Lloyd George Acoustics
PO Box 717
Hillarys WA 6923
T: 9401 7770
www.lgacoustics.com.au

Local Structure Plan Noise Assessment

Piara Waters West

Reference: 21036198-01d

Prepared for:
Stockland

Report: 21036198-01d

Lloyd George Acoustics Pty Ltd

ABN: 79 125 812 544

PO Box 717
Hillarys WA 6923

www.lgacoustics.com.au

Contacts	General	Daniel Lloyd	Terry George	Matt Moyle
E:	info@lgacoustics.com.au	daniel@lgacoustics.com.au	terry@lgacoustics.com.au	matt@lgacoustics.com.au
P:	9401 7770	0439 032 844	0400 414 197	0412 611 330
Contacts	**Ben Hillion**	**Rob Connolly**	**Daryl Thompson**	**Hao Tran**
E:	ben@lgacoustics.com.au	rob@lgacoustics.com.au	daryl@lgacoustics.com.au	hao@lgacoustics.com.au
P:	0457 095 555	0410 107 440	0420 364 650	0438 481 207

Date:	Rev	Description	Prepared By	Verified
28-Apr-21	0	Issued to Client	Terry George	Matt Moyle
10-May-21	A	Updated with preferred wall design	Terry George	-
21-May-21	B	Updated with final plan	Terry George	-
9-Jun-21	C	Concept plan updated	Terry George	-
17-Dec-21	D	Minor text changes and plan updated	Terry George	-

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1 INTRODUCTION

Stockland is proposing to develop land in the north-east quadrant of the Armadale Road and Warton Road intersection in Piara Waters – refer *Figure 1-1*. The concept plan is provided in *Figure 1-2*, noting that whilst Stockland own the majority of the site, the northern and eastern extremities are owned by others. With the site adjoining Warton Road and Armadale Road, consideration is to be given to noise impacts from road traffic. Also considered in this report, is the Cockburn-Fremantle Pistol Club at 886 Warton Road (highlighted in yellow on *Figure 1-1*).

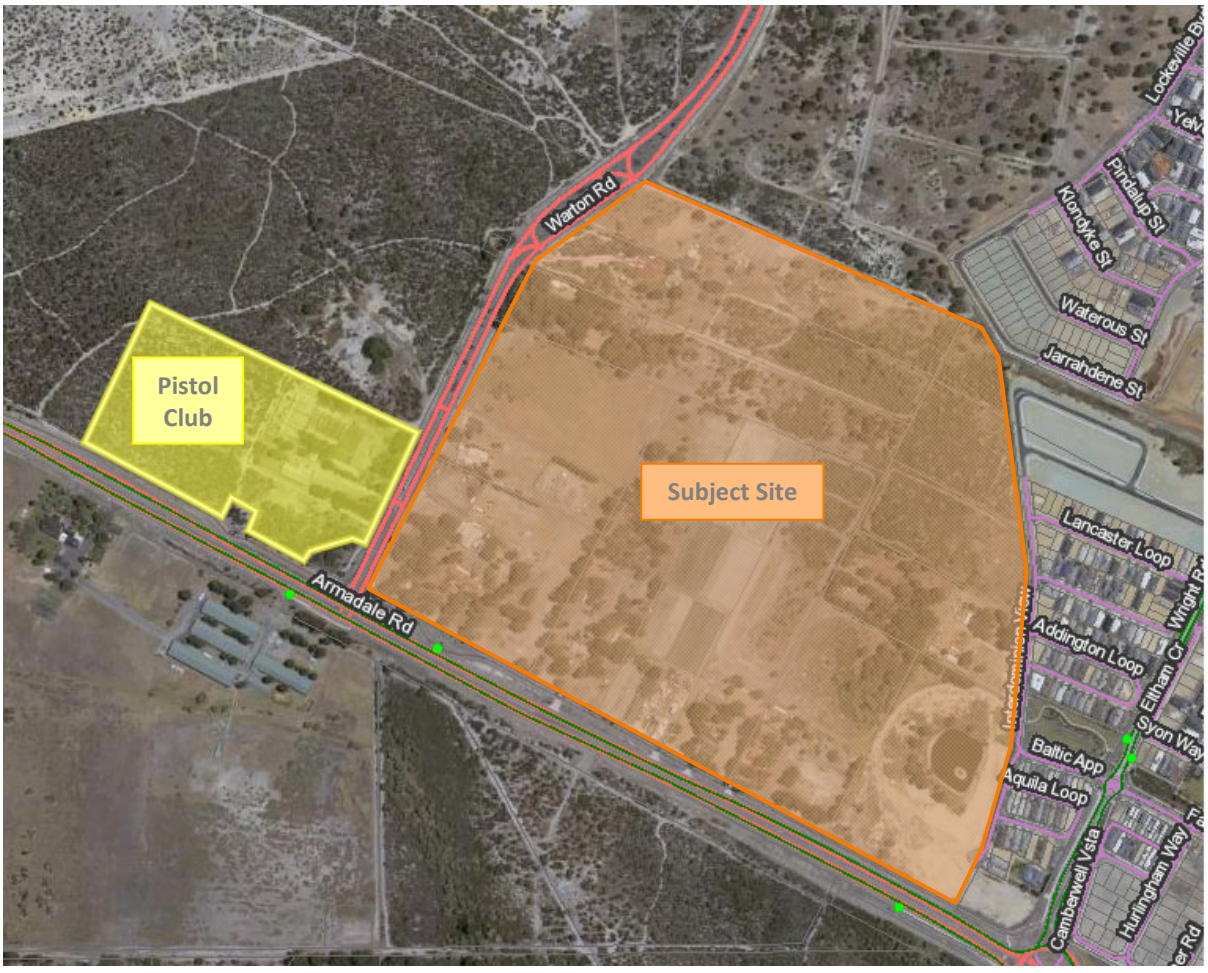


Figure 1-1 Proposed Site Locality

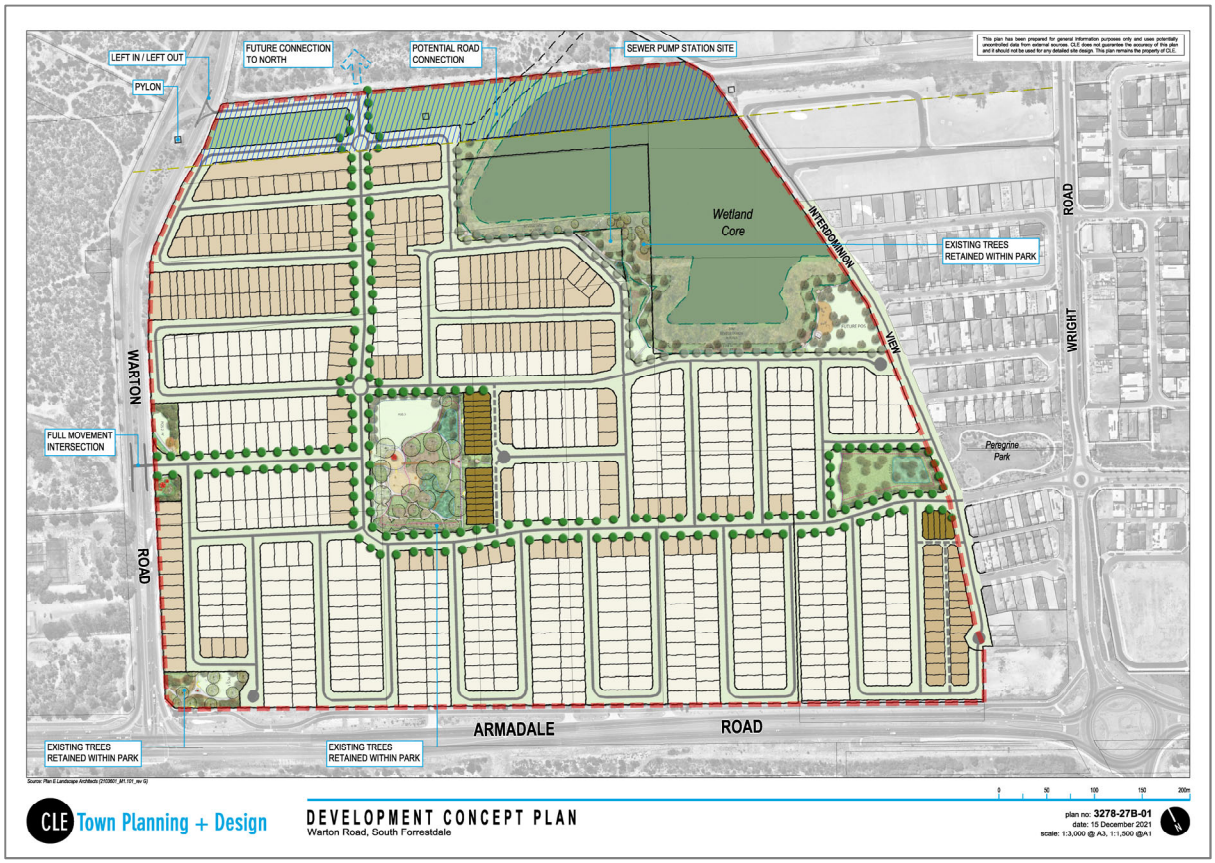


Figure 1-2 Proposed Concept Plan

Appendix B contains a description of some of the terminology used throughout this report.

