Westfield Booragoon

Acoustic Report

Development Application

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Stantec

Revision

Revision	Date	Comment	Prepared By	Approved By
001	25/09/2020	Draft DA for Review	BEM	IK
002	13/10/2020	Updated Draft DA for Review	BEM	IK
003	19/10/2020	Acoustic DA Report	BEM	IK
004	24/03/2021	Updated Acoustic DA Report	BEM	IK
005	29/07/2021	Updated Acoustic DA Report	BEM	IK

Contents

Executive Summary

Stantec Australia Limited (Stantec) have been commissioned by Scentre Group to undertake an acoustic assessment of the Westfield Booragoon redevelopment, located in Booragoon WA.

This report evaluates compliance with the *WA Environmental Protection (Noise) Regulations 1997* (EPNR) of the expected activities at the proposed loading docks associated with the development and the proposed tavern noise emissions.

Noise emissions from mechanical plant will be reviewed when more information is available at further stages of the design.

Section 2.1.2 of this report identifies the applicable criteria at each residential area studied. Section 3 collates the results of the noise survey undertaken on site over a week. Section 4 indicates the methodology used for the loading dock and tavern noise emission assessments and generally identifies compliance with the EPNR, with noise management measures proposed to achieve compliance where required.

Ambient noise levels at residences in the area have been measured over a week, and we have identified that current measured background noise levels at residential properties along the roads surrounding the site are equal to or higher than the Assigned Noise Levels for the studied noise sensitive receivers at those locations.

Loading Docks

Noise emissions from the Loading Docks are generally dominated by the open Loading Dock 03 and truck loading on the High Street. The other docks are fully enclosed, with exception to the open Loading Dock 05 used in Stage 1 of the development. Generally, compliance with the EPNR is predicted within the residential areas surrounding the development, with exception to an exceedance on Davy St during night-time periods due to the open Loading Dock 03.

The following noise management measures are required for Loading Dock 03 to mitigate the noise:

- Night-time (2200 hours on any day to 0700 hours Monday to Saturday, 0900 hours Sunday & public holidays);
  - 19m semi-articulated trucks are not permitted to be used at night-time; and
  - No use of the waste compactors.

Unloading of trucks during the evening and night-time periods should be conducted in a manner with deliberate intent to mitigate impact noise of pallets against trucks or the loading dock floor.

The measured night-time noise levels in the area are likely to mask the noise from the loading docks. It is noted that Loading Dock 03 is an existing loading dock hence residents may be accustomed to the noise and unlikely to have any adverse reaction to the operations.

Tavern and Entertainment and Leisure Precinct (ELP)

The proposed tavern and ELP have been designed such that compliance with the EPNR will be achieved at the nearest residential receivers under a typical use case scenario. This will require the following noise management measures:

- Limiting the number of patrons in the tavern based on the time of day to;
  - A maximum of 280 patrons in the day and evening times; and
  - A maximum of 250 patrons during night-time hours;
- Music levels within the tavern and ELP to be regulated based on the time of day, ensuring it is not audible at nearby residences.

Mechanical Plant

Mechanical plant details have not been provided at this stage and will be included in the acoustic assessment during the next stages of the design. Appropriate treatments to ensure compliance with the EPNR will be recommended if required.

In summary, in view of the available information and the site conditions, we consider that operations associated with loading dock operations, the proposed tavern and the ELP will be able to comply with the EPNR. The predictions in this report consider that the assumptions, building recommendations and noise management measures provided will be implemented.

1. Introduction

1.1 Overview

Stantec were commissioned by Scentre Group to undertake an acoustic assessment and prepare an acoustic Development Application report for the redevelopment of Westfield Booragoon shopping centre located in Booragoon, WA.

The proposed development is located within the City of Melville.

This report presents the key acoustic considerations and criteria pertinent to the project. The criteria will form the basis of acoustic design for the following;

- Environmental noise emissions from loading docks, mechanical plant, the tavern and ELP;
- Internal noise levels;
- Noise intrusion from building services, rain noise and other external services;
- Airborne and impact sound insulation performance between tenancies; and
- Reverberation control.

It is noted the acoustic performance requirements for the shopping centre – Internal noise levels, reverberation control, noise intrusion and airborne sound insulation does not impact the nearest noise sensitive receivers. Acoustic design of these parameters will form part of the detailed design stages of the project.

1.2 Study Inputs

Assessment and preparation of this report have been undertaken based on the received documentation detailed in Table 1.

Table 1: Received documentation

Date	Detail	Prepared by	Format
12 Aug 2020	Mechanical Services Spatial Design Plans *D11503-SDC-MEC-SP-SK-03[A]* *D11503-SDC-MEC-SP-SK-04[A]* *D11503-SDC-MEC-SP-SK-05[A]*	Scentre Group	.pdf
18 Aug 2020	Navisworks Model Export *SDC_BR_ARCHITECTURAL[001]*	Scentre Group	.nwd
20 Aug 2020	Tavern Concept Drawings *200827_TAVERN SECTIONS [002]*	Scentre Group	.pdf
24 Aug 2020	Architectural Drawing Set P5 Series *SDC-010802 SCH13C BASEMENT PLAN [P5]* *SDC-010803 SCH13C GROUND RETAIL PLAN [P5]* *SDC-010805 SCH13C LEVEL 1 RETAIL ROOF PARKING PLAN [P5]* *SCD-029052 SCH13C GROUND RETAIL PLAN STAGE 1 [P5]*	Scentre Group	.pdf
8 Oct 2020	Loading Dock 05 Arrangement *SDC-029081 STAGE 1 DJ LOADING DOCK PLAN 20200918*	Scentre Group	.pdf
18 Mar 2021	Architectural DA Drawing Package Series RevB	Scentre Group	.pdf

Date	Detail	Prepared by	Format
16 Jun 2021	Architectural Drawing Set – Updated DA *SDC 010813B – GA PLAN GROUND FLOOR STAGE 1* *SDC 010815B – GA PLAN LEVEL 1-ROOF STAGE 1*	Scentre Group	.pdf
24 Jun 2021	Loading Dock Movements *BN LOADING DOCK TRUCK MOVEMENTS REV D*	Scentre Group	.xls
26 Jul 2021	Architectural – Master Lease Plans Stage 1 *20210720-BN- SCH15A-Sheet – 02-9105* *20210720-BN- SCH15A-Sheet – 02-9104*	Gensler	.dwg / .pdf
28 Jul 2021	ELP Design Workshop Presentation *20210727_Client Meeting 04*	Gensler	.pdf

1.3 Information Sources

The following documentation has been reviewed for acoustic assessment and the preparation of this report:

- City of Melville — Local Planning Scheme No. 6 (LPS6);
- City of Melville — Melville City Centre Structure Plan – Activity Centre Structure Plan Booragoon (MCCSP), adopted by Council on the 9th December 2013;
- *Environmental Protection (Noise) Regulations 1997* (EPNR); and
- Australian and New Zealand Standard AS/NZS 2107:2016 — Acoustics – Recommended design sound levels and reverberation times for building interiors (AS2107.

1.4 Site Description

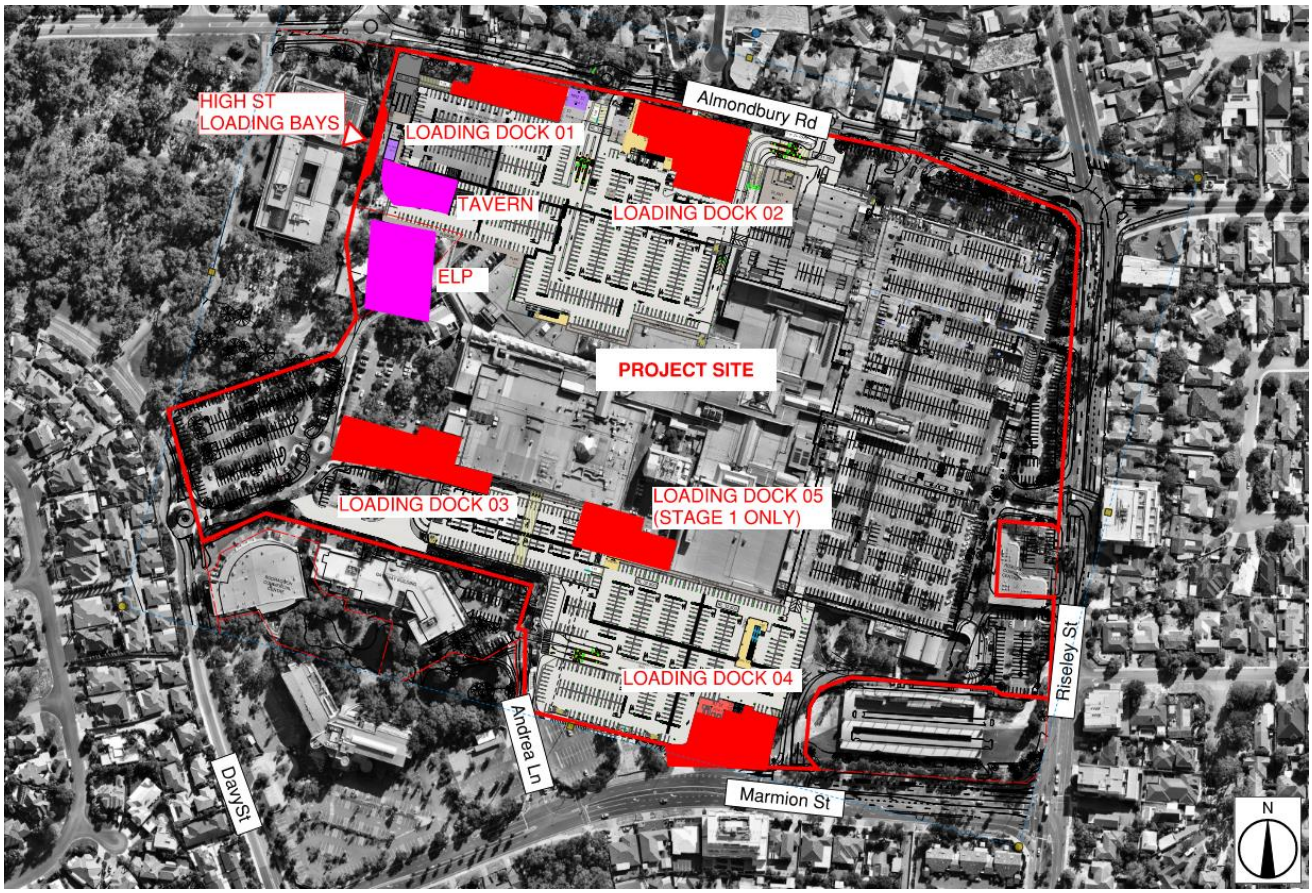
The project site is bounded by Almondbury Rd (north), Riseley St (east), Marmion St (south) and Davy St (west). The surrounding built environment primarily consists of existing residential developments. A small number of commercial establishments are located to the north, south and west of the project site.

The Melville City Centre Structure Plan (Frame Precinct B) indicates provisions for any new developments along Almondbury Rd, Riseley St and Marmion St to be up to 4-storeys.

Main Roads Western Australian (MRWA) indicates high traffic volumes along Riseley St and Marmion St.

The project location and surrounding areas have been indicated in Figure 1.

Figure 1: Project site



Source: Nearmaps / Architectural DA Drawing Package

2. Acoustic Criteria

2.1 Environmental Protection (Noise) Regulation 1997

Environmental noise impacts resulting from the noise emissions from the project are addressed through the Environmental Protection Act 1986, with the regulatory requirements detailed in the *Environmental Protection (Noise) Regulations 1997* (EPNR).

The EPNR establishes the maximum permissible noise emission levels (assigned levels) to be received at all adjacent noise-sensitive premises during specific periods of the day as a result of the cumulative noise emissions from all sources proposed for the project site. Compliance to relevant noise limits outlined in the EPNR is compulsory.

The EPNR states that noise emissions from any premises are considered not to *significantly contribute to* the noise at a receiver if the noise emissions are 5 dB or below the assigned levels.

In brief, the assigned levels are determined by considering of the amount of commercial and industrial zones, as well as main transport corridors surrounding the noise sensitive premises. The assigned levels apply at premises receiving the noise (noise sensitive receiver) and not to areas within the project site or lot.

Premises representative of the nearest noise sensitive premises to the project have been selected in each cardinal direction:

- 19 Almondbury Rd, Ardross (north);
- 146 Riseley St (east);
- 555 Marmion St, Booragoon (south); and
- 86 The Ramble, Booragoon (west), backing onto Davy St.

The current City of Melville — Local Planning Scheme No. 6 (LPS6) was accessed via Intramaps and the Western Australian Planning Commission to determine the land use types surrounding the nearest noise sensitive receivers.

Traffic data for roads surrounding the nearest noise sensitive receiver were obtained from Main Roads Western Australia (MRWA) on the 12th August 2020. The available traffic data has been presented in Table 2. Based on the historical information, Marmion St is considered to be a major road as defined by the EPNR.

