	7.5	15	15	15	15	5	7.5	15	7.5	15	15	15	15	15	7.5	15	5	15
W.01	Vegetation clearing		X	X				X				X		X									X	
W.02	Demolition							X			X			X								X	X	
W.03	Earthworks							X	X			X		X	X						X		X	
W.04	Excavation of Hard Rock							X	X		X	X		X									X	
W.05	Piling				X	X												X		X		X		X
W.06	Construction of roads	X															X		X		X			
W.07	Construction of pads and hardstands				X	X	X																	
W.08	Construction of Structures									X			X			X		X						

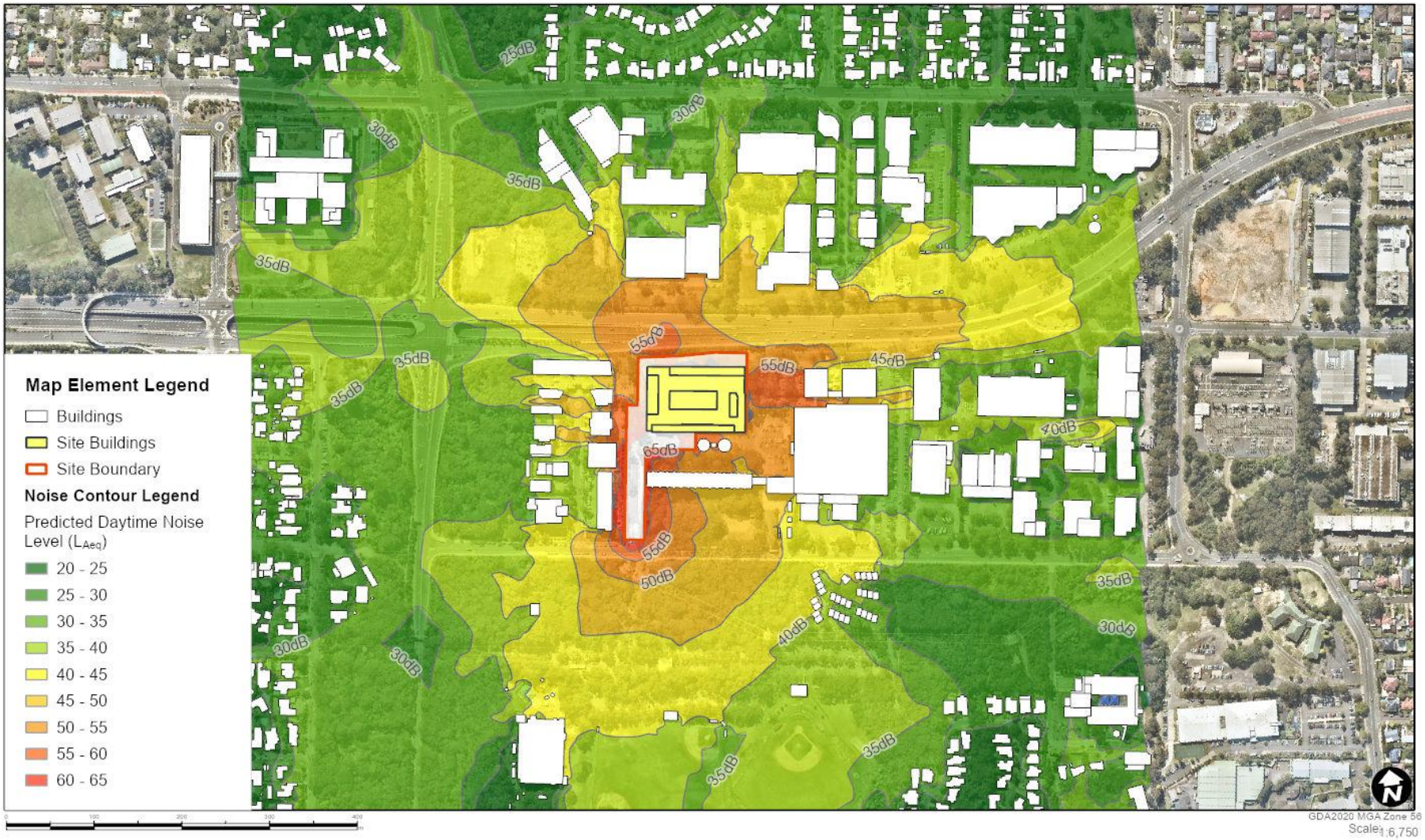
Note 1: Equipment classed as 'annoying' in the ICNG and requires a 5 dB correction.