2 CRITERIA

2.1 State Planning Policy No. 5.4

The criteria relevant to this assessment is provided in *State Planning Policy No. 5.4 Road and Rail Noise* (hereafter referred to as SPP 5.4) produced by the Western Australian Planning Commission (WAPC). The objectives of SPP 5.4 are to:

- Protect the community from unreasonable levels of transport noise;
- Protect strategic and other significant freight transport corridors from incompatible urban encroachment;
- Ensure transport infrastructure and land-use can mutually exist within urban corridors;
- Ensure that noise impacts are addressed as early as possible in the planning process; and
- Encourage best practice noise mitigation design and construction standards.

Table 2-1 sets out noise targets that are to be achieved by proposals under which SPP 5.4 applies. Where the targets are exceeded, an assessment is required to determine the likely level of transport noise and management/mitigation required.

Table 2-1 Noise Targets for Noise-Sensitive Land-Use

Outdoor Noise Target		Indoor Noise Target	
55 dB $L_{Aeq(Day)}$	50 dB $L_{Aeq(Night)}$	40 dB $L_{Aeq(Day)}$ (Living and Work Areas)	35 dB $L_{Aeq(Night)}$ (Bedrooms)

Notes:

- Day period is from 6am to 10pm and night period from 10pm to 6am.
- The outdoor noise target is to be measured at 1-metre from the most exposed, habitable[1] facade of the noise sensitive building.
- For all noise-sensitive land-use and/or development, indoor noise targets for other room usages may be reasonable drawn from Table 1 of Australian Standard/New Zealand Standard AS/NZS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors (as amended) for each relevant time period.
- Outdoor targets are to be met at all outdoor areas as far as is reasonable and practicable to do so using the various noise mitigation measures outlined in the Guidelines.

The application of SPP 5.4 is to consider anticipated traffic volumes for the next 20 years from when the noise assessment is undertaken.

In the application of the noise targets, the objective is to achieve:

- indoor noise levels specified in *Table 2-1* in noise-sensitive areas (e.g. bedrooms and living rooms of houses and school classrooms); and
- a reasonable degree of acoustic amenity for outdoor living areas on each residential lot. For non-residential noise-sensitive developments, for example schools and childcare centres, the design of outdoor areas should take into consideration the noise target.

It is recognised that in some instances, it may not be reasonable and/or practicable to meet the outdoor noise targets. Where transport noise is above the noise targets, measures are expected to be implemented that balance reasonable and practicable considerations with the need to achieve acceptable noise protection outcomes.

[1] A habitable room is defined in State Planning Policy 3.1 as a room used for normal domestic activities that includes a bedroom, living room, lounge room, music room, sitting room, television room, kitchen, dining room, sewing room, study, playroom, sunroom, gymnasium, fully enclosed swimming pool or patio.

2.2 Environmental Protection (Noise) Regulations 1997

Environmental noise in Western Australia is governed by the *Environmental Protection Act 1986*, through the *Environmental Protection (Noise) Regulations 1997* (the Regulations) and is applicable to noise from the pistol club.

Regulation 7 defines the prescribed standard for noise emissions as follows:

"7. (1) Noise emitted from any premises or public place when received at other premises –

(a) Must not cause or significantly contribute to, a level of noise which exceeds the assigned level in respect of noise received at premises of that kind; and

(b) Must be free of –

i. tonality;

ii. impulsiveness; and

iii. modulation,

when assessed under regulation 9"

A "…noise emission is taken to significantly contribute to a level of noise if the noise emission … exceeds a value which is 5 dB below the assigned level…"

Tonality, impulsiveness and modulation are defined in Regulation 9. Noise is to be taken to be free of these characteristics if:

(a) The characteristics cannot be reasonably and practicably removed by techniques other than attenuating the overall level of noise emission; and

(b) The noise emission complies with the standard prescribed under regulation 7 after the adjustments of *Table 2-2* are made to the noise emission as measured at the point of reception.

Table 2-2 Adjustments Where Characteristics Cannot Be Removed

Where Noise Emission is Not Music			Where Noise Emission is Music	
Tonality	Modulation	Impulsiveness	No Impulsiveness	Impulsiveness
+ 5 dB	+ 5 dB	+ 10 dB	+ 10 dB	+ 15 dB

Note: The above are cumulative to a maximum of 15dB.

The baseline assigned levels (prescribed standards) are specified in Regulation 8 and are shown in *Table 2-3*.

Table 2-3 Baseline Assigned Noise Levels

Premises Receiving Noise	Time Of Day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise sensitive premises: highly sensitive area[1]	0700 to 1900 hours Monday to Saturday (Day)	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sunday and public holidays (Sunday)	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours all days (Evening)	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	35 + influencing factor	45 + influencing factor	55 + influencing factor
Noise sensitive premises: any area other than highly sensitive area	All hours	60	75	80

1. ***highly sensitive area*** means that area (if any) of noise sensitive premises comprising —
   (a) a building, or a part of a building, on the premises that is used for a noise sensitive purpose; and
   (b) any other part of the premises within 15 metres of that building or that part of the building.

The influencing factor at the subject site will vary depending on a residences proximity to Warton Road and Armadale Road. Each road is considered a major road with counts above 15,000 vehicles per day (vpd) as per below:

- Warton Road – 15,601 vpd (2019/20) – MRWA Count Site #51134; and
- Armadale Road – 20,943 vpd (2020/21) – MRWA Count Site #0151.

As a result, three zones are created being:

1. Future residences within 100 metres of either or both Warton Road and Armadale Road (+ 6 dB);
2. Future residences greater than 100 metres but within 450 metres of either Warton Road and Armadale Road (+ 2 dB); and
3. Future residences greater than 450 metres from both Warton Road and Armadale Road (0 dB).

The assigned levels including the influencing factor are provided in *Table 2-4*.

Table 2-4 Assigned Noise Levels

Premises Receiving Noise	Time Of Day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Zone 1 – Within 100m of Major Road Noise sensitive premises: highly sensitive area[1]	0700 to 1900 hours Monday to Saturday (Day)	51	61	71
	0900 to 1900 hours Sunday and public holidays (Sunday)	46	56	71
	1900 to 2200 hours all days (Evening)	46	56	61
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	41	51	61
Zone 2 – Within 450m of Major Road Noise sensitive premises: highly sensitive area[1]	0700 to 1900 hours Monday to Saturday (Day)	47	57	67
	0900 to 1900 hours Sunday and public holidays (Sunday)	42	52	67
	1900 to 2200 hours all days (Evening)	42	52	57
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	37	47	57
Zone 3 – Greater than 450m from Major Road Noise sensitive premises: highly sensitive area[1]	0700 to 1900 hours Monday to Saturday (Day)	45	55	65
	0900 to 1900 hours Sunday and public holidays (Sunday)	40	50	65
	1900 to 2200 hours all days (Evening)	40	50	55
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	35	45	55
Noise sensitive premises: any area other than highly sensitive area	All hours	60	75	80

1. ***highly sensitive area*** means that area (if any) of noise sensitive premises comprising —
   (a) a building, or a part of a building, on the premises that is used for a noise sensitive purpose; and
   (b) any other part of the premises within 15 metres of that building or that part of the building.

It must be noted the assigned noise levels above apply outside the receiving premises and at a point at least 3 metres away from any substantial reflecting surfaces.

It is noted the assigned noise levels are statistical levels and therefore the period over which they are determined is important. The Regulations define the Representative Assessment Period (RAP) as *a period of time of not less than 15 minutes, and not exceeding 4 hours*, which is determined by an *inspector* or *authorised person* to be appropriate for the assessment of a noise emission, having regard to the type and nature of the noise emission. An *inspector* or *authorised person* is a person appointed under Sections 87 & 88 of the *Environmental Protection Act 1986* and include Local Government Environmental Health Officers and Officers from the Department of Environment Regulation. Acoustic consultants or other environmental consultants are not appointed as an *inspector* or *authorised person*. Therefore, whilst this assessment is based on a 4 hour RAP, which is assumed to be appropriate given the nature of the operations, this is to be used for guidance only.

3 METHODOLOGY

3.1 Road Traffic Methodology

Noise measurements and modelling have been undertaken generally in accordance with the requirements of SPP 5.4 and associated Guidelines[2] as described in *Section 3.1* and *Section 3.2*.

3.1.1 Road Traffic Measurements

Noise monitoring was undertaken at two (2) locations in order to:

- Quantify the existing noise levels;
- Determine the differences between different acoustic parameters ($L_{A10,18hour}$, $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$); and
- Calibrate the noise model for existing conditions.

The instruments used were Acoustic Research noise data loggers as follows:

1. 851 Warton Road- Logger ARL S/N: 15-301-468, approx. 15 metres from Warton Road; and
2. 405 Armadale Road- Logger Ngara S/N: 16-004-041, approx. 30 metres from Armadale Road.

The loggers were programmed to record hourly L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels. The instruments comply with the instrumentation requirements of *Australian Standard 2702-1984 Acoustics – Methods for the Measurement of Road Traffic Noise*. The loggers were field calibrated before and after the measurement session and found to be accurate to within +/- 1 dB. Lloyd George Acoustics also holds current laboratory calibration certificate for the loggers.