Table 2: Traffic count data (MRWA)

Transport Corridors	EPNR Classification [1)]	Average Daily Traffic Volumes			
		2016/17	2017/18	2018/19	2019/20
Riseley St (North of Marmion St)	Major road	-	22,410	16,529	-
Marmion St (West of Riseley St)	Major road	18,684	17,523	14,378	-

1) As defined by the EPNR. Major roads have greater than 15,000 vehicles per day. Secondary roads have between 6,000 – 15,000 vehicles per day.

2.1.1 Influencing Factor

The influencing factor which results from identifying the commercial and industrial land use, as well as primary transport corridors surrounding the nearest noise sensitive premises is provided in Table 3. The images that has been taken from Intramaps for calculation of Influencing Factor have been presented in Appendix B.

Table 3: Influencing factor (IF) at each noise sensitive receiver

Noise Sensitive Premises	Commercial Zones	Transport Corridors	Influencing Factor
19 Almondbury Rd	23% within a 100 m radius 32% within a 450 m radius	Riseley St within a 450 m radius	5 dB
146 Riseley St	16% within a 100 m radius 23% within a 450 m radius	Riseley St within a 100 m radius	8 dB
555 Marmion St	21% within a 100 m radius 32% within a 450 m radius	Marmion St within a 100 m radius	9 dB
86 The Ramble (backing onto Davy St)	28% within a 100 m radius 27% within a 450 m radius	Marmion St within a 450 m radius	5 dB

2.1.2 Assigned Levels

Table 4 summarises the assigned levels at the nearest noise sensitive premises, which is added to the influencing factors calculated for each receiver detailed in Table 3.

It is required that all noise emissions from the development are below the assigned level for all defined periods of the day and at the lot boundary of the receiver or 15 m from any associated building.

Table 4: Assigned levels

Type of premises receiving noise	Time of day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise sensitive premises: Highly sensitive area	0700 to 1900 hours Monday to Saturday	45 + IF	55 + IF	65 + IF
	0900 to 1900 hours Sunday & public holidays	40 + IF	50 + IF	65 + IF
	1900 to 2200 hours all days	40 + IF	50 + IF	55 + IF
	2200 hours on any day to 0700 hours Monday to Saturday, and 0900 hours Sunday & public holidays	35 + IF	45 + IF	55 + IF
Noise sensitive premises: any area other than highly sensitive areas	All Hours	60	75	80
Commercial premises	All Hours	60	75	80
Industrial and utility premises	All Hours	65	80	90

2.1.3 Noise Character Adjustments

Regulation 7 states that the noise character must be “free” of annoying characteristics, namely —

- Tonality, e.g. whining, droning;
- Modulation, e.g. like a siren; and
- Impulsiveness, e.g. banging, thumping.

Regulation 9 (1) establishes the methodology for determining noise characteristics. If these characteristics cannot be reasonably and practicably removed, a series of adjustments to the measured levels are required, indicated in Table 5.

Table 5: Noise character adjustment

Adjustment where noise emission is not music these adjustments are cumulative to a maximum of 15 dB			**Adjustment where noise emission is music**	
Where tonality is present	**Where modulation is present**	**Where impulsiveness is present**	**Where impulsiveness is not present**	**Where impulsiveness is present**
+ 5 dB	+ 5 dB	+ 10 dB	+ 10 dB	+ 15 dB

2.1.4 Exemptions (Regulation 3)

Regulation 3 of the EPNR states;

(1) Nothing in these regulations applies to the following noise emissions —
- *(a) noise emissions from the propulsion and braking systems of motor vehicles operating on a road;*
- *(b) noise emissions from a safety warning device, other than a reversing alarm, fitted to a motor vehicle operating on a road;*
- *(h) noise emissions from —*
  - *i. a reversing alarm fitted to a motor vehicle, mobile plant, or mining or earthmoving equipment; or*
  - *ii. a startup or movement alarm fitted to plant,*

  if —
    1. *it is a requirement under another written law that such an alarm be fitted; and*
    2. *it is not practicable to fit an alarm what complies with the written law under which it is required to be fitted and emits noise that complies with these regulations;*

2.1.5 Noise Emissions from Mechanical Plant

It is important that noise emissions from the site do not present any form of tonality, modulation or impulsiveness (as defined by the EPNR).

Given the data from mechanical plant manufacturers is generally limited to broadband data or in 1/1 octave band value, it is not possible to objectively determine tonality, as it is described in the EPNR. 1/3 octave band data is required yet is typically unavailable.

Therefore, a +5 dB adjustment shall be conservatively assigned to the predicted level of noise being received.

2.2 Internal Noise Levels

The internal noise level criteria detailed in this section are based on the recommendations provided in the Australian / New Zealand Standard AS/NZS 2107:2016 ‘Acoustics – Recommended design sound levels and reverberation times for building interiors’ (AS 2107).

AS2107 provides recommended internal noise levels (defined as the equivalent continuous A-weighted sound pressure level — $L_{Aeq,t}$) for optimising the acoustic amenity in occupied spaces. This document is a common reference for establishing satisfactory internal noise level goals due to steady and quasi-steady state sounds, such as mechanical plant and external traffic noise ingress.

AS2107 also provides the optimum reverberation times (T_{mf}) particular spaces. Adequate control of reverberation time is crucial as it can lead to increased noise levels within a space, as well as presenting adverse impacts on speech intelligibility.

The relevant internal noise level and reverberation criteria have been outlined in Table 6.

Table 6: Recommended internal noise level and reverberation from AS2107

Type of occupancy / activity	Recommended design sound level ($L_{Aeq,t}$) range, dB(A)	Recommended design reverberation time range, s
Coffee shops	40 – 50	See Note 1
Department stores — main floor	< 55	See Note 1
Department stores — upper floor	< 50	See Note 1
Enclosed carpark	< 65	—
Food courts	45 – 55	See Note 1
General office areas	40 – 45	0.4 – 0.6
Pharmacies	45 – 50	0.4 – 0.6
Restaurants	40 – 50	See Note 1
Shopping malls	< 55	See Note 1
Show rooms	< 50	See Note 1
Small retail stores (general)	< 50	See Note 1
Speciality shops (where detailed discussion is necessary in transactions)	< 45	See Note 1
Supermarkets	< 55	See Note 1
Toilets / amenities	< 55	—

NOTE 1: Reverberation time should be minimised for noise control (as per Note 3 of AS2107:2016)

2.2.1 Rain Noise

The internal noise levels indicated in Table 6 shall not be exceeded by more than 5 dB above the lower limit of the criteria due to rainfall events. Typically, this assessment is based on a rainfall rate of 15 mm/hr and is considered an appropriate assessment method for non-tropical areas of Australia.

2.2.2 Cinema

Specific internal noise and airborne sound insulation performance requirements for Cinemas shall be established once the tenant brief becomes available. It is expected the design of the cinema has no impact on the DA scope of work.

3. Noise Survey

Unattended noise measurements (noise logging) were conducted between the 5th August and 14th September 2020, in order to assess current noise levels during the DA stage of the project. The purpose of conducting noise measurements was to establish the existing acoustic environment at noise sensitive receivers surrounding the project site.

3.1 Measurement Methodology

3.1.1 Equipment Details

Unattended measurements have been conducted using instrumentation equivalent to an integrating sound level meter equipped with one octave and one-third octave band filters, and an omni-directional condenser microphone. All instrumentation meets Type 1 specifications as per ANSI S1.4 and ANSI S1.43.

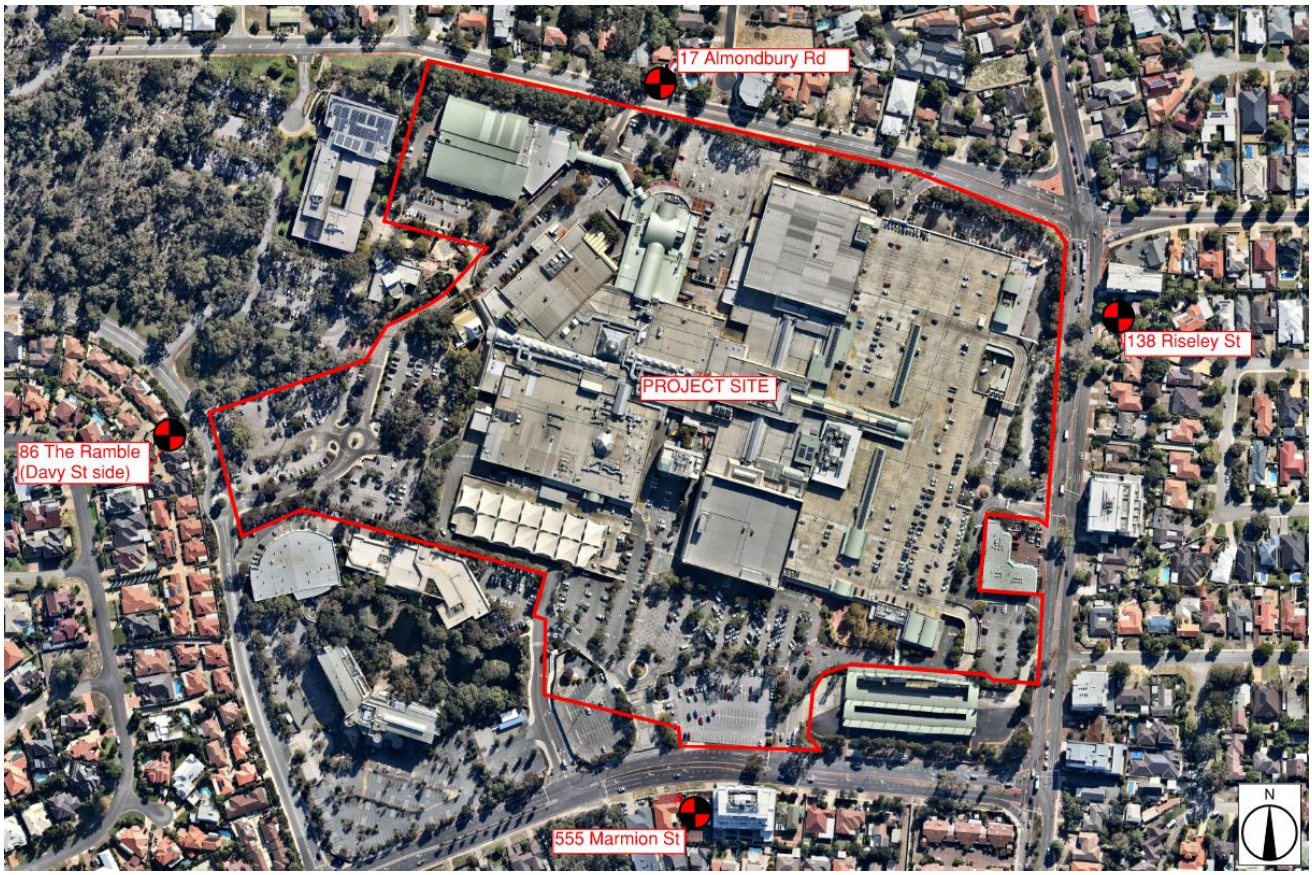
All sound level meters were calibrated by an authorised NATA (National Association of Testing Authorities) laboratory less than 2 years ago and have successfully passed all AS 1259 and AS/NZS 4476 standards and specifications.

The time constant for the RMS detector were set to a slow response (1 s) for all measurements on all sound level meters. A complete schedule of all equipment used during for acoustic measurements and calibration certificates for the relevant instrumentation may be provided upon request.

3.1.2 Measurement Locations

Noise from activities and other premises surrounding the project site are expected to regularly contribute to the overall noise levels at the project site. Noise measurements were undertaken at the locations indicated in Figure 2.

Figure 2: Measurement locations



Source: Nearmap

3.2 Noise Measurement Summary

3.2.1 Unattended Noise Measurements

The objective of noise logging was to identify daily noise trends and typical noise impacts affecting the proposed development site. A summary of the measured noise levels at each location identified in Figure 2 has been summarised in Table 7.

Each parameter was averaged over a minimum of 5 days. Average wind speeds of 5 m/s and minimal rainfall were recorded at Jandakot Aero weather station (9 km from the project site) during the measurement period.

Table 7: Summary of Measured Noise Levels

Measurement Location	Measured Noise Levels, dB(A)											
	Day				Evening				Night			
	L_{eq}	L_{90}	L_{10}	L_1	L_{eq}	L_{90}	L_{10}	L_1	L_{eq}	L_{90}	L_{10}	L_1
19 Almondbury Rd	58	48	60	69	51	48	53	58	51	44	54	62
146 Riseley St	57	50	60	64	54	45	57	61	50	41	53	60
555 Marmion St	59	50	62	68	54	42	58	65	52	41	54	62
86 The Ramble (Davy Street)	59	51	62	69	52	43	54	63	51	44	54	62

The data provided in Table 7 indicates a typical suburban profile surrounding the project site with average daytime noise levels that are 7 – 8 dB higher than night time periods. Traffic noise is attributed as the dominant noise source at all four locations. Detailed noise logger graphs for each location are presented in Appendix C.