Note 2: Sound power level data is taken from the DEFRA Noise Database, RMS *Construction and Vibration Guideline* and TfNSW *Construction Noise and Vibration Strategy*.

Appendix D:

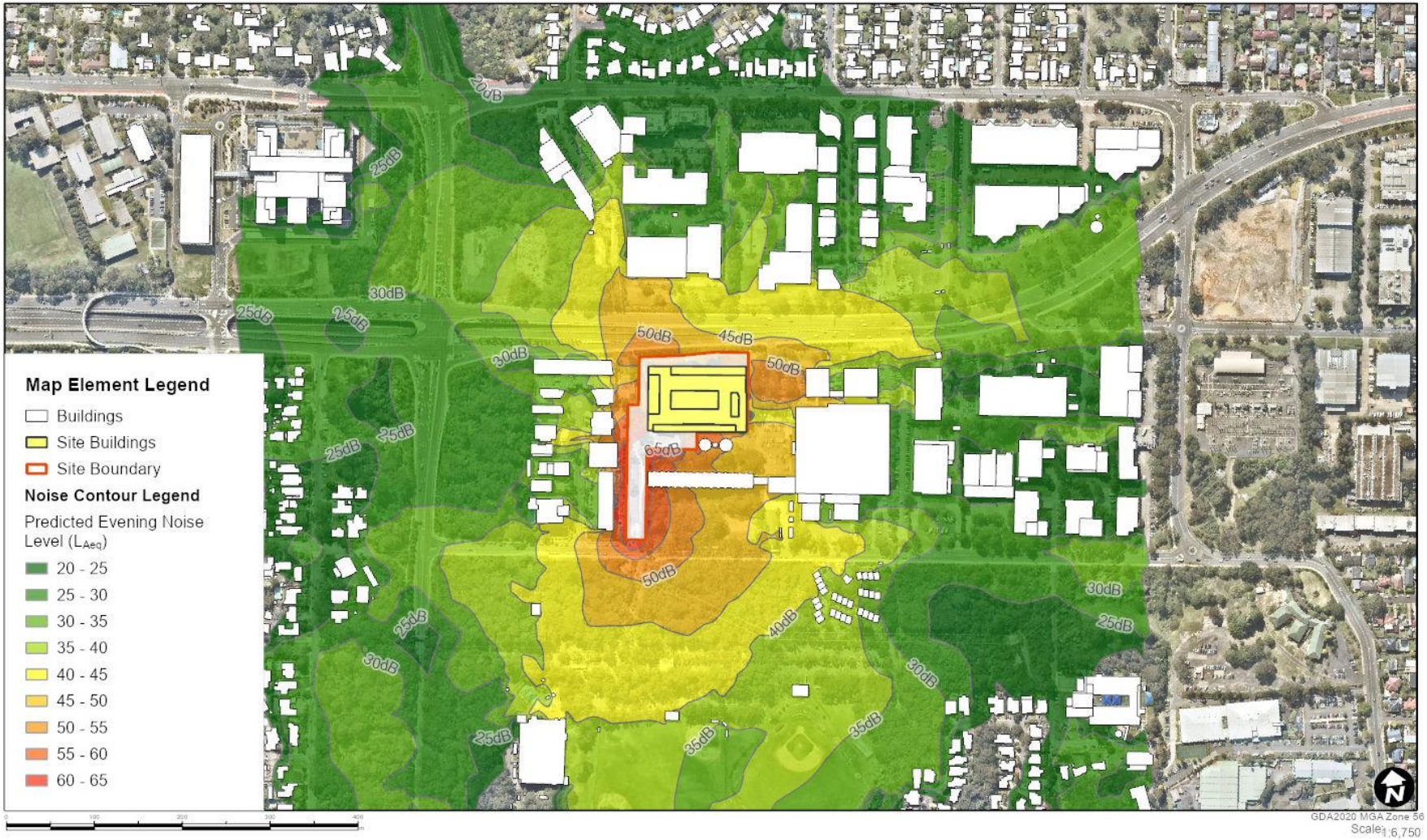
Operational Noise Contours