The logger locations are adequate to capture the road traffic conditions for the proposed subdivision and provide appropriate points for model calibration, to then allow extrapolation by modelling across the entire subdivision.

[2] Road and Rail Noise Guidelines, September 2019

Figure 3-1 Logger Positions and Photographs

The noise data collected was verified by inspection and professional judgement. Where hourly data was considered atypical, an estimated value was inserted.

3.1.2 Noise Modelling

The computer programme *SoundPLAN 8.2* was utilised incorporating the *Calculation of Road Traffic Noise* (CoRTN) algorithms, modified to reflect Australian conditions. The modifications included the following:

- Vehicles were separated into heavy (Austroads Class 3 upwards) and non-heavy (Austroads Classes 1 & 2) with non-heavy vehicles having a source height of 0.5 metres above road level and heavy vehicles having two sources, at heights of 1.5 metres and 3.6 metres above road level, to represent the engine and exhaust respectively. By splitting the noise source into three, allows for less barrier attenuation for high level sources where barriers are to be considered.
- Note that a -8.0 dB correction is applied to the exhaust and -0.8 dB to the engine (based on Transportation Noise Reference Book, Paul Nelson, 1987), so as to provide consistent results with the CoRTN algorithms for the no barrier scenario;

Predictions are made at heights of 1.4 m above ground floor level for single storey houses and 4.2 m for double storey houses. The noise is predicted at 1.0 metre from an assumed building facade resulting in a + 2.5 dB correction due to reflected noise.

Various input data are included in the modelling such as ground topography, road design, traffic volumes etc. These model inputs are discussed in the following sections.

3.1.3 Ground Topography

For the site, the existing topography was provided by the project team with the surrounding area imported from *Google*. Armadale Road was recently upgraded and the MRWA reference road design on file was utilised and incorporated. For the future scenario, the proposed design levels of the Stockland area were included.

3.1.4 Traffic Data

Traffic data includes:

- Road Surface – The noise relationship between different road surface types is shown in *Table 3-1*.

Table 3-1 Noise Relationship Between Different Road Surfaces

Road Surfaces							
Chip Seal				Asphalt			
14mm	10mm	5mm	Slurry	Dense Graded	Novachip	Stone Mastic	Open Graded
+3.5 dB	+2.5 dB	+1.5 dB	+1.0 dB	0.0 dB	-0.2 dB	-1.5 dB	-2.5 dB

The existing and future road surfaces for each road are assumed to be dense graded asphalt for Warton Road and Stone Mastic Ashpalt for Armadale Road.

- Vehicle Speed – The existing and future posted speeds for both roads are 80km/hr.
- Traffic Volumes – Existing (2016) and forecast (2041) traffic volumes were provided by Main Roads WA (Thomas Ng, Traffic Modelling Analyst, Reference: #41838) with more recent existing counts obtained from the Main Roads WA Traffic Map. A validation plot was also provided allowing the Main Roads WA traffic volume model to be calibrated against actual counts. *Table 3-2* provides the traffic volume input data in the model.

Table 3-2 Traffic Information Used in the Modelling

Road	Parameter	Scenario			
		Existing		Future - 2041	
		NB/EB	SB/WB	NB/EB	SB/WB
Warton Road – North of Armadale Road	24 Hour Volume	8,705	6,896	12,000	10,200
	% Heavy	7	8	3	3
Armadale Road – West of Warton Road	24 Hour Volume	16,933	16,207	36,800	34,700
	% Heavy	6	9	6	6
Armadale Road, East of Warton Road	24 Hour Volume	10,486	10,457	29,400	30,800
	% Heavy	12	7	7	6

3.1.5 Ground Attenuation

The ground attenuation has been assumed to be 0.0 (0%) for the road, 0.5 (50%) throughout the subject site, except for the public open space, which was set to 1.00 (100%). Note 0.0 represents hard reflective surfaces such as water and 1.00 represents absorptive surfaces such as grass.

3.1.6 Parameter Conversion

The CoRTN algorithms used in the *SoundPLAN* modelling package were originally developed to calculate the $L_{A10,18hour}$ noise level. SPP 5.4 however uses $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$. The relationship between the parameters varies depending on the composition of traffic on the road (volumes in each period and percentage heavy vehicles).

As noise monitoring was undertaken, the relationship between the parameters is based on the results of the monitoring – refer *Section 4.1*.

3.2 Pistol Club Methodology

Lloyd George Acoustics was involved in the structure plan for this site and that to the north[3]. As part of this process, noise monitoring was undertaken opposite the pistol club, as shown in *Figure 3-2*. The monitoring was occurred between 07 and 08 July 2018 at one location opposite the pistol club in order to subjectively assess whether any shooting noise was audible at times, when the shooting range is known to be open. If audible, the noise levels from various events were quantified.

The instrument used was a Brüel and Kjaer type 2250 noise data logger (S/N 3011946), located at the residence opposite the pistol club, approximately 120 metres from the shooting range with the microphone 1.4 metres above ground level. The logger was programmed to record various noise parameters every second over the duration of the survey, as well as audio. The logger complies with the instrumentation requirements of schedule 4 of the Regulations and was field calibrated before and after the measurement session and found to be accurate to within +/- 1 dB. Lloyd George Acoustics also holds current laboratory calibration certificate for the logger.

Figure 3-2 Logger Location for Pistol Club Noise Monitoring

[3] Noise Impact Assessment, Warton Road, South Forrestdale Concept Plan; Reference: 18014294-01b, 31-Dec-19

4 RESULTS

4.1 Road Traffic Noise Measurements

The results of the noise monitoring are summarised in *Table 4-1* and *Table 4-2* and shown graphically in *Figure 4-1* and *Figure 4-2*.

Table 4-1 Measured Average Noise Levels: Warton Road

Date	Average Weekday Noise Level, dB			
	$L_{A10,18hour}$	$L_{Aeq,24hour}$	$L_{Aeq\ (Day)}$	$L_{Aeq\ (Night)}$
Tuesday 20 April 2021	63.6	59.9	61.2	55.1
Wednesday 21 April 2021	63.6	60.1	61.4	54.7
Thursday 22 April 2021	63.6	59.9	61.2	54.4
Weekday Average	**63.6**	**60.0**	**61.3**	**54.7**

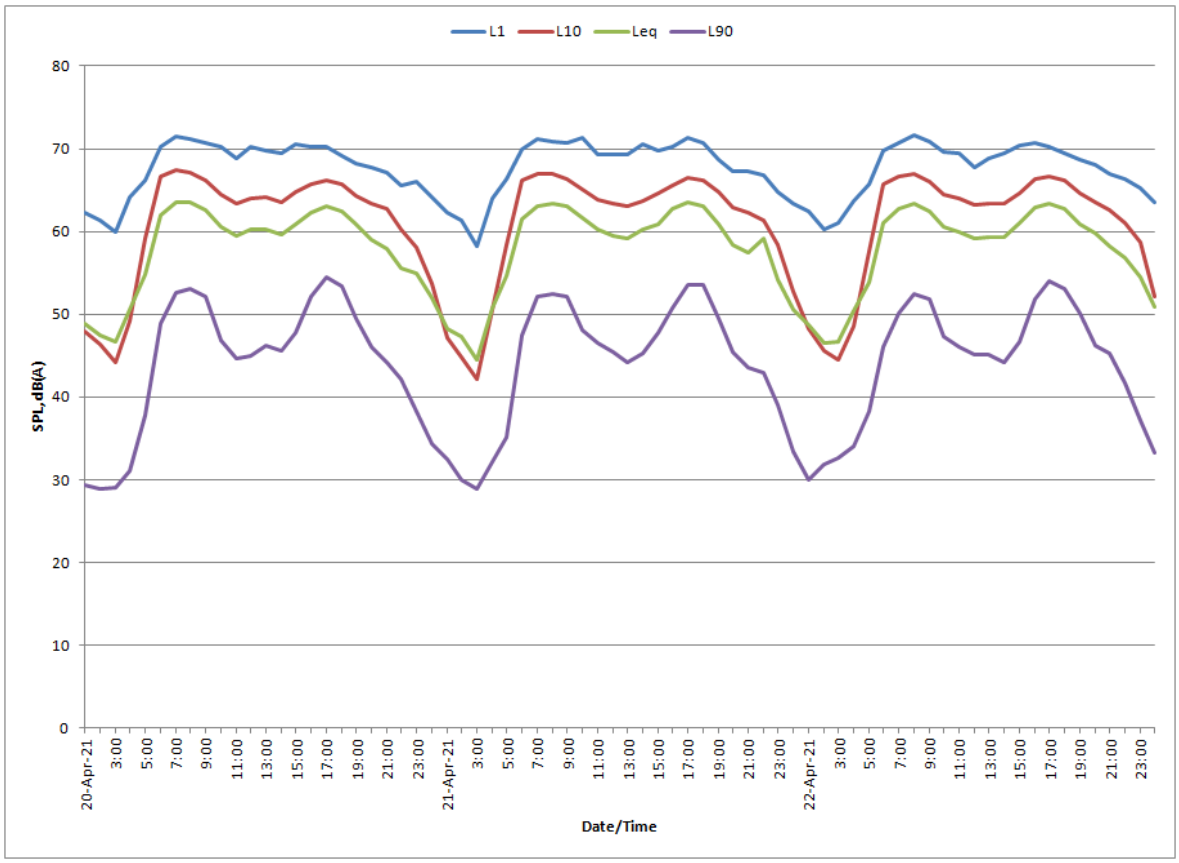


Figure 4-1 Noise Monitoring Results: Warton Road

The average differences between the weekday $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ is 6.5 dB. This same difference has been assumed to exist in future years. As such, it is the daytime noise levels that will dictate compliance since these are at least 5 dB more than night-time levels.