4. Environmental Noise Emissions Assessment

4.1 Overview of Assessment

Noise emissions from all possible noise emitting sources proposed redevelopment are required to comply with the *Environmental Protection (Noise) Regulations 1997* (EPNR).

The following noise sources have been identified based on proposed architectural layouts;

- Loading docks;
- Tavern and ELP; and
- Mechanical Plant (including cooling towers, exhaust systems for car parks, condensers).

To determine compliance to the assigned level criteria detailed by the EPNR (refer to Section 2.1 of this report), acoustic assessments of the loading docks and tavern were undertaken, based on details provided by the design team and current architectural model.

Noise emissions assessments have been undertaken using current noise modelling software (SoundPLAN v8.2). Design advice and recommendations have been detailed where exceedance to the EPNR are predicted. Noise contours for the loading docks and tavern with applicable noise management measures are presented in Appendix D.

Mechanical plant details have not been provided at this stage and will be included in the acoustic assessment once available. Appropriate treatments to ensure compliance with the EPNR (e.g. solid barriers, acoustic cowlings/louvres, low noise fans) will be recommended if required.

We note that noise from vehicles on public roads and in the shopping centre car park has not been assessed. As per Regulation 3 of the EPNR, the regulations do not apply to noise emissions from the propulsion and braking systems of motor vehicles operating on a road. It is generally accepted that if the car park is considered equivalent to a public road, then car park noise would also not be assessible. Car park movements and operations are likely to contribute to the acoustic environment, however as the proposed redevelopment adds 126 bays to an existing 4250 (an increase of 3%), are considered unlikely to have a perceptible adverse impact on the existing acoustic amenity of the community.

4.2 Noise Model Inputs

4.2.1 Topography

The topographical data for the project site and surrounding areas was determined from a review of ground contours detailed as previously received from Scentre Design Group.

4.2.2 Ground Absorption

A ground factor of 0.6 was assumed in the model to account for attenuation due to ground absorption with relatively sparse vegetation cover.

4.2.3 Meteorological Conditions

The CONCAWE algorithm has been selected for meteorological conditions, as presented Table 8, and have been factored into the model in consideration of the worst case environmental conditions for propagation of noise.

Table 8: Meteorological conditions incorporated into the noise model

Parameter	Day (0700 – 1900)	Evening / Night (1900 – 0700)
Temperature	20	15
Humidity	50	50

Parameter	Day (0700 – 1900)	Evening / Night (1900 – 0700)
Wind Speed (m/s)	4	3
Wind Direction	All	All
Pasquill Stability Class	E	F

4.3 Noise Sources and Receiver Locations

The Melville City Centre Structure Plan (Frame Precinct B) indicates provisions for any new developments proposed Almondbury Rd, Riseley St and Marmion St to be of up to 4-storeys.

To ensure compliance to the EPNR for any existing and possible future developments, receivers included in the noise model have be positioned at the boundary of each noise sensitive premise, as well as at each level up to 4-storeys.

The nearest noise sensitive receivers to the project site that have been assessed are indicated in Figure 3 along with proposed loading dock locations.

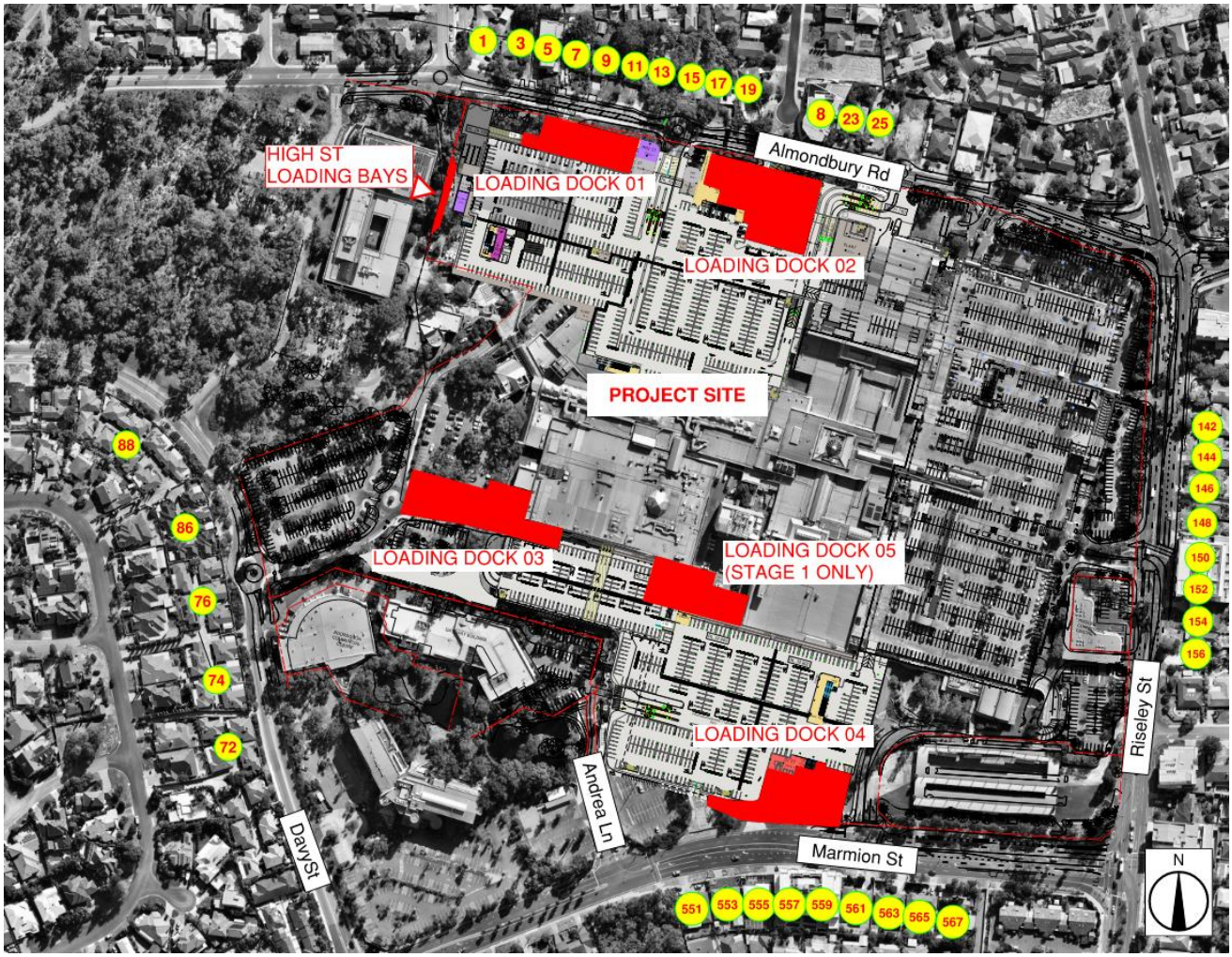


Figure 3: Loading Dock and Receiver Locations

4.4 Loading Dock Assessment

Noise emissions from loading docks are required to be compliant to the assigned levels outlined in the EPNR. Assessment of each noise source against the EPNR criteria (L_{A10}, L_{A1}, or L_{Amax}) is proportional to the period of the day, and the combined frequency and duration of each noise event.

Noise emissions which are likely to be present for ≥ 10% of the "representative assessment period" (24 minutes in 4 hours) are to be assessed against the L_{A10} criteria. Typically, a single truck is considered present for less than 10 % of a representative measurement period, and therefore, assessment is conducted against the L_{A1} criteria. However, the cumulative number of trucks in a "representative assessment period" may result in assessment against the L_{A10} criteria. Therefore, L_{A10} criteria has been used as a worst-case scenario.

4.4.1 Assumptions

Each loading dock assessment has been conducted with reference to the loading dock plans from the architectural drawings (received 8 Oct 2020, 18 Mar 2021 and 16 Jun 2021), Navisworks model export (received 18 Aug 2020) and loading dock movements (BN Loading Dock Truck Movements RevD received 24 Jun 2021) provided by Scentre Group.

Loading docks 01, 02 and 04 and 05 are documented as fully enclosed. Loading dock 03 is an expansion of existing loading dock and is not fully enclosed. Loading dock 05 is not fully enclosed and is only in operation during Stage 1 of the development, ultimately being replaced by Loading Dock 04. Truck loading bays for keg trucks and courier vans are proposed to the High Street.

Based on the details provided, a summary of the expected traffic volumes accessing each loading dock has been detailed in Table 9.

Table 9: Expected vehicle movements at each loading dock during each period of the day

Loading Dock	Time of Day	Vehicle Type	Number of deliveries in period per vehicle type	Waste Compactors
LOADING DOCK 01 Corner of Almondbury Road and High street Cinema, Tavern + food specialty tenancies	0700 – 1900 hrs Mon – Sat 0900 – 1900 hrs Sun & Pub. Hol.	Rigid vehicle (12.5 m)	2	3
	1900 – 2200 hrs	No deliveries expected during these periods		
	2200 – 0700 hrs Mon – Sat 2200 – 0900 hrs Sun & Pub. Hol.			
HIGH STREET TRUCK BAYS Cinema, Tavern + food specialty tenancies	0700 – 1900 hrs Mon – Sat	Courier vans	2	—
	0900 – 1900 hrs Sun & Pub. Hol.	Keg Truck (9m)	20	
	1900 – 2200 hrs	No deliveries expected during these periods		
	2200 – 0700 hrs Mon – Sat 2200 – 0900 hrs Sun & Pub. Hol.			

Loading Dock	Time of Day	Vehicle Type	Number of deliveries in period per vehicle type	Waste Compactors
LOADING DOCK 02 Almondbury Road – Woolworths, mini major supermarket, fresh food market	0700 – 1900 hrs Mon – Sat 0900 – 1900 hrs Sun & Pub. Hol.	Courier vans	4	4
		Rigid vehicle (12.5 m)	8	
		Semi articulated vehicle (19 m)	3	
	1900 – 2200 hrs	Courier vans	2	
		Rigid vehicle (12.5 m)	0	
		Semi articulated vehicle (19 m)	1	
	2200 – 0700 hrs Mon – Sat 2200 – 0900 hrs Sun & Pub. Hol.	Courier vans	2	
		Rigid vehicle (12.5 m)	2	
		Semi articulated vehicle (19 m)	2	
LOADING DOCK 03 Andrea Lane - Aldi, convenience specialties	0700 – 1900 hrs Mon – Sat 0900 – 1900 hrs Sun & Pub. Hol.	Courier vans	5	4
		Rigid vehicle (12.5 m)	2	
		Semi articulated vehicle (19 m)	2	
	1900 – 2200 hrs	Courier vans	3	
		Rigid vehicle (12.5 m)	0	
		Semi articulated vehicle (19 m)	1	
	2200 – 0700 hrs Mon – Sat 2200 – 0900 hrs Sun & Pub. Hol.	Courier vans	2	
		Rigid vehicle (12.5 m)	2	
		Semi articulated vehicle (19 m)	3	
LOADING DOCK 04 / 05 [1] Marmion Street - David Jones, Fashion Specialities	0700 – 1900 hrs Mon – Sat 0900 – 1900 hrs Sun & Pub. Hol.	Courier vans	6	3
		Rigid vehicle (12.5 m)	6	
		Semi articulated vehicle (19 m)	0	
	1900 – 2200 hrs	No deliveries expected during these periods		
	2200 – 0700 hrs Mon – Sat 2200 – 0900 hrs Sun & Pub. Hol.			

NOTE: Loading Dock 05 is only in operation during Stage 1 of the development, ultimately being replaced by Loading Dock 04. The expected number and type of deliveries are the same.

4.4.2 Sound Levels – Loading Docks

Noise emissions from truck movements and associated operations within these areas are generally formed by a combination of successive and transient, noise events. This typically includes;

- Engine noise (ignition, idle, acceleration, deceleration), reversing alarms (beepers), brake squeals, compression release;

- Unloading activities (forklifts, pallet trucks);
- Hydraulic lifts; and
- Roller doors and associated alarms.

To objectively assess truck movements and additional loading dock operations, the sound power levels of some typical activities obtained from previous measurements conducted by Stantec have been provided in Table 10.

Table 10: Sound power levels of typical loading dock activities

Noise Source [1]	Sound Power Level, dB(A)
19m Semi-articulated trucks driving and reversing	102
Rigid 12.5m truck driving and reversing	99
Keg truck 9m driving and reversing	96
19m Truck unloading activities (i.e. forklifts, pallet trucks etc.)	95
12.5m Truck unloading activities (i.e. forklifts, pallet trucks etc.)	90
9m Truck unloading activities (i.e. pallet trucks etc.)	85
Waste compactor	89

NOTE 1: The combined spectrum has been corrected based measurement conditions (i.e. distance, proximity to reflective surfaces etc.)

