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Road Traffic Noise Assessment

Kwinana Freeway, South Lake & Bibra Lake

Reference: 16073651-01.docx

Prepared for:
City of Cockburn

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1 INTRODUCTION

The City of Cockburn are undertaking The Lakes Revitalisation Strategy Scheme Amendment, covering the areas shown in *Figure 1-1*, being in the suburbs of North Lake, Bibra Lake and South Lake, WA. This report focuses on the areas of South Lake and Bibra Lake, in relation to the potential noise impacts associated with Kwinana Freeway. The proposed density and zoning in the areas of interest are shown in *Figures 1-2 & 1-3*.

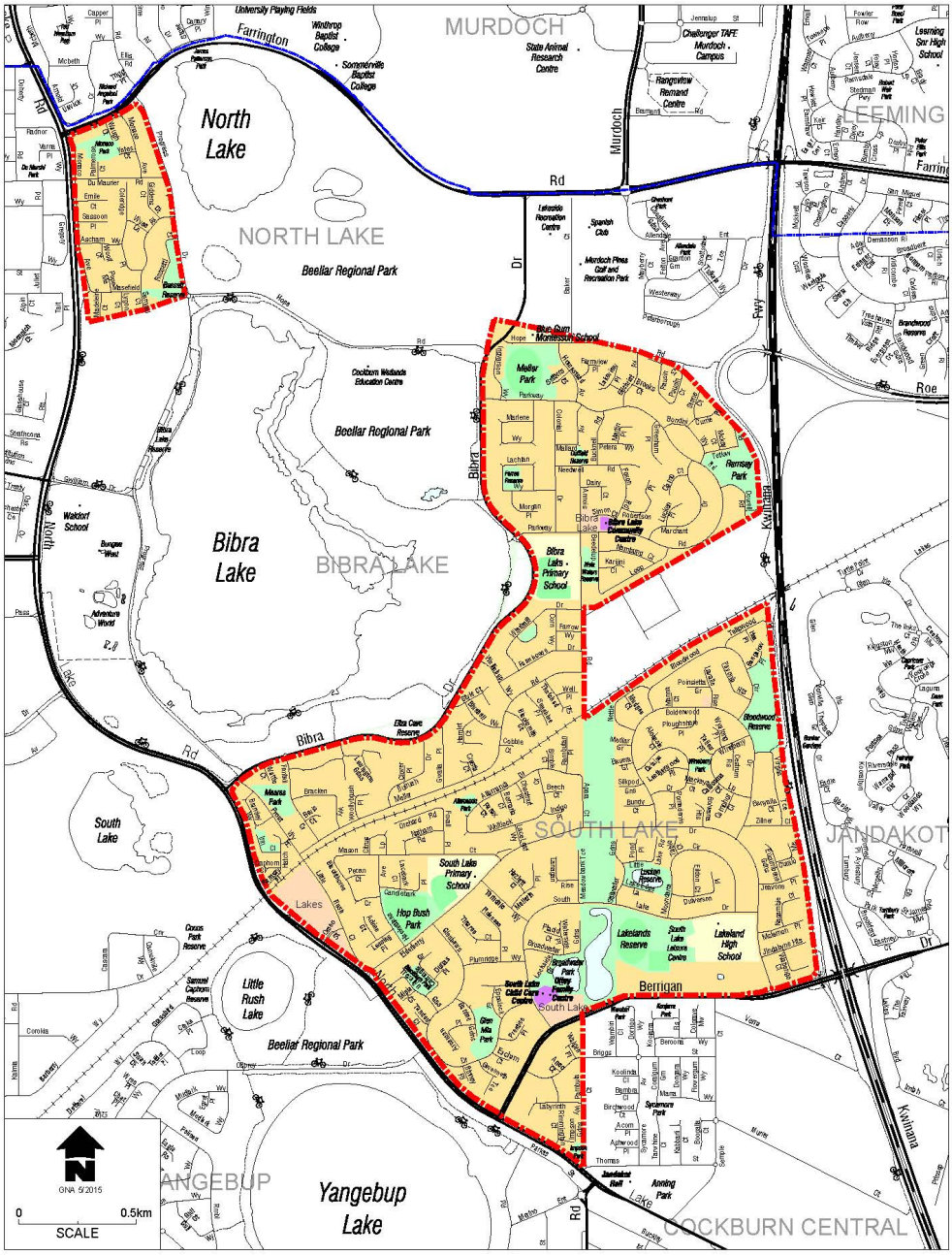


Figure 1-1 The Lakes Revitalisation and Scheme Amendment Area

Figure 1-2 Proposed Density and Zoning for Bibra Lake

Figure 1-3 Proposed Density and Zoning for South Lake

The zoning remains residential, but increases in density nominally from R20 increasing to R30, R40, R60 and some small areas of R80. *Figure 1-4* shows the implications of the new density codes. For R20, R30 and R40, single storey or double storey dwellings are permitted whereas R60 may be three storeys and R80 four storeys and potentially higher.