Table 4-2 Measured Average Noise Levels: Armadale Road

Date	Average Weekday Noise Level, dB			
	$L_{A10,18hour}$	$L_{Aeq,24hour}$	$L_{Aeq\ (Day)}$	$L_{Aeq\ (Night)}$
Tuesday 20 April 2021	61.7	58.5	59.8	53.3
Wednesday 21 April 2021	61.5	58.2	59.5	57.7
Thursday 22 April 2021	61.2	57.6	59.0	52.0
Weekday Average	**61.5**	**58.1**	**59.4**	**52.6**

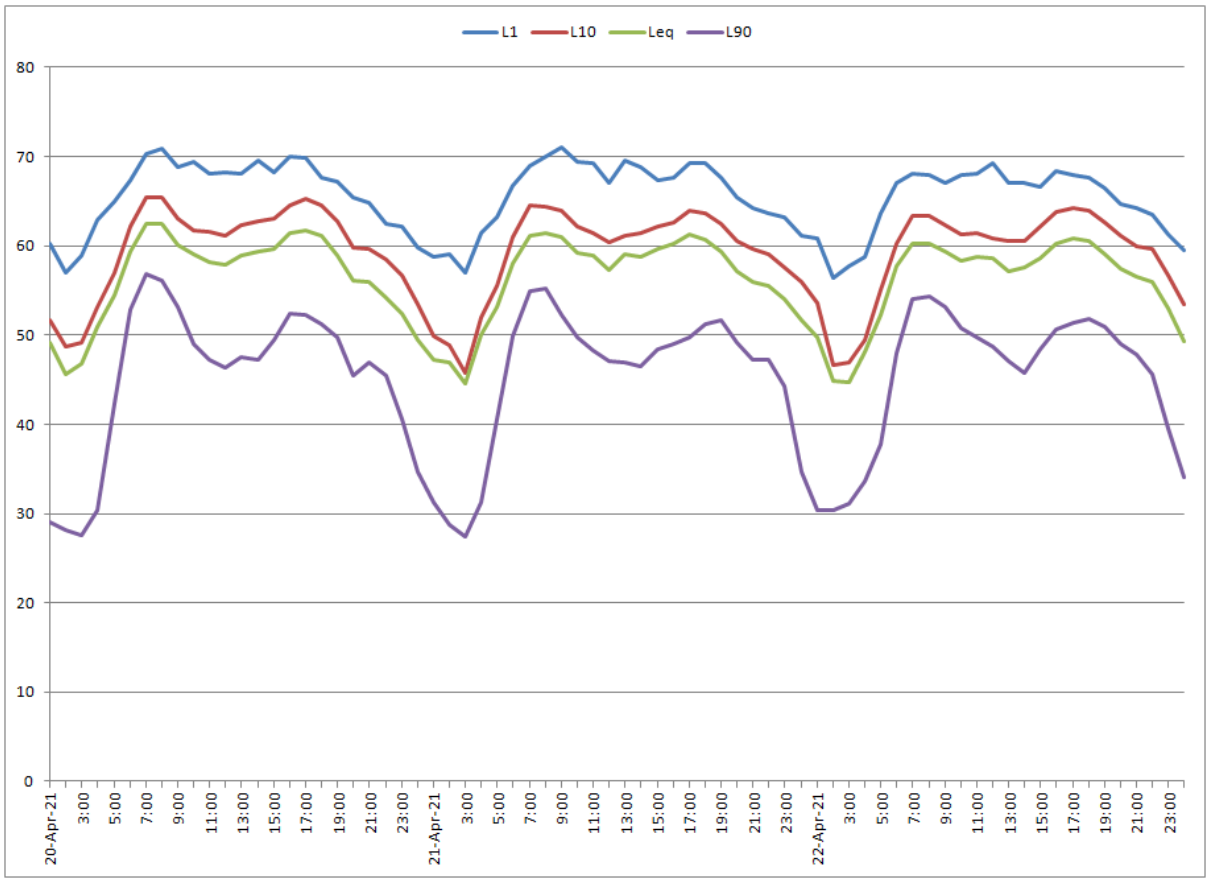


Figure 4-2 Noise Monitoring Results: Armadale Road

The average differences between the weekday $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ is 6.8 dB. This same difference has been assumed to exist in future years. As such, it is the daytime noise levels that will dictate compliance since these are at least 5 dB more than night-time levels.

4.2 Road Traffic Noise Modelling

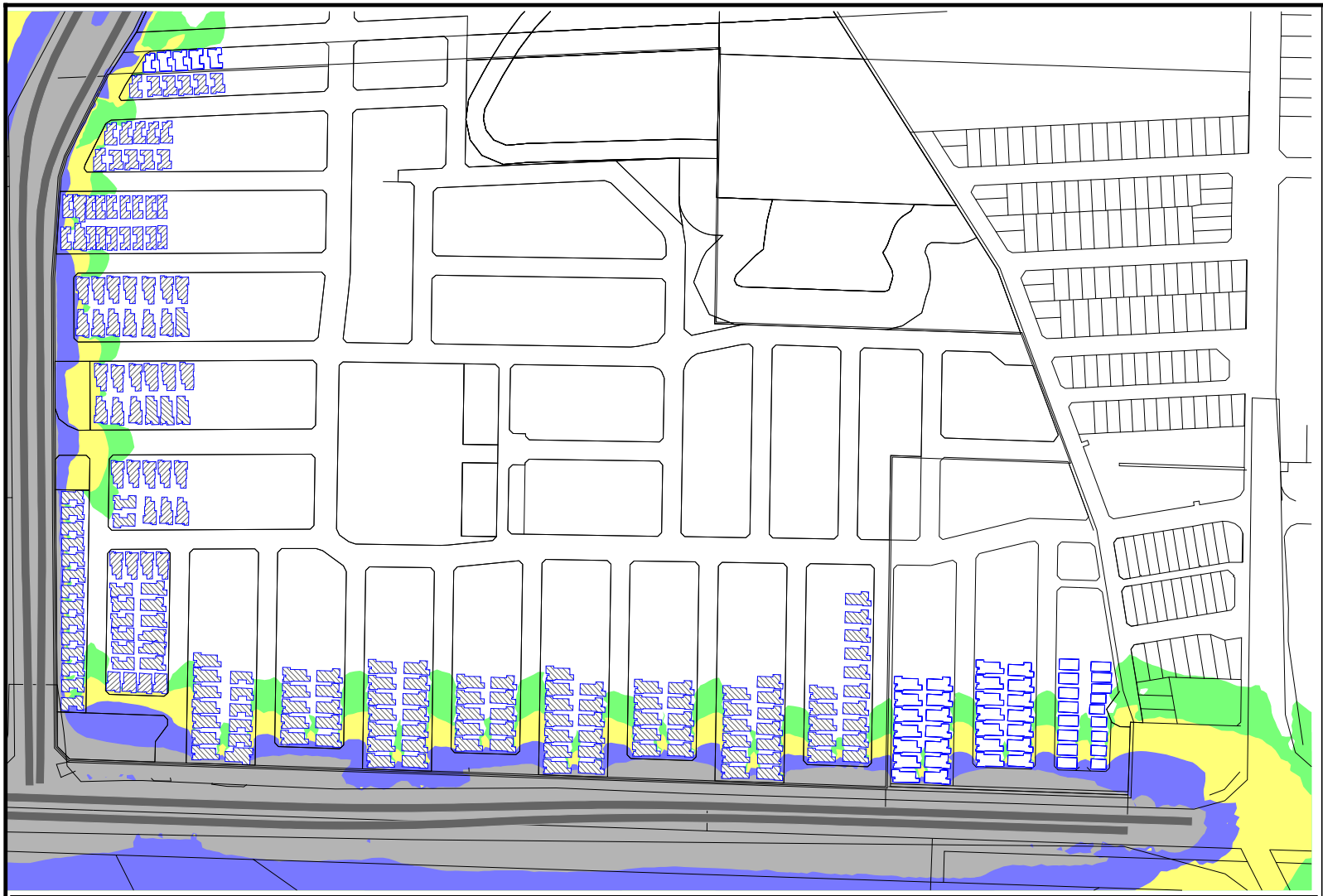
The noise model is initially set-up for existing conditions and calibrated against the noise monitoring. The model is then modified to reflect future conditions with the noise contours provided in *Figure 4-3*. It can be seen that predicted noise levels at the nearest houses will be above the outdoor noise target and therefore noise control is to be considered.