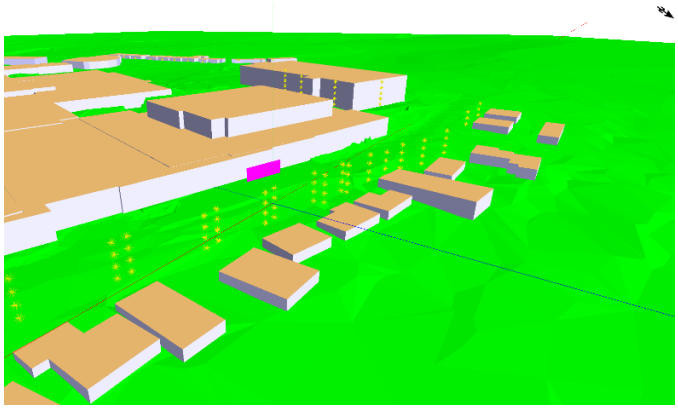
4.4.3 Loading Dock Arrangements

The following sections detail the loading dock arrangements and noise sources incorporated into the noise model to determine expected noise levels at each noise sensitive receiver due to loading dock operations. Each assessment has considered the highest possible number of noise sources to occur simultaneously as a worst case scenario.

As discussed in Section 4.3 of this report, receivers were positioned at the existing residential/commercial boundaries nearest to each loading dock, as well as at heights (of up to 4-storeys) for possible future developments.

Loading Dock 01

- *Client has indicated loading dock to be completely enclosed with gate.*
- *Gate is assumed to be a sliding, non-continuous screen to dock entrance.*



Modelled Noise Sources (Day Only inclusive of Sundays & Public Holidays)

1 x 12.5 rigid truck driving and reversing

1 x unloading activities of 12.5m rigid truck

3 x waste compactors

Noise radiating from within the enclosed loading dock has been modelled as an area source (in pink).

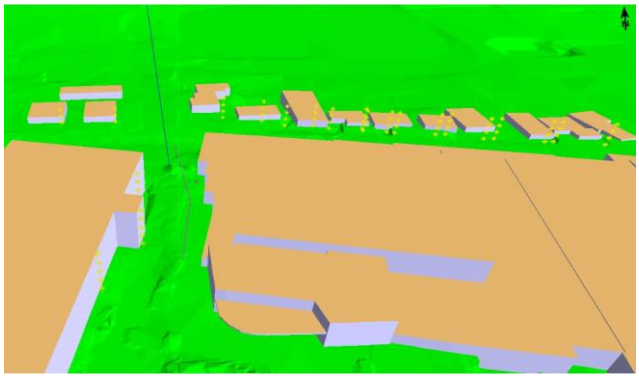
High Street Truck Loading Bays

- *Client has indicated loading bays to be open (i.e. not enclosed or screened).*

Modelled Noise Sources (Day Only inclusive of Sundays & Public Holidays)

1 x 9m keg truck driving to loading bay

1 x unloading activities of 9m keg truck



Loading Dock 02

- *Client has indicated loading dock to be completely enclosed with gate.*
- *Gate is assumed to be a sliding, non-continuous screen to dock entrance.*

Modelled Noise Sources (Day, Evening including Sundays & Public Holidays)

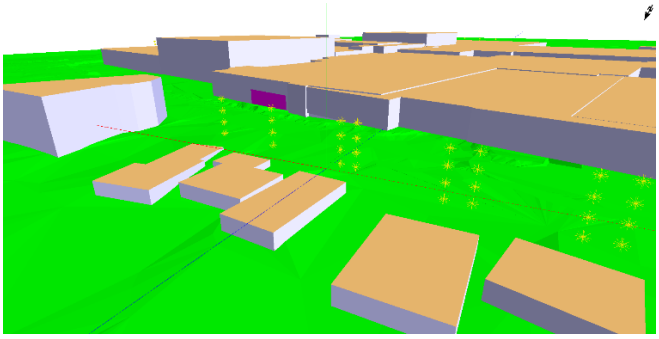
1 x 19m semi-articulated truck driving and reversing

1 x 12.5m rigid truck driving and reversing

1 x unloading activities of 19m semi-articulated truck

1 x unloading activities of 12.5m rigid truck

4 x waste compactors



Modelled Noise Sources (Night)

1 x 19m semi-articulated truck driving and reversing

1 x unloading activities of 12.5m rigid truck

4 x waste compactors

Noise radiating from within the enclosed loading dock has been modelled as an area source (in pink).

Loading Dock 03

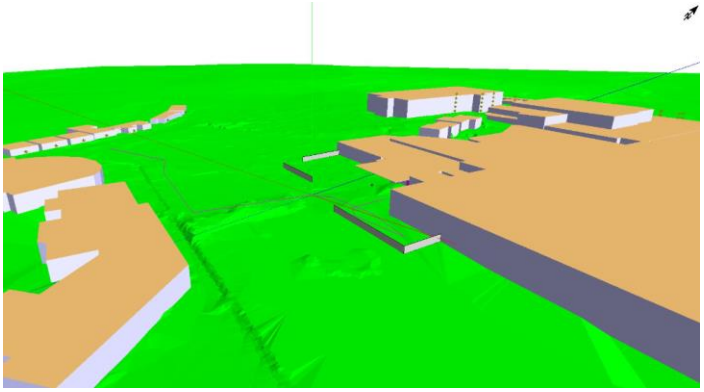
- *Client has indicated loading dock to be open (i.e. not completely enclosed).*

Modelled Noise Sources (All times of the day)

1 x 19m semi-articulated truck driving and reversing

1 x unloading activities of 19m semi-articulated truck

1 x waste compactor



Loading Dock 04

- *Client has indicated loading dock to be completely enclosed with gate.*
- *Gate is assumed to be a sliding, non-continuous screen to dock entrance.*

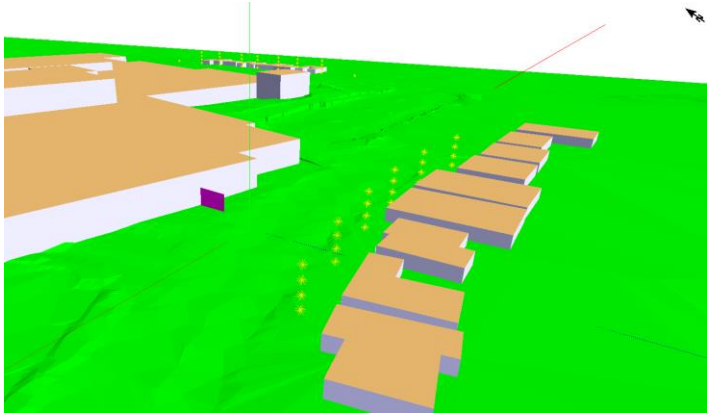
Modelled Noise Sources (Day Only inclusive of Sundays & Public Holidays)

1 x 12.5m rigid truck driving and reversing

1 x unloading activities of 12.5m rigid truck

3 x waste compactors

Noise radiating from within the enclosed loading dock has been modelled as an area source (in pink). Note that the entrance to the dock leads below ground height.



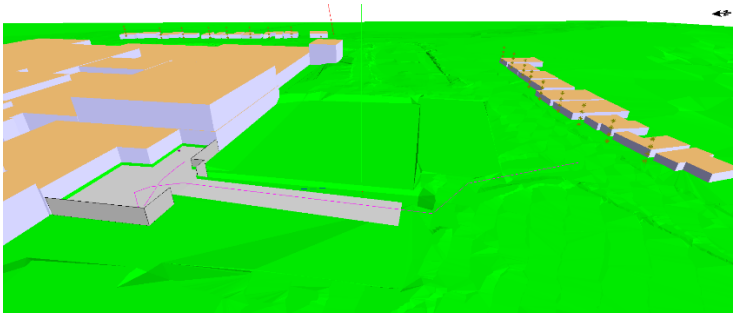
Loading Dock 05 (Interim Stage 1)

- *Client has indicated loading dock to be open (i.e. not completely enclosed).*

Modelled Noise Sources (Day Only inclusive of Sundays & Public Holidays)

1 x 12.5m rigid truck driving and reversing

1 x waste compactor



4.4.4 Predicted Noise Levels

The predicted noise levels at each receiver as a result of noise emissions for two stages of the project:

- Stage 1 – Loading Docks 1, 2, 3 and 5 and High Street loading bays in use (interim development). Docks 2 & 3 only at night; and
- Stage 2 – Loading Docks 1 – 4 and High Street loading bays in use (final development). Docks 2 & 3 only at night.

Results are presented in Table 11. The assessment considers both existing and potential future multi-storey developments. Loading Dock 05 is a temporary Stage 1 location for Loading Dock 04, having the same expected delivery movements. It does not operate during 'night' hours.

Table 11: Highest Predicted Noise Levels - Untreated

Surrounding Road	Time Period [1]	EPNR L_{10} Assigned Level - dBA	Highest Modelled L_{10} – dBA Inc 19m Truck on Andrea Ln & 9m Truck on High St	Predicted EPNR Exceedance - dB
Almondbury Rd	Day (Mon – Sat)	50	44 (Stages 1 & 2)	Complies
	Day (Sun & Pub Hol), Evening	45	44 (Stages 1 & 2)	Complies
	Night	40	37	Complies
Davy St	Day (Mon – Sat)	50	45 (Stages 1 & 2)	Complies
	Day (Sun & Pub Hol), Evening	45	45 (Stages 1 & 2)	Complies
	Night	40	**45 (Stages 1 & 2)**	**+5 dB**
Marmion St	Day (Mon – Sat)	54	42 (Stage 1) 38 (Stage 2)	Complies
	Day (Sun & Pub Hol), Evening	49	42 (Stage 1) 38 (Stage 2)	Complies
	Night	44	37 (Stages 1 & 2)	Complies

NOTE 1: Time periods per the EPNR. Criteria listed are based on the worst-case receiver location for each road.

NOTE 2: The Melville City Centre Structure Plan does not indicate multi-storey developments for Davy St. Therefore, only the existing environment has been assessed.

4.4.5 Noise Management Measures

4.4.5.1 Loading Dock 03

Noise emissions from loading docks are dominated by the open Loading Dock 03. In order to maintain compliance with the night-time assigned levels through noise management measures, the following would be required:

- Night-time (2200 hours on any day to 0700 hours Monday to Saturday, 0900 hours Sunday & public holidays);
  - 19m semi-articulated trucks are not permitted to be used at night-time; and
  - No use of the waste compactors.

Table 12 presents the predicted Loading Dock noise levels with the above noise management measures applied to the open Loading Dock 03.

Table 12: Highest Predicted Noise Levels – Loading Dock 03 with Noise Management Measures Applied

Surrounding Road	Time Period [1]	EPNR L_{10} Assigned Level - dBA	MANAGEMENT MEASURES Highest Modelled L_{10} – dBA	Predicted EPNR Exceedance - dB
Davy St	Night	40	39	Complies

NOTE 1: Time periods per the EPNR. Criteria listed are based on the worst-case receiver location for each road.
NOTE 2: The Melville City Centre Structure Plan does not indicate multi-storey developments for Davy St. Therefore, only the existing environment has been assessed.

It is noted that unloading activities are typically dominated by the noise of pallets impacting the truck bed or floor of the loading dock. Unloading of trucks during the evening and night-time periods should be conducted in a manner with deliberate intent to reduce this noise.

The measured night-time background (L_{90}) noise levels in the area are 43 – 44 dBA, being likely to mask the noise from the loading dock. It is noted that loading dock 03 is an existing loading dock hence residents may be accustomed to the noise and unlikely to have any adverse reaction to the operations.

4.4.5.2 High Street Truck Loading Bays

The high street truck loading bays are proposed to only be used during daytime hours. In order to maintain compliance with the assigned levels:

- Day time (0900 – 1900 hours Sundays & Public Holidays) – Only one Keg Truck (9m) may be unloaded at any one time.

4.4.5.3 All Loading Docks

All loading docks require the following measures to be applied:

- Fully enclosed loading docks should have a solid gate or roller door, consisting of the following:
  - Have minimum surface mass of 7-10 kg/m^2 (sheet steel or similar) and have an airborne sound insulation performance rating of $R_W \geq 25$;
  - Solid construction consisting of a non-perforated material and continuous throughout (where practical);
  - Minimal gaps/holes between gate and framework;
  - Noise from the mechanical systems to operate the door has not been considered. It should comply with the Assigned Noise Levels;
- Gates should be open as soon as each delivery truck arrives, and immediately closed once inside the loading dock to minimise unnecessary noise;
- Trucks should not be permitted to idle at any time whilst at the entrance to any loading docks, or within the loading dock areas;
- Unloading activities and use of compactor should not take place whilst loading dock doors are open;
- Refrigerated trucks must be off when unloading if the door is open;
- When air brakes are used inside the loading dock, all efforts should be made to ensure that the loading dock door is closed during the maneuvering process;
- Reversing of trucks is to occur in full inside the loading dock, whilst doors are closed. Doors must remain open for the minimum time possible, and never with reverse beepers in operation; and

- Trucks must be fitted with broadband type reversing alarms (sometimes referred to as quackers or croakers), rather than single tone alarms (beepers) which may contribute to tonal characteristics at the receiver locations.