Daytime



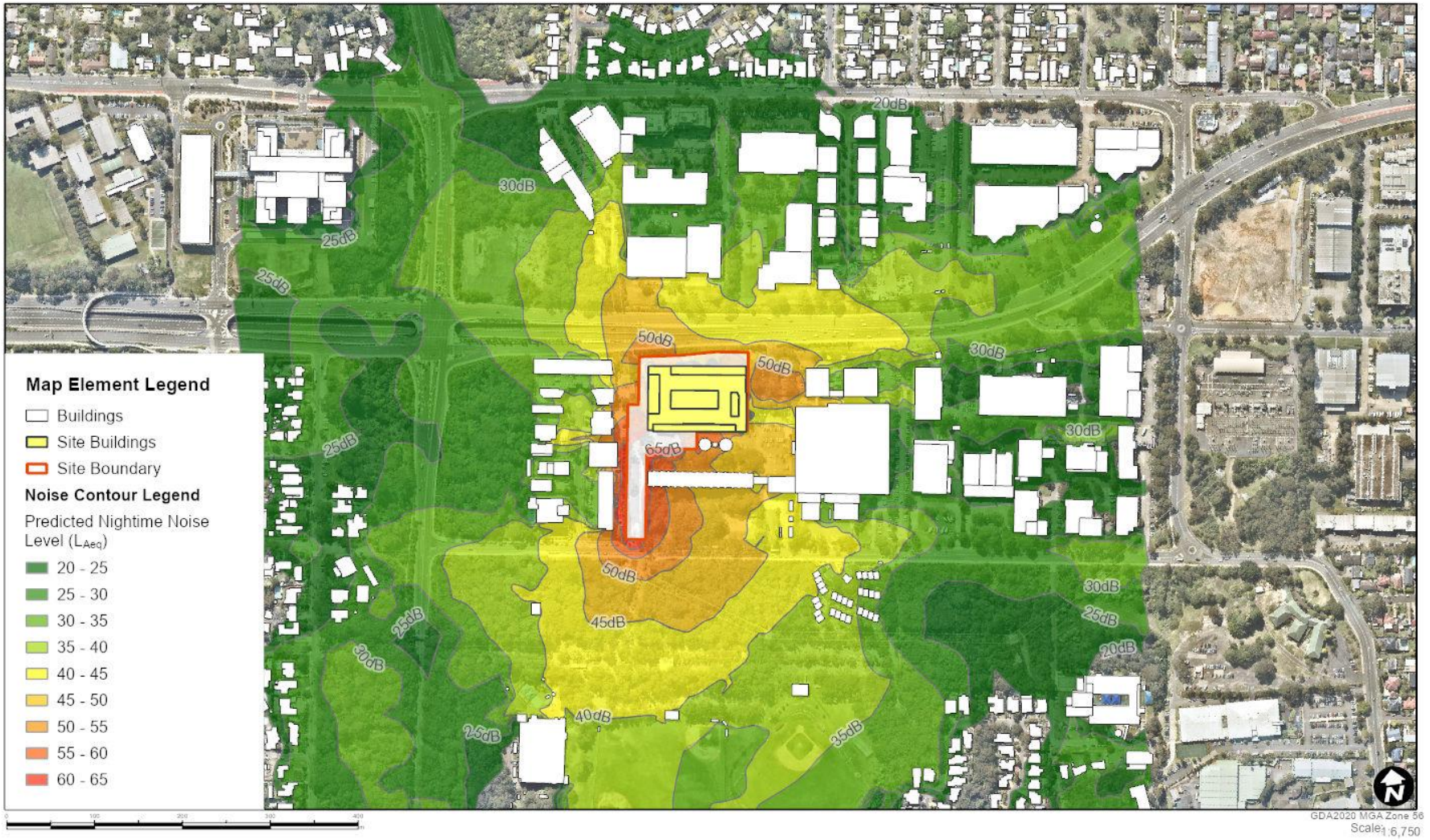
Note 1: Contours are at 1.5 m height and are free field.

Evening



Note 1: Contours are at 1.5 m height and are free field.

Night-time



Note 1: Contours are at 1.5 m height and are free field.