4.3 Pistol Club Noise Measurements

Various audio files were reviewed at times of known shooting events and it was found that road traffic noise was the dominant source of noise in the area, and no noise event associated with the pistol club could be determined based on the logged data.

It is therefore concluded that the pistol club noise emissions onto the subject site are not likely to be intrusive.

Figure 4-3



Noise levels
$L_{Aeq(Day)}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

SPP 5.4 (Sep 2019)

Signs and symbols
- Road
- Building
- Houses Outside of Stockland

N

Length Scale 1:5000

0 25 50 100 150 200 m

Piara Waters West - Future Noise Level Contours

$L_{Aeq(Day)}$ Noise Level Contours Based on Future Conditions
Ground Floor Level

SoundPLAN v8.2
CoRTN Algorithms

14 December 2021

Lloyd George Acoustics
PO Box 717
HILLARYS WA 6923
(08) 9401 7770

5 ASSESSMENT

Noise from the pistol club could not be determined above background noise from the monitoring such that this is no longer considered.

Road traffic noise to the site is significant. The objectives of SPP 5.4 are to achieve:

- indoor noise levels specified in *Table 2-1* in noise-sensitive areas (e.g. bedrooms and living rooms of houses and school classrooms); and
- a reasonable degree of acoustic amenity for outdoor living areas on each residential lot.

Where the outdoor noise targets of *Table 2-1* are achieved, no further controls are necessary.

With reference to the predicted noise levels in *Section 4.2*, it is evident the outdoor noise target will be exceeded. The preferred noise mitigation to comply with SPP 5.4 is:

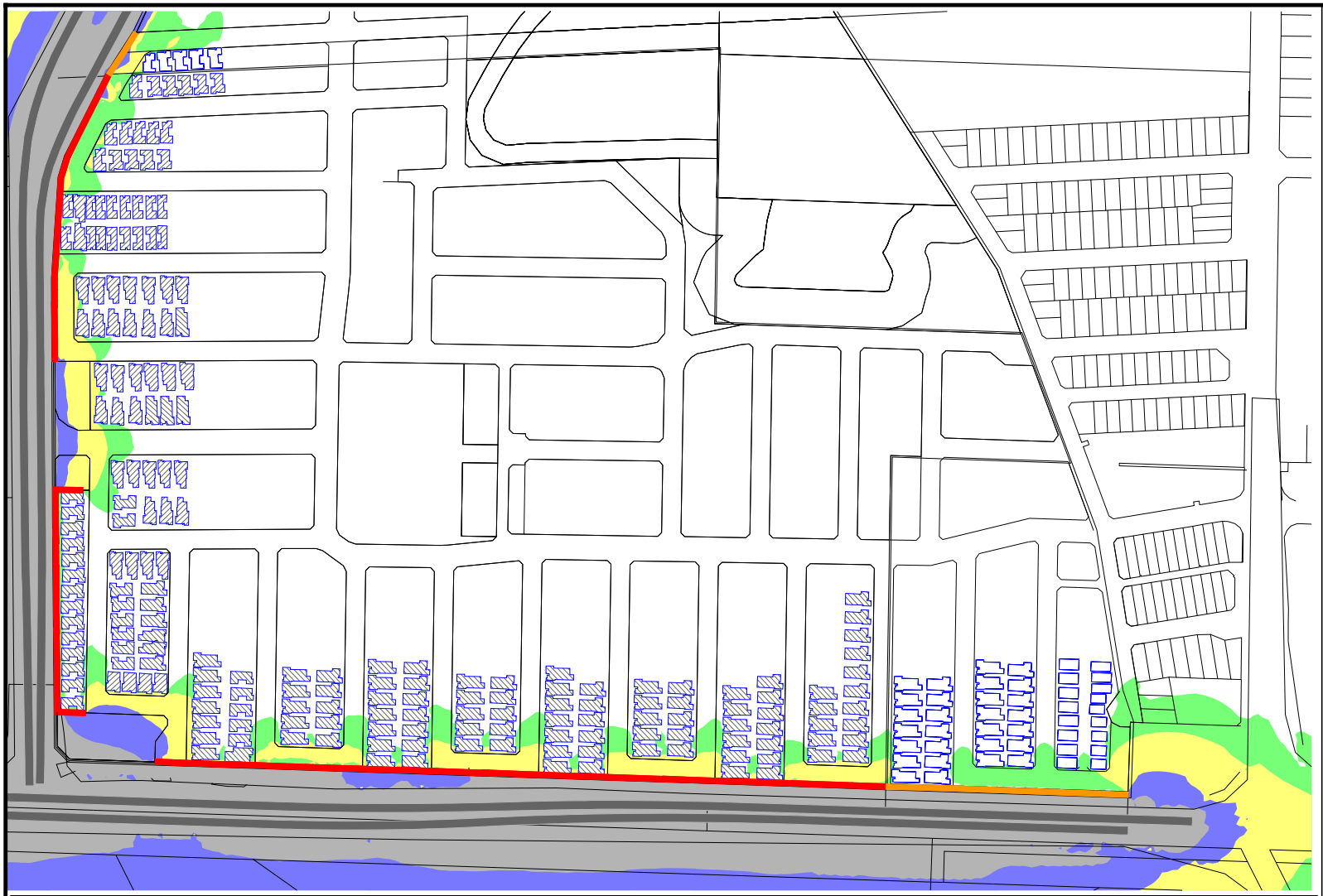
- Noise walls to be generally 2.1 metres high, relative to finished lot level. Any wall must have a minimum surface mass of 15 kg/m^2, be solid and free of gaps.
- Where noise levels are above the outdoor noise target, a notification on lot title is required and the implementation of Quiet House Package A, B or C.

  Alternative constructions from the *Appendix A* deemed to satisfy packages may be acceptable if supported by a report undertaken by a suitably qualified acoustical consultant (member firm of the Association of Australasian Acoustical Consultants (AAAC)), once the lots specific building plans are available. Such a specialist assessment is also required if an upper floor exists for those lots immediately adjoining Armadale Road.

The noise contours at ground level and first floor level are provided in *Figure 5-1* and *Figure 5-2* respectively. The associated packages for ground floor/single storey and first floor are provided on *Figure 5-3* and *Figure 5-4* respectively.

It is noted the noise wall does not extend across the POS near the intersection of Armadale Road and Warton Road, so that access to the bus station from the subdivision is still possible.

Figure 5-1



Noise levels
$L_{Aeq(Day)}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

SPP 5.4 (Sep 2019)

Signs and symbols

- Road
- Building
- Wall
- Houses not within Stockland
- Wall not within Stockland

Length Scale 1:5000

0 25 50 100 150 200 m

Piara Waters West -
Future Noise Level Contours with Generally 2.1m High Wall

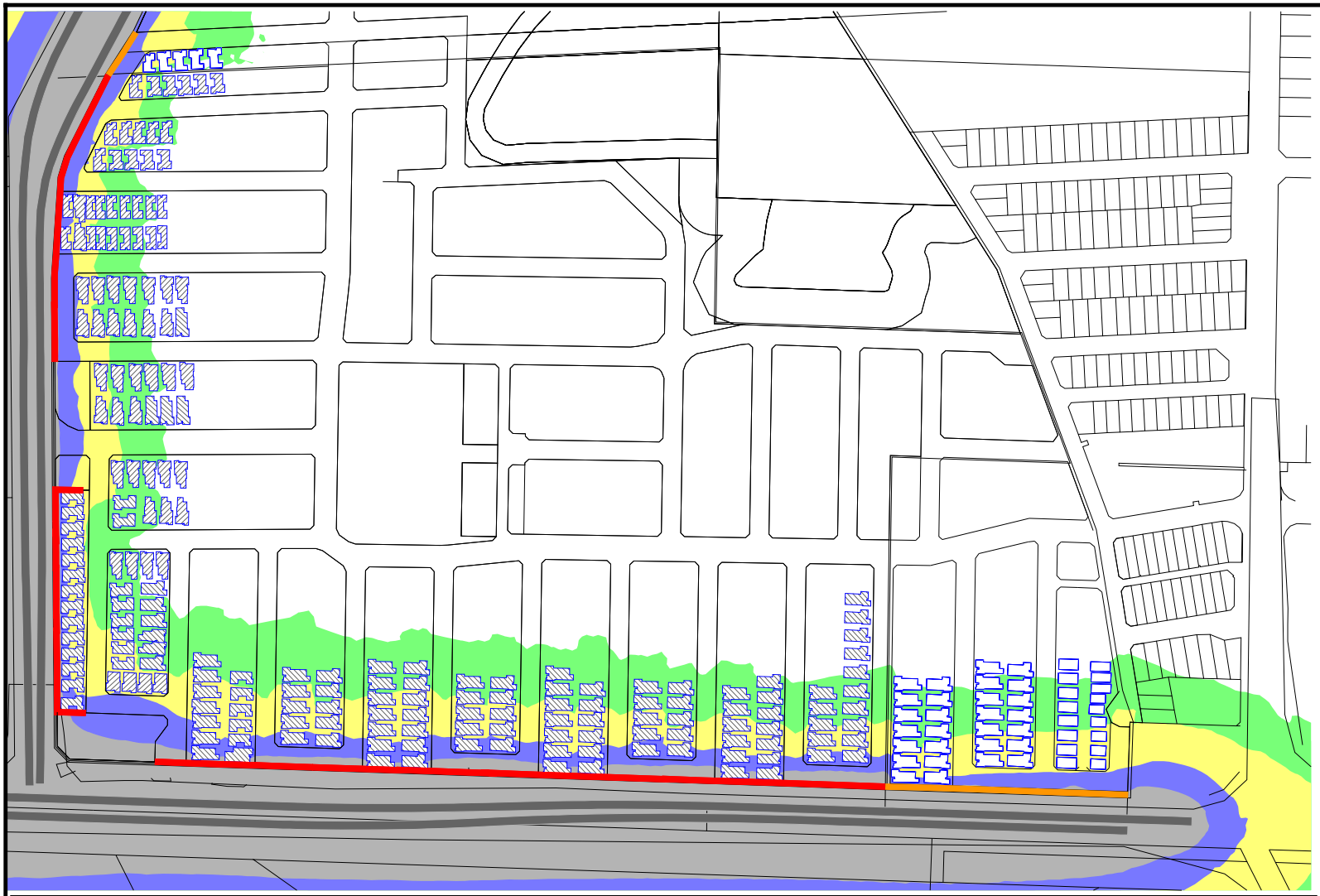
$L_{Aeq(Day)}$ Noise Level Contours Based on Future Conditions
Ground Floor Level