4.5 Tavern and ELP Assessment

This section details the noise assessment conducted for the tavern and ELP. The preliminary assessment provides design advice such that patron and music noise will comply with the EPNR at the nearest noise sensitive receivers. As the tavern design progresses, Stantec will provide recommendations for external façade construction and/or noise management measures for ongoing predicted compliance.

The location of the tavern and ELP and a 3D image from the noise model are shown in Figure 4. The tavern and ELP locations are highlighted in red, while the areas shaded purple in the noise model image represent patron and music noise emanating from the areas.

Figure 4: Tavern and ELP Location and Noise Model Image

The distances to the nearest receivers are approximately:

- Melville Council Chambers (commercial land use) – 45m;
- Almondbury Rd (residential) receivers – 120m; and
- Davy St (residential) receivers – 220m.

4.5.1 Sound Levels – Tavern

At this stage, the maximum patronage of the tavern has not been advised to Stantec. Architectural master lease plans indicate a floor area of 1862 m^2 over 2 floors including balcony areas. The tavern was designed to have maximum allowable patronage, given that the tavern is open to the outdoors, while maintaining compliance to the EPNR.

The technical research paper '*Prediction of Noise from Small to Medium Sized Crowds'* (Hayne et al., November 2011), was used to estimate patron noise levels.

Patron noise levels used in the noise emissions assessment have considered the following:

- Sound level associated with speech from a 50% mixture of male and female patrons;
- Corrections for elevated patron noise in the tavern, due to the consumption of alcohol (+3 dB); and
- Even distribution of patrons around the outdoor areas.

It has been assumed that some form of AV / music system will be installed and used frequently within the tavern. As such, low frequency attenuation becomes increasingly pertinent when proposing treatments for music as a source of noise compared with crowd noise at a numerically equivalent sound power level. The design does not allow for the use of sub-woofers with high low-frequency output.

An acoustic assessment was conducted for varying levels of music within the tavern. L_{10} spectral noise data for music was sourced from measured levels on similar Stantec projects. Noise management measures have been proposed to achieve compliance to external noise levels as per the nominated criteria in Section 2.1.2. In addition, the adjustments detailed in Table 5 would become applicable if music is audible at a noise sensitive receiver.

Patron and music noise inputs to the noise model are presented in Table 13.

Table 13: Combined Patron and Music Sound Power Levels – Tavern

Time of Day	No. Patrons[1]	SWL dBA	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
0700 to 1900 hours Monday to Saturday; 0900 to 1900 hours Sunday and Public Holidays; and 1900 to 2200 hours all days.	280 Patrons + Music	**107**	100	97	93	94	97	100	101	101
2200 hours on any day to 0700 hours Monday to Saturday; and 0900 hours Sunday & public holidays	250 Patrons + Music	**106**	95	91	92	93	96	99	100	101

Note 1) Music levels were set for each scenario such that they would not become audible over patron noise and attract adjustments to the received level per the EPNR criteria.

The tavern amplifier system should have known output sound levels via the controls to assist in ensuring music from the venue is inaudible at the receivers. When music becomes audible at the receiver, adjustments of 10 – 15 dB are required per the EPNR, introducing a non-compliance. Music levels should be set based on field measurements to the north, west and south so as not to be audible at nearby receivers and attract adjustments for music as per the EPNR. It is not recommended for external parties to bring their own speaker systems to the venue nor that music is played in the outdoor areas above what may be considered an "ambient" level (e.g. patrons remain able to converse without raising their voices). Noise emissions from the venue should be addressed in the venue operations noise management plan.

4.5.2 Tavern Building Envelope

Based on the architectural layouts, the proposed external envelope construction will consist of a combination of solid, glazed and shading elements. Façade treatments have been recommended based on calculations which consider the predicted noise emissions from patrons and music in tavern, which are required to comply with the EPNR. This includes a 15dB adjustment where music becomes audible at the nearest noise sensitive receivers.

Architectural concept drawings indicate that large operable glazing elements separate the tavern bar service and other indoor areas from the outdoor areas. This is assumed to be fully open to the environment while the tavern is in operation to allow patrons to move back and forth from indoors to outdoors. Should the tavern design allow for automatic closing doors, or the intent is to have all operable glazing closed during certain times of operation, advice on façade construction will be provided.

Glazing systems and entryway elements typically provide lower airborne sound insulation performance than external walls, forming weak acoustic links in the building envelope. Doors in particular are weak acoustically as they cannot achieve higher performance due to the presence of seals and operating mechanisms.

The following treatments are required to the external facades in order to ensure noise emissions comply with the EPNR. Assumed patron numbers and music levels are stated in Table 14.

Tavern Building Envelope

Where solid elements are used as the external wall, the walls are required to achieve $R_W + C_{tr}$ 45 as a minimum to achieve acceptable internal noise levels. As the architectural concept drawings show brick facades, the following solid element configurations are suggested to achieve this rating;

- Solid elements:
  - 110mm brickwork + 70mm air gap + 110mm brick work, with cavity insulation. Cavity ties are recommended to be resilient type; or
  - 110mm brickwork + 70mm air gap + 90mm brick work, with cavity insulation. Cavity ties are recommended to be resilient type.
- Glazed elements, doors and ceilings:
  - A solid and continuous balustrade of 1.5m height is required for all tavern first floor balconies. Glazed balustrades should be 6.38mm laminated glass or thicker;
  - Acoustic rating of operable glazing, doors and ceilings is not beneficial if the tavern is to operate with all operable glazing open to the environment. Should the tavern design allow for automatic closing doors, or the intent is to have all operable glazing closed during certain times of operation, advice on acoustic ratings will be provided.

Table 14: **Predicted tavern patron numbers and music levels for EPNR compliance, Operable Glazing Fully Open**

Time of Day	Music Levels for EPNR Compliance [1, 2]	Patron Numbers [1, 2]
Day / Evening (Inc. Sun & Public Holidays) 0700 to 1900 hours Monday to Saturday, 0900 to 1900 hours Sunday and Public Holidays and 1900 to 2200 hours all days	Music: Sound Pressure Level of **below 80 dBA** in the space.	280 Patrons maximum

Time of Day	Music Levels for EPNR Compliance [1, 2]	Patron Numbers [1, 2]
Night 2200 hours on any day to 0700 hours Monday to Saturday, and 0900 hours Sunday & public holidays	Music: Sound Pressure Level of **below 75 dBA** in the space.	250 Patrons maximum

Note 1: Architectural concept drawings indicate that large operable glazing elements separate the tavern bar service and other indoor areas from the outdoor areas. This is assumed to be fully open to the environment while the tavern is in operation to allow patrons to move back and forth from indoors to outdoors. Higher patron numbers and music levels could be achieved should the operable glazing be closed majority of the time.

Note 2: Design stage predictions are a starting point for achieving compliance to the EPNR. Noise management measures should be addressed in a separate Venue Management Plan, with environmental noise monitoring used to confirm noise levels at the nearest receivers.

4.5.3 Sound Levels – ELP

The ELP noise emissions have been calculated to predict the impact on the nearest sensitive receivers. Based on the Design Workshop Presentation provided (Table 1), the ELP is expected to host a number of patrons, a children's play area and occasionally ambient music during the day and evening time.

Noise model inputs were based on the following:

- Patron noise – up to 100 persons typically expected to be within the ELP area. Patron noise was calculated per the paper referenced in Section 4.5.1, with no correction for consumption of alcohol;
- Music noise from outdoor speakers – occasional outdoor ambient music may be expected in the ELP. Sound spectrum of speakers were obtained from SoundPLAN 8.2 system library (*JBL – AW 266, 12" 2 – way rotatable horn all weather loudspeaker*), including speaker directivity information;
- Children's play area – a total of 25 children playing were modelled. Sound data was sourced from the '*Guideline for Child Care Acoustic Assessment*', Association of Australian Acoustical Consultants, 2013. Mixed ages were used from 0 – 6 years, with the mid-point of the stated Sound Power Level range selected for each age group; and
- It is assumed that no music, children playing or large crowds of people will be within the ELP at night-time (after 2200hr on any day).

The noise sources modelled in the ELP are summarised in Table 15. Figure 5 shows the noise source locations in the noise model. Similarly to the tavern, noise management measures should be put in place to ensure that **music noise from outdoor speakers in the ELP does not become audible at the receiver locations**.

Note that where the noise received at a premises is music, adjustments to the received level are required when assessing compliance to the EPNR. Should music become audible and dominant, adjustments of +10 to 15 dB are required. This would likely result in non-compliance to the EPNR.

Thus, it is critical that any music be level calibrated to a level no higher than the SWL advised in Table 15. The system should have known output sound levels indicated on the controls to assist in ensuring the amplified sound is kept within acceptable limits at nearby receivers. The limits should be set based on field measurements at nearby sensitive premises, or alternatively, speakers are not to exceed a Sound Pressure Level of 85 dB(A) measured at 1m.

Table 15: Noise Sources – ELP

Noise Source	SWL dB(A)
100 Patrons	97
Outdoor Speakers, Maximum 2 Off	95, per speaker
25 Children Playing	89

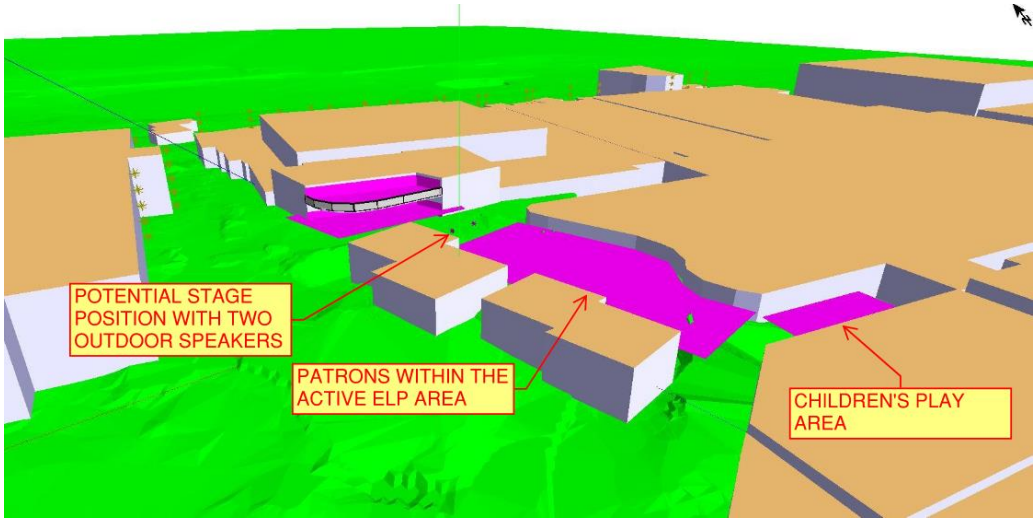


Figure 5: ELP patron and music noise source locations

4.5.4 Predicted Noise Levels – Tavern & ELP

The predicted noise levels received from the tavern and ELP are presented in Table 16.

Table 16: Combined Tavern and ELP Noise Levels

Receiver	Time of Day [1]	Tavern Patrons [2] + Music	ELP Patrons + Music	Assigned Level L_{10} – dBA	Highest Modelled L_{10} – dBA	Predicted EPNR Exceedance – dB
Almondbury Rd Residences	Day (Mon – Sat)	280	100	50	44	Complies
	Day (Sun & Pub Hol) / Evening	280	100	45	44	Complies
	Night	250	—	40	40	Complies
Davy St Residences	Day (Mon – Sat)	280	100	50	44	Complies
	Day (Sun & Pub Hol) / Evening	280	100	45	44	Complies
	Night	250	—	40	40	Complies
Marmion St Residences	Day (Mon – Sat)	280	100	54	40	Complies
	Day (Sun & Pub Hol) / Evening	280	100	49	40	Complies
	Night	250	—	44	35	Complies
Melville Council Chambers Commercial	All Hours	Max 280	100	60	60	Complies

Note 1) Time of day as defined in the EPNR. 'Evening' criteria is applicable during the day on Sundays and public holidays.
Note 2) No more than 50 patrons to be admitted on the Level 1 balcony. Solid balustrades 1.5m high are required.

The tavern and ELP contributions are less likely to be noticed as the measured background noise is similar to the predicted noise levels.