Appendix E

CNVG Mitigation Measures

CNVG Standard Mitigation and Management Measures

Action Required	Applies To	Details
Management measures		
Implementation of any project specific mitigation measures required.	Airborne noise	Implementation of any project specific mitigation measures required.
Implement community consultation or notification measures.	Airborne noise Ground-borne noise & vibration	Notification detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule over the night-time period, any operational noise benefits from the works (where applicable) and contact telephone number. Notification should be a minimum of 7 calendar days prior to the start of works. For projects other than maintenance works more advanced consultation or notification may be required. Please contact Roads and Maritime Communication and Stakeholder Engagement for guidance. Website (If required) Contact telephone number for community Email distribution list (if required) Community drop-in session (if required by approval conditions).
Site inductions	Airborne noise Ground-borne noise & vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • all project specific and relevant standard noise and vibration mitigation measures • relevant licence and approval conditions • permissible hours of work • any limitations on high noise generating activities • location of nearest sensitive receivers • construction employee parking areas • designated loading/unloading areas and procedures • site opening/closing times (including deliveries) • environmental incident procedures.
Behavioral practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Verification	Airborne noise Ground-borne noise & vibration	Where specified under Appendix C of the CNVG a noise verification program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurements	Ground-borne vibration	Where required attended vibration measurements should be undertaken at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Update Construction Environmental Management Plans	Airborne noise Ground-borne noise & vibration	The CEMP must be regularly updated to account for changes in noise and vibration management issues and strategies.

Action Required	Applies To	Details
Building condition surveys	Vibration Blasting	Undertake building dilapidation surveys on all buildings located within the buffer zone prior to commencement of activities with the potential to cause property damage
Source controls		
Construction hours and scheduling	Airborne noise Ground-borne noise & vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.
Construction respite period during normal hours and out-of-hours work	Ground-borne noise & vibration Airborne noise	See Appendix C of the CNVG for more details on the following respite measures: • Respite Offers (RO) • Respite Period 1 (R1) • Respite Period 2 (R2) • Duration Respite (DR)
Equipment selection.	Airborne noise Ground-borne noise & vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits. Ensure plant including the silencer is well maintained.
Plant noise levels.	Airborne-noise	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the criteria in Appendix H of the CNVG. Implement a noise monitoring audit program to ensure equipment remains within the more stringent of the manufacturers specifications or Appendix H of the CNVG.
Rental plant and equipment.	Airborne-noise	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in Table 2 of the CNVG.
Use and siting of plant.	Airborne-noise	The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers. Only have necessary equipment on site.
Plan worksites and activities to minimise noise and vibration.	Airborne noise Ground-borne vibration	Locate compounds away from sensitive receivers and discourage access from local roads. Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site. Where additional activities or plant may only result in a marginal noise increase and speed up works, consider limiting duration of impact by concentrating noisy activities at one location and move to another as quickly as possible. Very noise activities should be scheduled for normal working hours. If the work can not be undertaken during the day, it should be completed before 11:00pm. Where practicable, work should be scheduled to avoid major student examination periods when students are studying for examinations such as before or during Higher School Certificate and at the end of higher education semesters. If programmed night work is postponed the work should be re-programmed and the approaches in this guideline apply again.

Action Required	Applies To	Details
Reduced equipment power	Airborne noise Ground-borne vibration	Use only the necessary size and power.
Non-tonal and ambient sensitive reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
Minimise disturbance arising from delivery of goods to construction sites.	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible. Avoid or minimise these out of hours movements where possible.
Engine compression brakes	Construction vehicles	Limit the use of engine compression brakes at night and in residential areas. Ensure vehicles are fitted with a maintained Original Equipment Manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'In-service test procedure' and standard.
Path controls		
Shield stationary noise sources such as pumps, compressors, fans etc.	Airborne noise	Stationary noise sources should be enclosed or shielded where feasible and reasonable whilst ensuring that the occupational health and safety of workers is maintained. Appendix D of AS 2436:2010 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities.	Airborne noise	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.
Receptor control		
Structural surveys and vibration monitoring	Ground-borne vibration	Pre-construction surveys of the structural integrity of vibration sensitive buildings may be warranted. At locations where there are high-risk receptors, vibration monitoring should be conducted during the activities causing vibration.
See Appendix C of the CNVG for additional measures	Airborne noise Ground-borne vibration	In some instances, additional mitigation measures may be required.

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