SoundPLAN v8.2
CoRTN Algorithms

14 December 2021

Lloyd George Acoustics
PO Box 717
HILLARYS WA 6923
(08) 9401 7770

Figure 5-2



Noise levels
$L_{Aeq(Day)}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

SPP 5.4 (Sep 2019)

Signs and symbols

- Road
- Building
- Wall
- Houses not within Stockland
- Wall not within Stockland

N

Length Scale 1:5000

0 25 50 100 150 200 m

Piara Waters West -
Future Noise Level Contours with Generally 2.1m High Wall

$L_{Aeq(Day)}$ Noise Level Contours Based on Future Conditions
Upper Floor Level

SoundPLAN v8.2
CoRTN Algorithms

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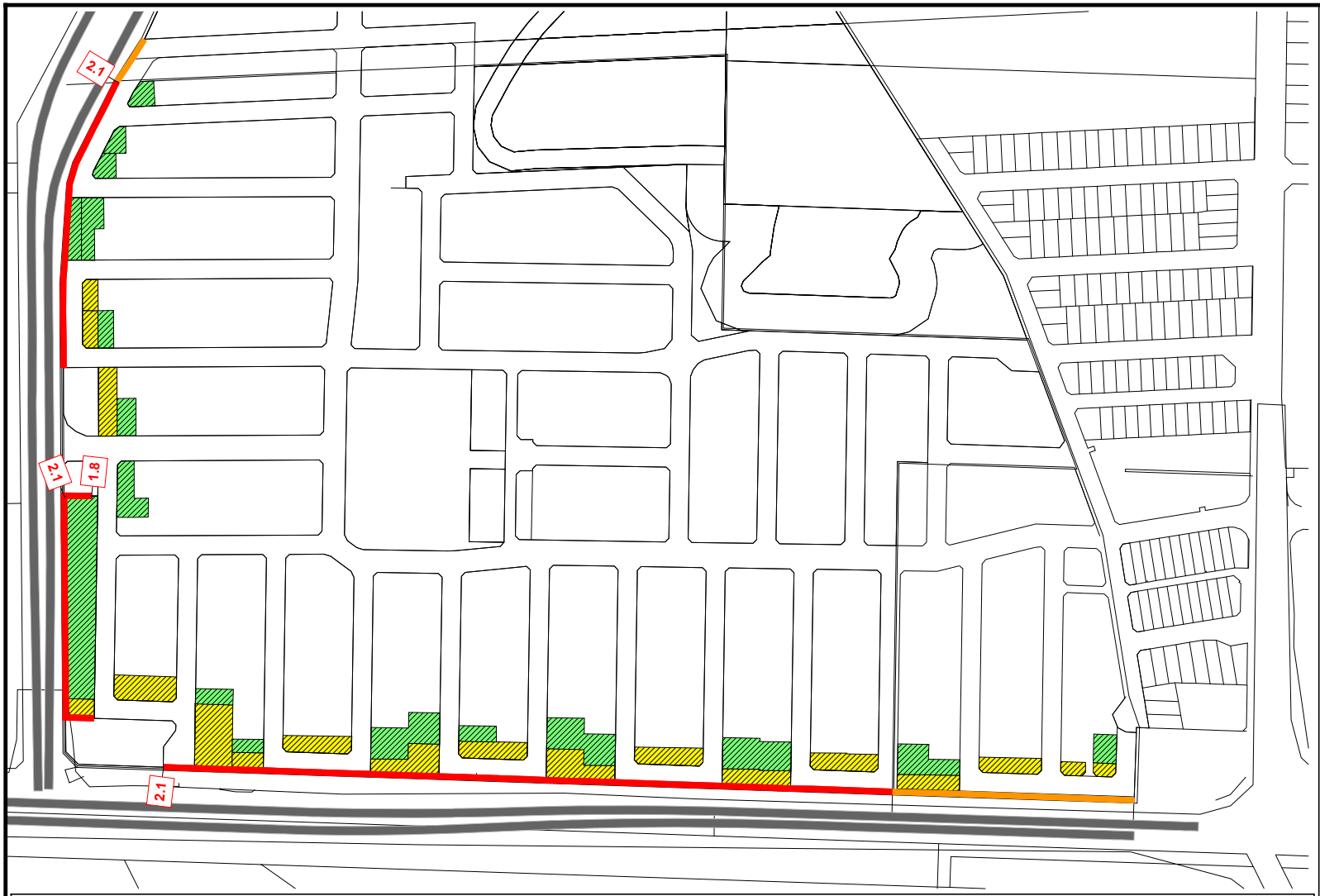
Lloyd George Acoustics
PO Box 717
HILLARYS WA 6923
(08) 9401 7770

Figure 5-3



Signs and symbols

- Road
- Noise Wall
- Package A
- Package B
- Package C
- Wall not within Stockland

Piara Waters West -
Noise Mitigation With Generally 2.1m High Wall

Ground Floor Level

SoundPLAN v8.2
CoRTN Algorithms

14 December 2021

Length Scale 1:5000

0 25 50 100 150 200 m

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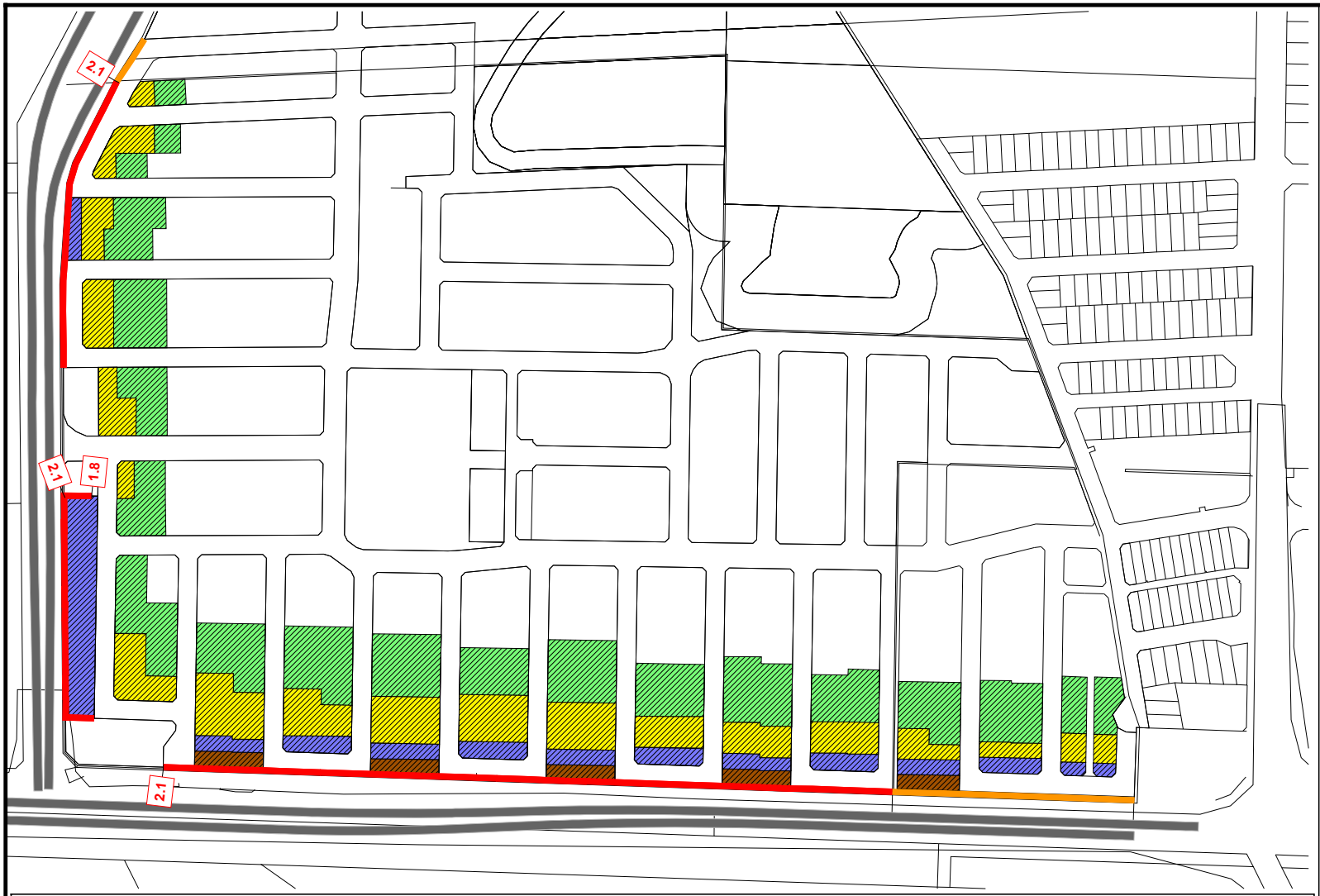
PO Box 717
HILLARYS WA 6923
(08) 9401 7770