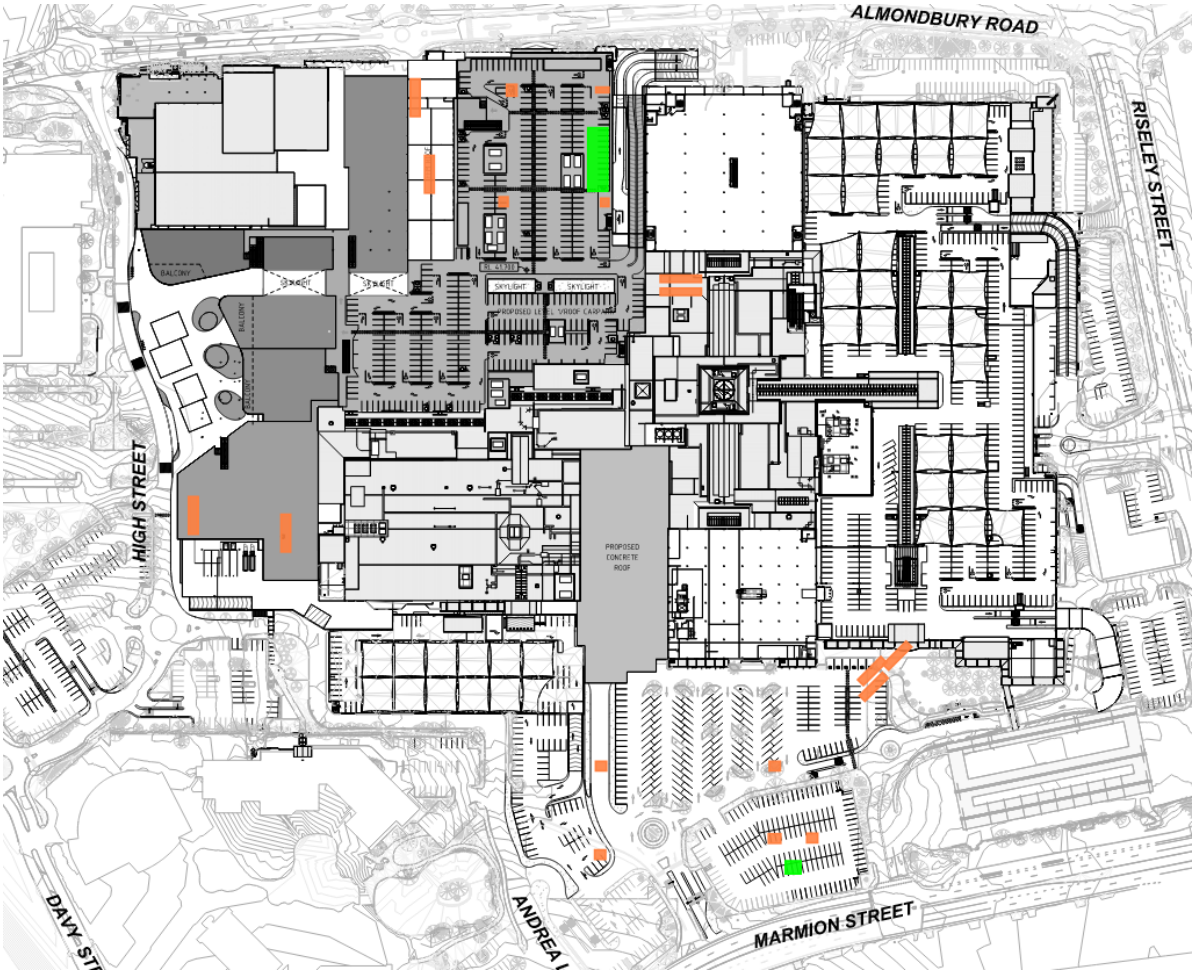
4.6 Mechanical Plant Assessment

Mechanical plant details have not been provided at this stage and will be included in the acoustic assessment once available. Appropriate treatments to ensure compliance with the EPNR (e.g. solid barriers, acoustic cowlings/louvres, low noise fans) will be recommended if required.

The following major noise emitted plant items have been identified, with their general locations indicated in Figure 6.

- Cooling towers;
- Smoke extract fans (SEF);
  - Note these items would operate in emergency scenarios only, yet are required to comply with the EPNR criteria; and
- Refrigeration condensers;
  - Location of the refrigeration condensers is yet to be advised to Stantec. Note that refrigeration condensers for the supermarkets are likely to be tonal and modulating per the definitions provided in the EPNR, with the predicted received noise levels to be adjusted accordingly (+10 dB).

In general, mechanical plant items typically have a tonal characteristic as defined by the EPNR. 1/3 octave band data is required yet is typically unavailable. Therefore, a +5 dB adjustment shall be conservatively assigned to the predicted level of noise being received.



Source: Scentre Group – Mechanical Services Plans

Figure 6: Roof Plan – Cooling Tower (Green) and Smoke Extract Fan (Orange) Indicative Locations

5. Conclusion

Stantec were commissioned by Scentre Group to undertake an acoustic assessment of the Westfield Booragoon redevelopment in Booragoon WA.

Predictive acoustic assessment of the proposed loading docks, tavern and ELP associated with the development were made against the criteria of the EPNR.

Noise emissions from mechanical plant will be reviewed when more information is available at further stages of the design.

The assessment generally identifies compliance with the EPNR, with noise management measures proposed where required for compliance. Noise emissions are generally not expected to have an adverse impact the acoustic amenity of the community, given that the expected levels are comparable with the measured background noise levels.

Ambient noise levels at residences in the area were measured over a week, and we have identified that current measured noise levels at residential properties along the roads surrounding the site are equal to or higher than the Assigned Noise Levels for the studied noise sensitive receivers at those locations.

In summary, in view of the available information and the site conditions, we consider that operations associated with loading dock operations, proposed tavern and ELP will be able to comply with the EPNR. The predictions in this report consider that the assumptions, building recommendations and noise management measures provided will be implemented.

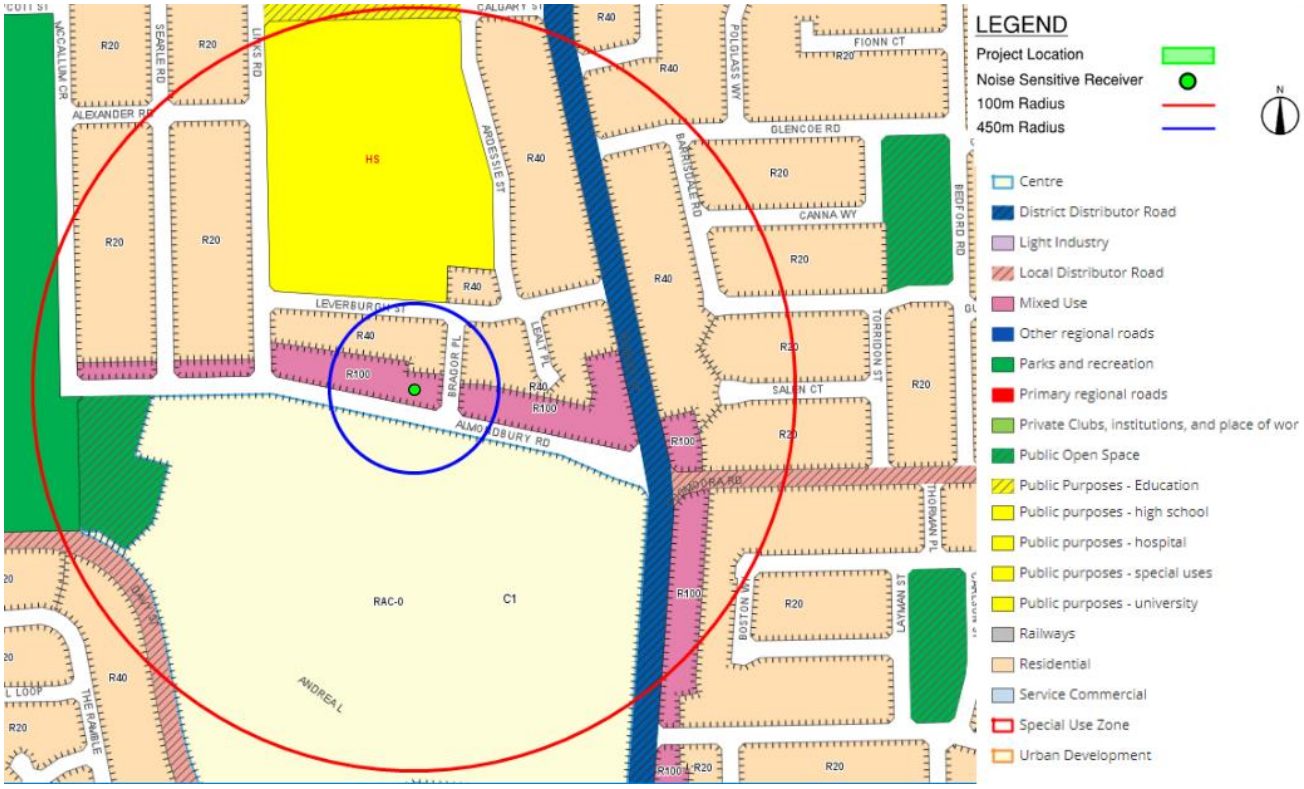
Appendix A Glossary of Acoustic Terms

NOISE	
Acceptable Noise Level:	The acceptable LAeq noise level from industrial sources, recommended by the EPA (Table 2.1, INP). Note that this noise level refers to all industrial sources at the receiver location, and not only noise due to a specific project under consideration.
Adverse Weather:	Weather conditions that affect noise (wind and temperature inversions) that occur at a particular site for a significant period of time. The previous conditions are for wind occurring more than 30% of the time in any assessment period in any season and/or for temperature inversions occurring more than 30% of the nights in winter).
Acoustic Barrier:	Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc. used to reduce noise.
Ambient Noise:	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment Period:	The period in a day over which assessments are made.
Assessment Location	The position at which noise measurements are undertaken or estimated.
Background Noise:	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level.
Decibel [dB]:	The units of sound pressure level.
dB(A):	A-weighted decibels. Noise measured using the A filter.
Extraneous Noise:	Noise resulting from activities that are not typical of the area. Atypical activities include construction, and traffic generated by holidays period and by special events such as concert or sporting events. Normal daily traffic is not considered to be extraneous.
Free Field:	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground
Frequency:	Frequency is synonymous to pitch. Frequency or pitch can be measured on a scale in units of Hertz (Hz).
Impulsive Noise:	Noise having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent Noise:	Level that drops to the background noise level several times during the period of observation.
LAmax	The maximum A-weighted sound pressure level measured over a period.
LAmin	The minimum A-weighted sound pressure level measured over a period.
LA1	The A-weighted sound pressure level that is exceeded for 1% of the time for which the sound is measured.
LA10	The A-weighted sound pressure level that is exceeded for 10% of the time for which the sound is measured.
LA90	The A-weighted level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
LAeq	The A-weighted “equivalent noise level” is the summation of noise events and integrated over a selected period of time.

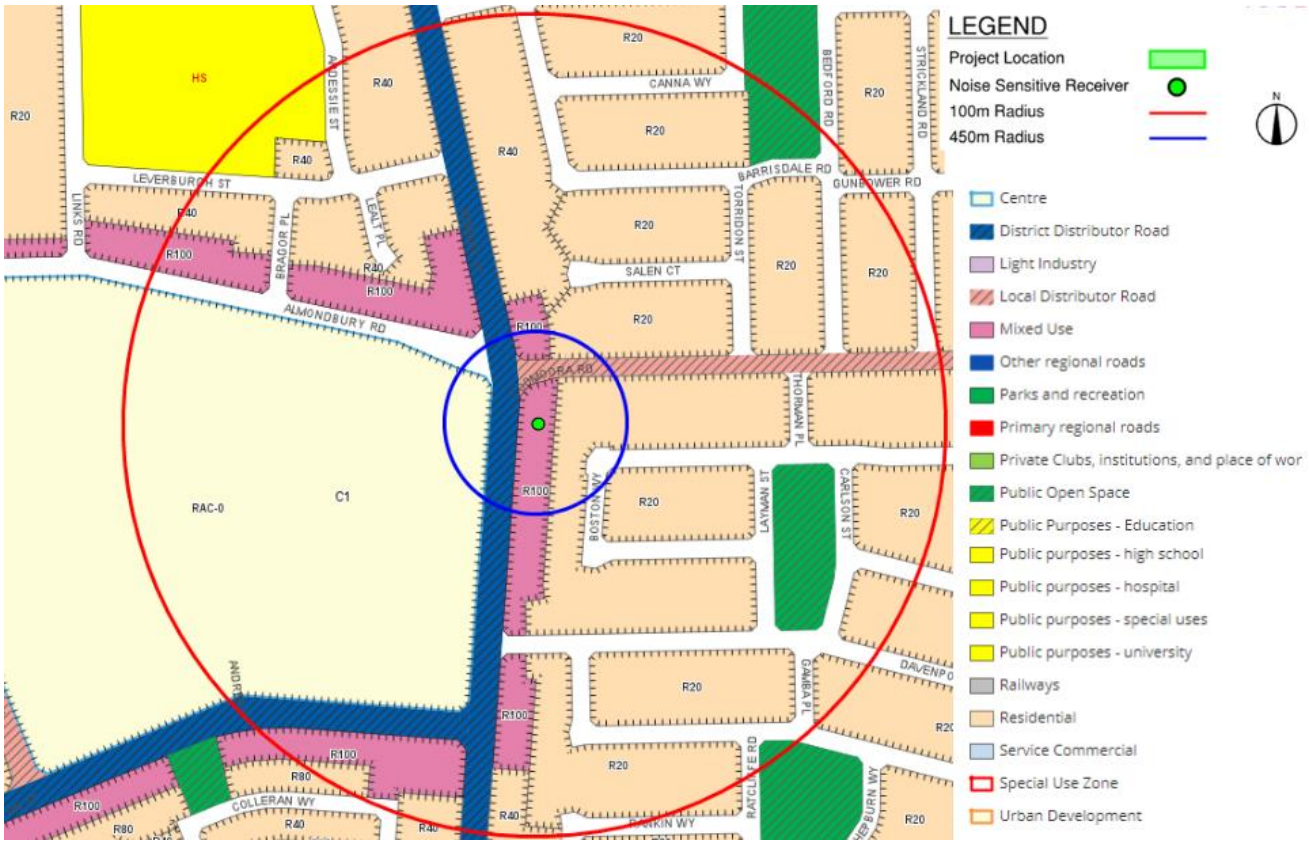
LAeqT	The constant A-weighted sound which has the same energy as the fluctuating sound of the traffic, averaged over time T.
Reflection:	Sound wave changed in direction of propagation due to a solid object met on its path.
R-w:	The Sound Insulation Rating R-w is a measure of the noise reduction performance of the partition.
SEL:	Sound Exposure Level is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound Absorption:	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter:	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level:	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level:	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise:	Containing a prominent frequency and characterised by a definite pitch.

Appendix B Influencing Factor Calculations

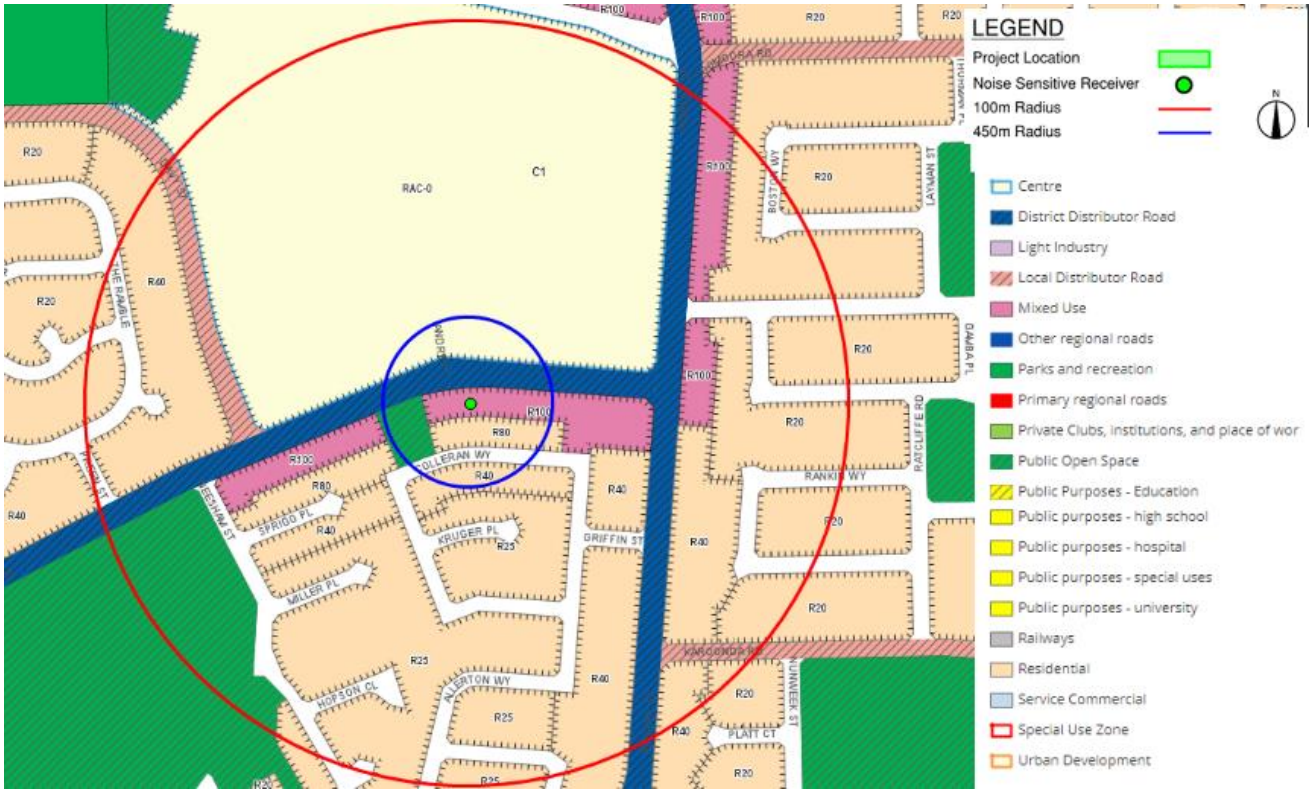
19 Almondbury Road



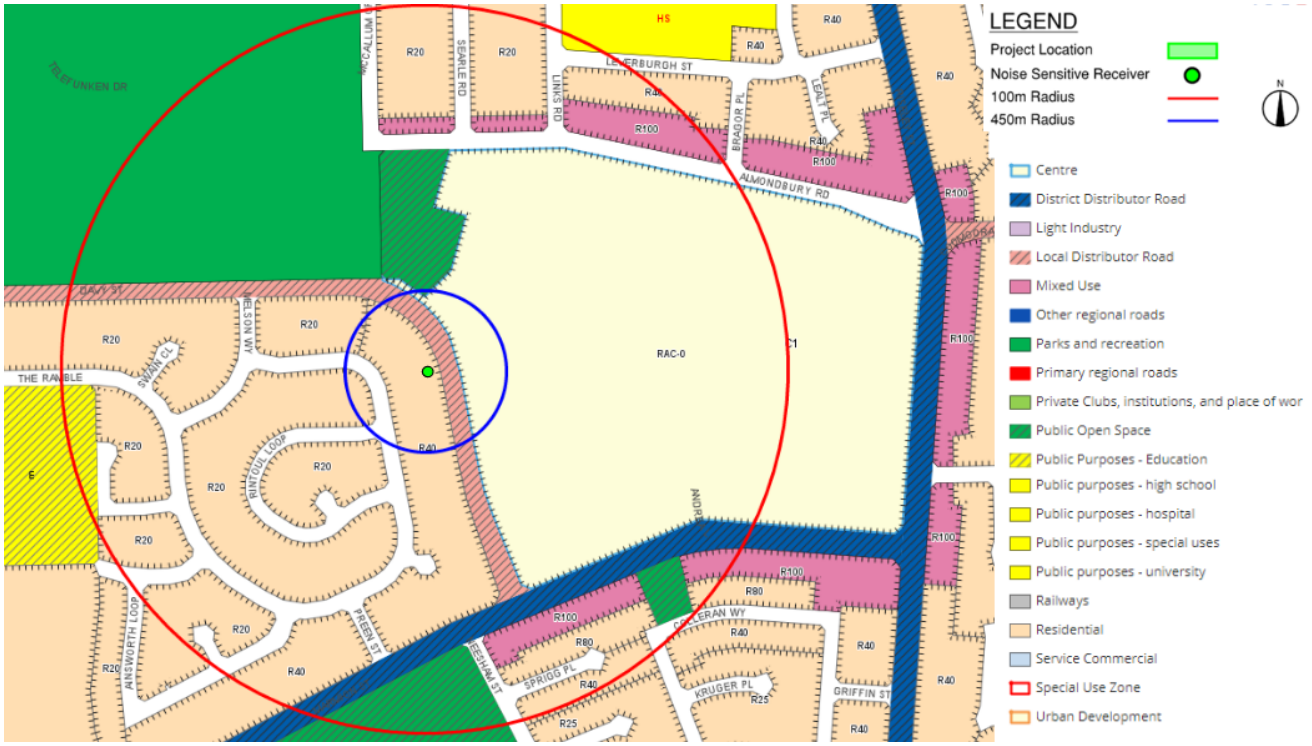
146 Riseley Street



555 Marmion Street

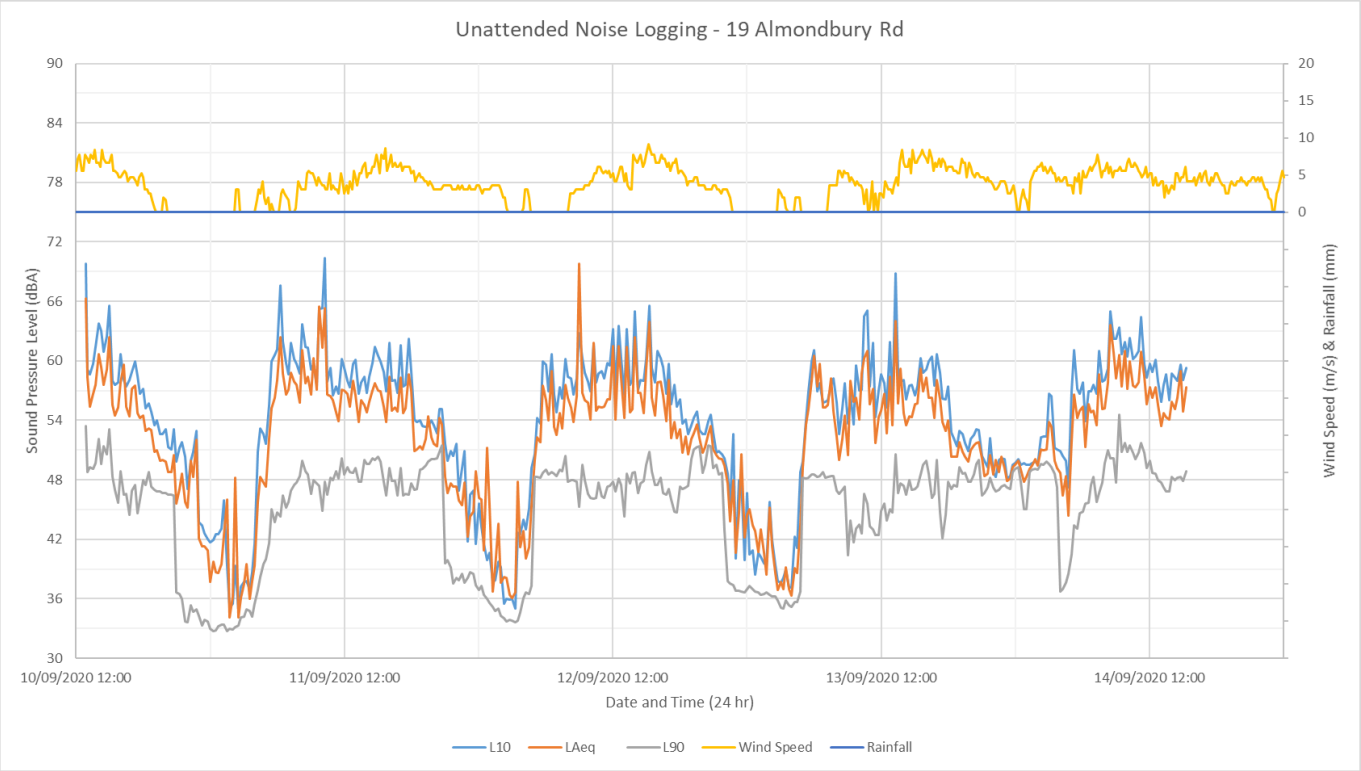


86 The Ramble (Davy St)

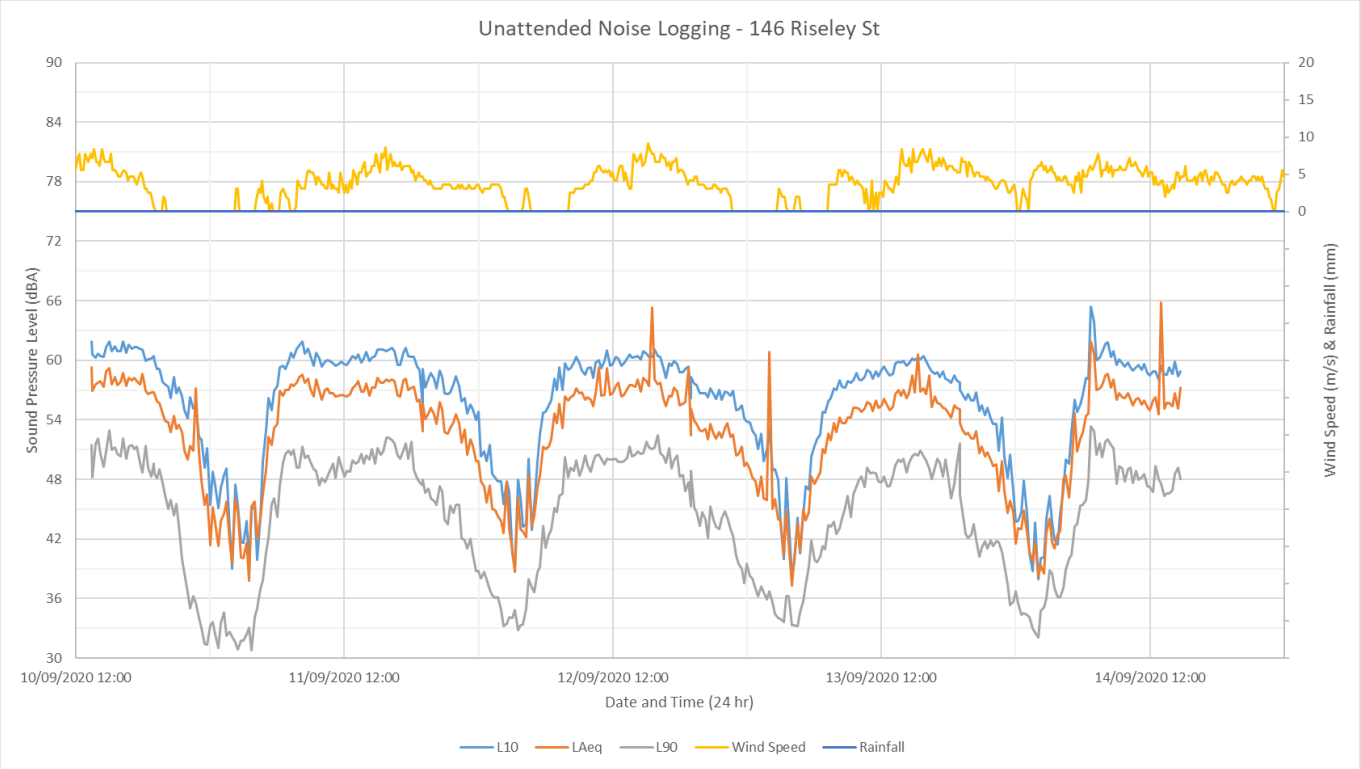


Appendix C Noise Logger Graphs

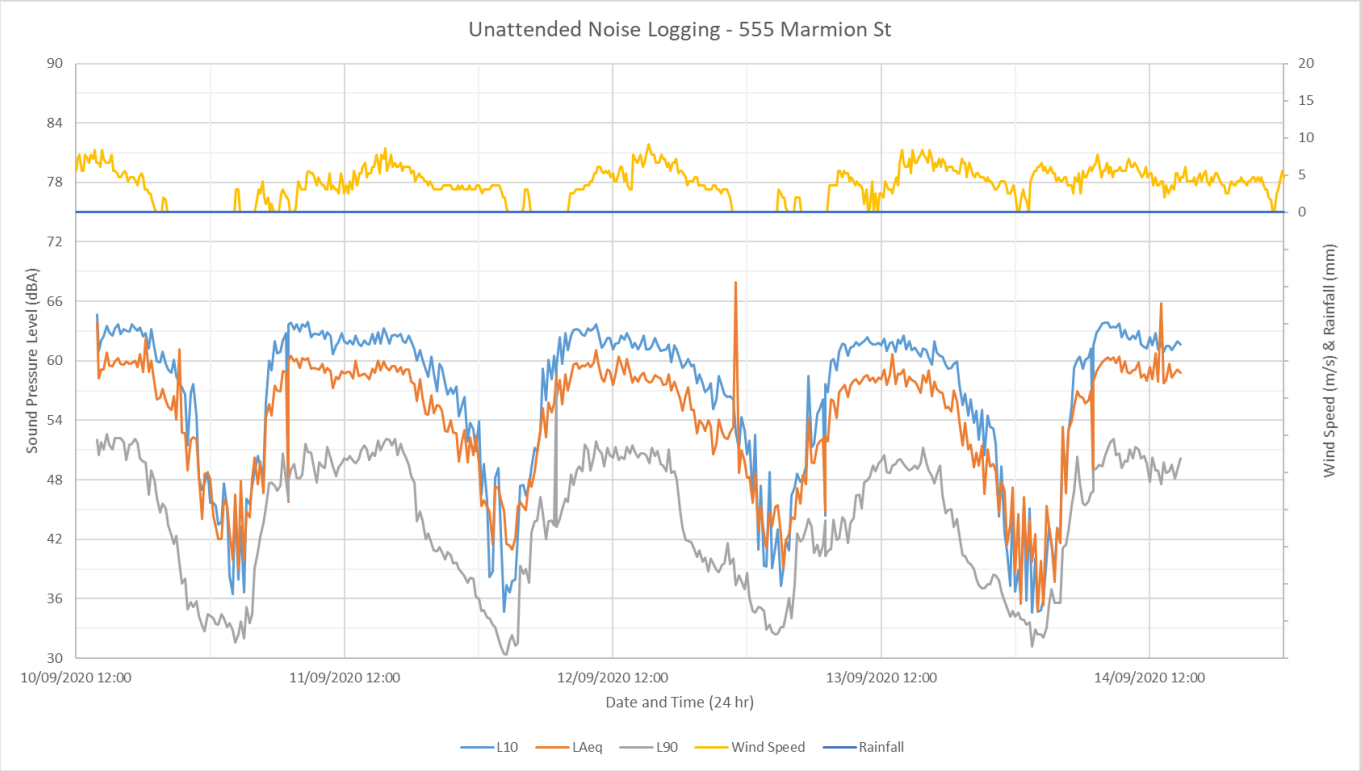
19 Almondbury Road



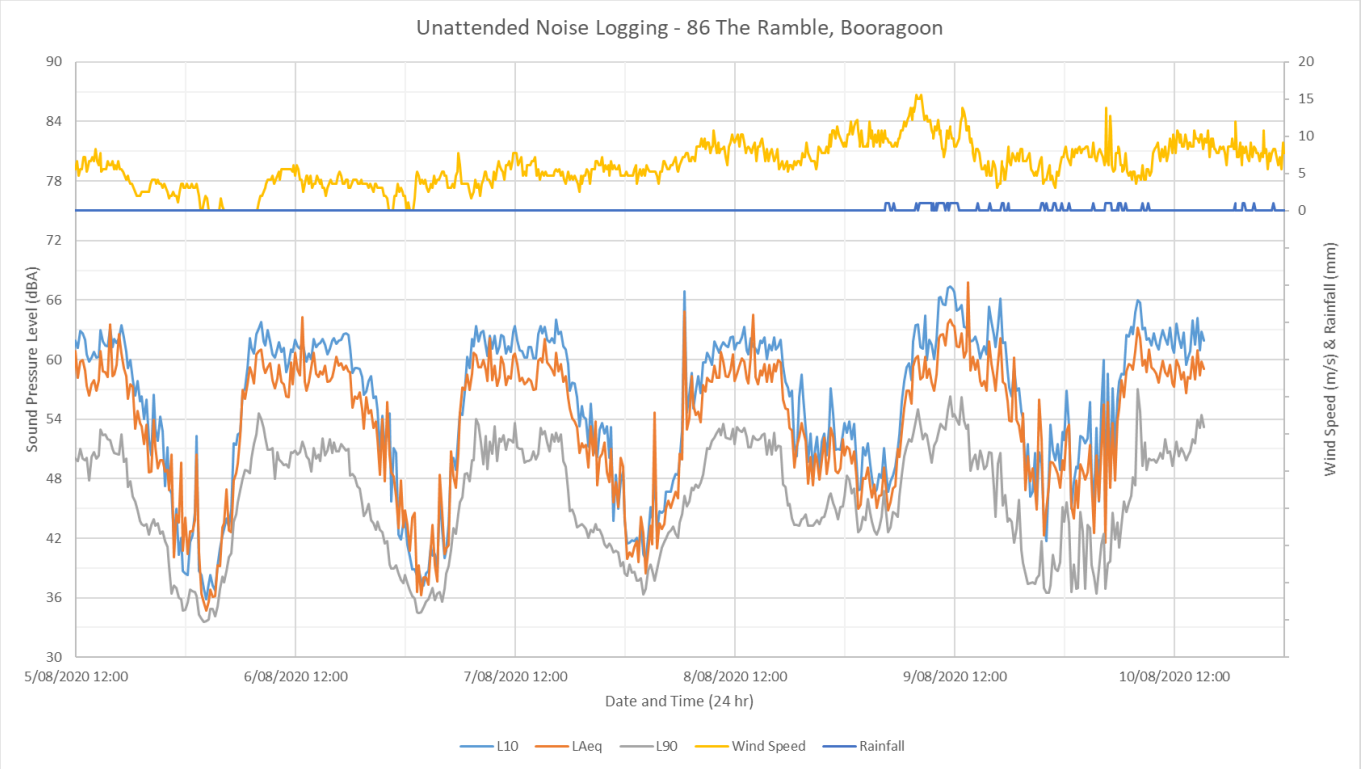
146 Riseley Street



555 Marmion Street



86 The Ramble (Davy Street)



Appendix D Noise Contours

Westfield Booragoon

47434
29/07/21
BEM

LOADING DOCK
NOISE EMISSIONS -
STAGE 1 - DAY/EVENING

NOISE CONTOUR AT
1.5m HEIGHT

Noise level
in dB(A)

	< 35.0
35.0 <=	< 38.0
38.0 <=	< 41.0
41.0 <=	< 44.0
44.0 <=	< 47.0
47.0 <=	< 50.0
50.0 <=	< 53.0
53.0 <=	< 56.0
56.0 <=	< 59.0
59.0 <=	< 62.0
62.0 <=	< 65.0
65.0 <=	< 68.0
68.0 <=	< 71.0
71.0 <=	< 74.0
74.0 <=	< 77.0

0 10 20 30 40 50
m

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Westfield Booragoon

47434
29/07/21
BEM

LOADING DOCK
NOISE EMISSIONS -
STAGE 2 - DAY/EVENING

NOISE CONTOUR AT
1.5m HEIGHT

Noise level
in dB(A)

	< 35.0
35.0 <=	< 38.0
38.0 <=	< 41.0
41.0 <=	< 44.0
44.0 <=	< 47.0
47.0 <=	< 50.0
50.0 <=	< 53.0
53.0 <=	< 56.0
56.0 <=	< 59.0
59.0 <=	< 62.0
62.0 <=	< 65.0
65.0 <=	< 68.0
68.0 <=	< 71.0
71.0 <=	< 74.0
74.0 <=	< 77.0

0 10 20 30 40 50
m

Stantec