Figure 5-4



Signs and symbols

- Road
- Noise Wall
- Package A
- Package B
- Package C
- Specialist Advice
- Wall not within Stockland

Piara Waters West -
Noise Mitigation With Generally 2.1m High Wall

First Floor Level

SoundPLAN v8.2
CoRTN Algorithms

14 December 2021

Length Scale 1:5000

0 25 50 100 150 200 m

Lloyd George Acoustics
PO Box 717
HILLARYS WA 6923
(08) 9401 7770

Appendix A

Quiet House Packages

The packages and information provided on the following pages are taken from *Road and Rail Noise Guidelines* (September 2019).

Where outdoor and indoor noise levels received by a noise-sensitive land-use and/or development exceed the policy's noise target, implementation of quiet house requirements is an acceptable solution.

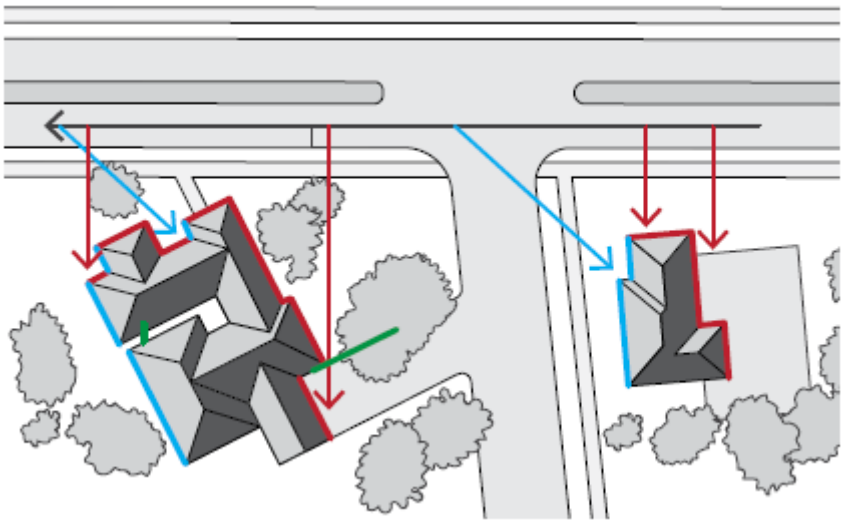
The quiet house packages are not the only solution to achieving acceptable internal transport noise levels. A suitably qualified acoustical engineer or consultant may also determine more tailored acoustic design requirements for buildings in a transport noise corridor by carrying out acoustic design in accordance with relevant industry standards. This includes the need to meet the relevant design targets specified in AS/NZS 2107:2016 for road traffic noise.

With regards to the packages, the following definitions are provided:

- **Facing** the transport corridor (red): Any part of a building façade is 'facing' the transport corridor if any straight line drawn perpendicular (at a 90 degree angle) to its nearest road lane or railway line intersects that part of the façade without obstruction (ignoring any fence).

- **Side-on** to transport corridor (blue): Any part of a building façade that is not 'facing' is 'side-on' to the transport corridor if any straight line, at any angle, can be drawn from it to intersect the nearest road lane or railway line without obstruction (ignoring any fence).

- **Opposite** to transport corridor (green): Neither 'side on' nor 'facing', as defined above.



Quiet House Package A

56-58 dB $L_{Aeq(Day)}$ & 51-53 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas

External Windows	Facing	• Up to 40% floor area ($R_w + C_{tr} \geq 28$):
		  ○ Sliding or double hung with minimum 10mm single or 6mm-12mm-10mm double insulated glazing;
		  ○ Sealed awning or casement windows with minimum 6mm glass.
		• Up to 60% floor area ($R_w + C_{tr} \geq 31$):
		  ○ Sealed awning or casement windows with minimum 6mm glass.
			• Up to 40% floor area ($R_w + C_{tr} \geq 25$):
			  ○ Sliding or double hung with minimum 6mm single or 6mm-12mm-6mm double insulated glazing;
			• Up to 60% floor area ($R_w + C_{tr} \geq 28$);
			• Up to 80% floor area ($R_w + C_{tr} \geq 31$).

	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	No specific requirements	

External Doors	Facing	• Fully glazed hinged door with certified $R_w + C_{tr} \geq 28$ rated door and frame including seals and 6mm glass.	• Doors to achieve $R_w + C_{tr} \geq 25$:
			  ○ 35mm Solid timber core hinged door and frame system certified to R_w 28 including seals;
			  ○ Glazed sliding door with 10mm glass and weather seals.

	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less.	
	Opposite	No specific requirements	

External Walls	All	• $R_w + C_{tr} \geq 45$:
		  ○ Two leaves of 90mm thick clay brick masonry with minimum 20mm cavity; or
		  ○ Single leaf of 150mm brick masonry with 13mm cement render on each face; or
		  ○ One row of 92mm studs at 600mm centres with:
		  ▪ Resilient steel channels fixed to the outside of the studs; and
		  ▪ 9.5mm hardboard or fibre cement sheeting or 11mm fibre cement weatherboards fixed to the outside;
		  ▪ 75mm thick mineral wool insulation with a density of at least 11kgkg/m^3; and
		  ▪ 2 x 16mm fire-rated plasterboard to inside.	

Roofs and Ceilings	All	• $R_w + C_{tr} \geq 35$: ○ Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard.	

Quiet House Package B

59-62 dB $L_{Aeq(Day)}$ & 54-57 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 40% floor area ($R_w + C_{tr} \geq 31$): ○ Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 60% floor area ($R_w + C_{tr} \geq 34$): ○ Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.	• Up to 40% floor area ($R_w + C_{tr} \geq 28$): ○ Sliding or double hung with 6mm-12mm-10mm double insulated glazing; ○ Sealed awning or casement windows with minimum 6mm glass. • Up to 60% floor area ($R_w + C_{tr} \geq 31$); • Up to 80% floor area ($R_w + C_{tr} \geq 34$).
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Doors	Facing	• Fully glazed hinged door with certified $R_w + C_{tr} \geq 31$ rated door and frame including seals and 10mm glass.	• Doors to achieve $R_w + C_{tr} \geq 28$: ○ 40mm Solid timber core hinged door and frame system certified to R_w 32 including seals; ○ Fully glazed hinged door with certified $R_w + C_{tr} \geq 28$ rated door and frame including seals and 6mm glass.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Walls	All	• $R_w + C_{tr} \geq 50$: ○ Two leaves of 90mm thick clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester (24kg/m^3). Resilient ties used where required to connect leaves. ○ Two leaves of 110mm clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m^3). ○ Single leaf of 220mm brick masonry with 13mm cement render on each face. ○ 150mm thick unlined concrete panel or 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face. ○ Single leaf of 90mm clay brick masonry with: ▪ A row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; ▪ A cavity of 25mm between leaves; ▪ 50mm glasswool or polyester insulation (11kg/m^3) between studs; and ▪ One layer of 10mm plasterboard fixed to the inside face.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 35$: ○ Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard ceiling with R3.0+ fibrous insulation.	
Outdoor Living Areas		One outdoor living area must be located on the opposite of the building from the transport corridor. Where site specific assessment shows noise levels are within Exposure A to alfresco area, this is deemed a reasonable acoustic amenity.	

Quiet House Package C

63-66 dB $L_{Aeq(Day)}$ & 58-61 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 20% floor area ($R_w + C_{tr} \geq 31$): ○ Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 40% floor area ($R_w + C_{tr} \geq 34$): ○ Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.	• Up to 40% floor area ($R_w + C_{tr} \geq 31$): ○ Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 60% floor area ($R_w + C_{tr} \geq 34$): ○ Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Doors	Facing	• Not recommended.	• Doors to achieve $R_w + C_{tr} \geq 30$: ○ Fully glazed hinged door with certified $R_w + C_{tr} \geq 31$ rated door and frame including seals and 10mm glass; ○ 40mm Solid timber core side hinged door, frame and seal system certified to R_w 32 including seals. Any glass inserts to be minimum 6mm.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Walls	All	• $R_w + C_{tr} \geq 50$: ○ Two leaves of 90mm thick clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m^3). Resilient ties used where required to connect leaves. ○ Two leaves of 110mm clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m^3). ○ Single leaf of 220mm brick masonry with 13mm cement render on each face. ○ 150mm thick unlined concrete panel or 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face. ○ Single leaf of 90mm clay brick masonry with: ▪ A row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; ▪ A cavity of 25mm between leaves; ▪ 50mm glasswool or polyester insulation (11kg/m^3) between studs; and ▪ One layer of 10mm plasterboard fixed to the inside face.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 40$: ○ Concrete or terracotta tile roof with sarking, or metal sheet roof with foil backed R2.0+ fibrous insulation between steel sheeting and roof battens; ○ R3.0+ insulation batts above ceiling; ○ 2 x 10mm plasterboard ceiling or 1 x 13mm sound-rated plasterboard affixed using steel furring channel to ceiling rafters.	
Outdoor Living Areas		One outdoor living area must be located on the opposite of the building from the transport corridor. Where site specific assessment shows noise levels are within Exposure A to alfresco area, this is deemed a reasonable acoustic amenity.	

Mechanical Ventilation requirements

In implementing the acceptable treatment packages, the following mechanical ventilation / air-conditioning considerations are required:

- Acoustically rated openings and ductwork to provide a minimum sound reduction performance of R_w 40 dB into sensitive spaces;
- Evaporative systems require attenuated ceiling air vents to allow closed windows;
- Refrigerant based systems need to be designed to achieve National Construction Code fresh air ventilation requirements;
- Openings such as eaves, vents and air inlets must be acoustically treated, closed or relocated to building sides facing away from the corridor where practicable.

Notification

Notifications on title advise prospective purchasers of the potential for noise impacts from major transport corridors and help with managing expectations.

The Notification is to state as follows:

This lot is in the vicinity of a transport corridor and is affected, or may in the future be affected, by road and rail transport noise. Road and rail transport noise levels may rise or fall over time depending on the type and volume of traffic.

Appendix B

Terminology

The following is an explanation of the terminology used throughout this report.

Decibel (dB)
The decibel is the unit that describes the sound pressure and sound power levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

A-Weighting
An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as L_A dB.

L_1
An L_1 level is the noise level which is exceeded for 1 per cent of the measurement period and is considered to represent the average of the maximum noise levels measured.

L_{10}
An L_{10} level is the noise level which is exceeded for 10 per cent of the measurement period and is considered to represent the "*intrusive*" noise level.

L_{90}
An L_{90} level is the noise level which is exceeded for 90 per cent of the measurement period and is considered to represent the "*background*" noise level.

L_{eq}
The L_{eq} level represents the average noise energy during a measurement period.

$L_{A10,18hour}$
The $L_{A10,18\ hour}$ level is the arithmetic average of the hourly L_{A10} levels between 6.00 am and midnight. The *CoRTN* algorithms were developed to calculate this parameter.

$L_{Aeq,24hour}$
The $L_{Aeq,24\ hour}$ level is the logarithmic average of the hourly L_{Aeq} levels for a full day (from midnight to midnight).

$L_{Aeq,8hour}$ / $L_{Aeq\ (Night)}$
The $L_{Aeq\ (Night)}$ level is the logarithmic average of the hourly L_{Aeq} levels from 10.00 pm to 6.00 am on the same day.

$L_{Aeq,16hour}$ / $L_{Aeq\ (Day)}$
The $L_{Aeq\ (Day)}$ level is the logarithmic average of the hourly L_{Aeq} levels from 6.00 am to 10.00 pm on the same day. This value is typically 1-3 dB less than the $L_{A10,18hour}$.

Noise-sensitive land use and/or development
Land-uses or development occupied or designed for occupation or use for residential purposes (including dwellings, residential buildings or short-stay accommodation), caravan park, camping ground, educational establishment, child care premises, hospital, nursing home, corrective institution or place of worship.

About the Term 'Reasonable'

An assessment of reasonableness should demonstrate that efforts have been made to resolve conflicts without comprising on the need to protect noise-sensitive land-use activities. For example, have reasonable efforts been made to design, relocate or vegetate a proposed noise barrier to address community concerns about the noise barrier height? Whether a noise mitigation measure is reasonable might include consideration of:

- The noise reduction benefit provided;
- The number of people protected;
- The relative cost vs benefit of mitigation;
- Road conditions (speed and road surface) significantly differ from noise forecast table assumptions;
- Existing and future noise levels, including changes in noise levels;
- Aesthetic amenity and visual impacts;
- Compatibility with other planning policies;
- Differences between metropolitan and regional situations and whether noise modelling requirements reflect the true nature of transport movements;
- Ability and cost for mobilisation and retrieval of noise monitoring equipment in regional areas;
- Differences between Greenfield and infill development;
- Differences between freight routes and public transport routes and urban corridors;
- The impact on the operational capacity of freight routes;
- The benefits arising from the proposed development;
- Existing or planned strategies to mitigate the noise at source.

About the Term 'Practicable'

'Practicable' considerations for the purposes of the policy normally relate to the engineering aspects of the noise mitigation measures under evaluation. It is defined as "reasonably practicable having regard to, among other things, local conditions and circumstances (including costs) and to the current state of technical knowledge" (*Environmental Protection Act 1986*). These may include:

- Limitations of the different mitigation measures to reduce transport noise;
- Competing planning policies and strategies;
- Safety issues (such as impact on crash zones or restrictions on road vision);
- Topography and site constraints (such as space limitations);
- Engineering and drainage requirements;
- Access requirements (for driveways, pedestrian access and the like);
- Maintenance requirements;
- Bushfire resistance or BAL ratings;
- Suitability of the building for acoustic treatments.

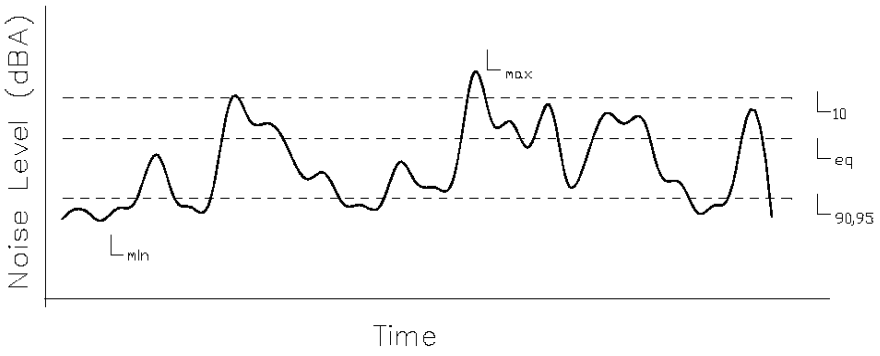
R_w

This is the weighted sound reduction index and is similar to the previously used STC (Sound Transmission Class) value. It is a single number rating determined by moving a grading curve in integral steps against the laboratory measured transmission loss until the sum of the deficiencies at each one-third-octave band, between 100 Hz and 3.15 kHz, does not exceed 32 dB. The higher the R_w value, the better the acoustic performance.

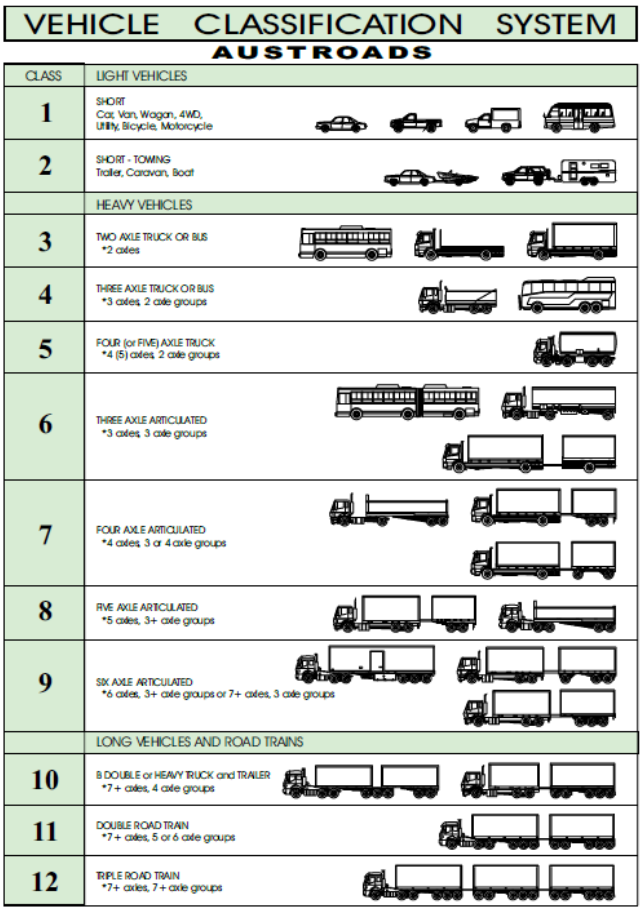
C_{tr}

This is a spectrum adaptation term for airborne noise and provides a correction to the R_w value to suit source sounds with significant low frequency content such as road traffic or home theatre systems. A wall that provides a relatively high level of low frequency attenuation (i.e. masonry) may have a value in the order of –4 dB, whilst a wall with relatively poor attenuation at low frequencies (i.e. stud wall) may have a value in the order of -14 dB.

Chart of Noise Level Descriptors



Austroads Vehicle Class



Typical Noise Levels