Westfield Booragoon

47434
29/07/21
BEM

LOADING DOCK
NOISE EMISSIONS -
STAGES 1 & 2 - NIGHT
w NOISE MANAGEMENT

NOISE CONTOUR AT
1.5m HEIGHT

Noise level
in dB(A)

	< 35.0
35.0 <=	< 38.0
38.0 <=	< 41.0
41.0 <=	< 44.0
44.0 <=	< 47.0
47.0 <=	< 50.0
50.0 <=	< 53.0
53.0 <=	< 56.0
56.0 <=	< 59.0
59.0 <=	< 62.0
62.0 <=	< 65.0
65.0 <=	< 68.0
68.0 <=	< 71.0
71.0 <=	< 74.0
74.0 <=	< 77.0

0 10 20 30 40 50
m

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Westfield Booragoon

47434
29/07/21
BEM

TAVERN & ELP
NOISE EMISSIONS -
DAY/EVENING

NOISE CONTOUR AT
1.5m HEIGHT

Noise level
in dB(A)

	< 35.0
35.0 <=	< 38.0
38.0 <=	< 41.0
41.0 <=	< 44.0
44.0 <=	< 47.0
47.0 <=	< 50.0
50.0 <=	< 53.0
53.0 <=	< 56.0
56.0 <=	< 59.0
59.0 <=	< 62.0
62.0 <=	< 65.0
65.0 <=	< 68.0
68.0 <=	< 71.0
71.0 <=	< 74.0
74.0 <=	< 77.0

0 10 20 30 40 50
m

Stantec

Westfield Booragoon

47434
29/07/21
BEM

TAVERN & ELP
NOISE EMISSIONS - NIGHT

NOISE CONTOUR AT 1.5m HEIGHT

Noise level
in dB(A)

	< 35.0
35.0 <=	< 38.0
38.0 <=	< 41.0
41.0 <=	< 44.0
44.0 <=	< 47.0
47.0 <=	< 50.0
50.0 <=	< 53.0
53.0 <=	< 56.0
56.0 <=	< 59.0
59.0 <=	< 62.0
62.0 <=	< 65.0
65.0 <=	< 68.0
68.0 <=	< 71.0
71.0 <=	< 74.0
74.0 <=	< 77.0

0 10 20 30 40 50
m

Stantec

Design with
community in mind

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For more information please visit
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