R-Code	Dwelling Type	Minimum site area per dwelling (m2)
R20	Single house* or grouped dwelling**	Min 350 Ave 450
	Multiple dwelling	450
R25	Single house or grouped dwelling	Min 300 Ave 350
	Multiple dwelling	350
R30	Single house or grouped dwelling	Min 260 Ave 300
	Multiple dwelling	300
R35	Single house or grouped dwelling	Min 220 Ave 260
	Multiple dwelling	260
R40	Single house or grouped dwelling	Min 180 Ave 220
R50	Single house or grouped dwelling	Min 160 Ave 180
R60	Single house or grouped dwelling	Min 120 Ave 150
R80	Single house or grouped dwelling	Min 100 Ave 120

Figure 1-4 Implications of Different Residential Densities

Changing the density has the potential to encourage redevelopment. As an example, 80 Bolderwood Drive, South Lake currently has a single storey dwelling on a 698m^2 lot, which is the maximum number of dwellings for the lot size under R20 Coding. Under the R60 coding, it is permitted to have 4 single, grouped or multiple dwellings.

The expectation is that the redevelopment will occur over a number of years. The focus of this report is to define noise affected areas, based on computer modelling. This will allow the City of Cockburn to identify lots that are affected and provide deemed-to-satisfy acoustic (DTS) construction packages for redevelopment of the site as development applications are submitted. Alternatively, site specific acoustic assessments may be requested by City of Cockburn or may be undertaken by the developer rather than adopting the DTS standard.

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

2 CRITERIA

The criteria relevant to this assessment is the *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning* (hereafter referred to as the Policy) produced by the Western Australian Planning Commission (WAPC). The objectives in the Policy are to:

- Protect people from unreasonable levels of transport noise by establishing a standardised set of criteria to be used in the assessment of proposals;
- Protect major transport corridors and freight operations from incompatible urban encroachment;
- Encourage best practice design and construction standards for new development proposals and new or redevelopment transport infrastructure proposals;
- Facilitate the development and operation of an efficient freight network; and
- Facilitate the strategic co-location of freight handling facilities.

The Policy's outdoor noise criteria are shown below in *Table 2-1*. These criteria apply at any point 1-metre from a habitable façade of a noise sensitive premises and in one outdoor living area.

Table 2-1 Outdoor Noise Criteria

Period	Target	Limit
Day (6am to 10pm)	55 dB $L_{Aeq(Day)}$	60 dB $L_{Aeq(Day)}$
Night (10pm to 6am)	50 dB $L_{Aeq(Night)}$	55 dB $L_{Aeq(Night)}$

Note: The 5 dB difference between the target and limit is referred to as the margin.

In the application of these outdoor noise criteria to new noise sensitive developments, the objectives of this Policy is to achieve -

- acceptable indoor noise levels in noise-sensitive areas (e.g. bedrooms and living rooms of houses); and
- a 'reasonable' degree of acoustic amenity in at least one outdoor living area on each residential lot.

If a noise sensitive development takes place in an area where outdoor noise levels will meet the *target*, no further measures are required under this policy.

In areas where the *target* is exceeded, customised noise mitigation measures should be implemented with a view to achieving the *target* in at least one outdoor living area on each residential lot, or if this is not practicable, within the *margin*. Where indoor spaces are planned to be facing outdoor areas that are above the *target*, mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces.

For residential buildings, "acceptable indoor noise levels" are taken to be 40 dB $L_{Aeq(Day)}$ in living areas and 35 dB $L_{Aeq(Night)}$ in bedrooms.

3 METHODOLOGY

Noise modelling has been undertaken in accordance with the requirements of the Policy as described in *Section 3.2*. Noise monitoring was undertaken as part of Lloyd George Acoustics' involvement with the southbound carriageway widening of the Kwinana Freeway and as such, this has been utilised as part of this study.

3.1 Site Measurements

Noise monitoring was undertaken as part of a previous study in relation to the southbound carriageway widening of the Kwinana Freeway. The purpose of the monitoring is 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 ARL Type 316 noise data loggers, located at existing residences, with the microphone 1.4 metres above ground level. The logger was programmed to record hourly L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels. This instrument complies with the instrumentation requirements of *Australian Standard 2702-1984 Acoustics – Methods for the Measurement of Road Traffic Noise*. The logger 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 loggers. A photograph of the logger is provided in *Figure 3-1*.

Figure 3-1 Photograph of Noise Data Logger: 16 Virgilia Terrace, South Lake

As part of the earlier study, other loggers were also deployed, however these were focused on the east side of the Freeway, since noise control would be implemented on this side. Whilst these results are not provided, they still contribute to the calibration of the previously developed noise model.

The noise data collected was verified by inspection and professional judgement.

3.2 Noise Modelling

The computer programme *SoundPLAN 7.4* 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 corrections are applied to the exhaust of –8.0 dB (based on Transportation Noise Reference Book, Paul Nelson, 1987) and to the engine source of –0.8 dB, so as to provide consistent results with the CoRTN algorithms for the no barrier scenario;

Predictions are made at heights of 1.4, 4.4, 7.4 & 10.4 metres above ground, representing ground to third floor noise levels. A +2.5 dB façade correction is also applied to account for reflected noise when measuring 1.0 metre from a facade.

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

3.2.1 Ground Topography, Road Design & Cadastral Data

Topographical data was based on that provided by the City of Cockburn and sourced from Landgate. This information includes existing topographical contours, road elevations and existing building heights. This information enables a 3D noise model to be created. For the future Kwinana Freeway, the northbound carriageway is assumed to be widened at the same vertical level as the existing.

3.2.2 Traffic Data

Traffic data includes:

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

Table 3-1 Noise Relationship Between Different Road Surfaces

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

The existing and future road surface of Kwinana Freeway and the Roe Highway on/off ramps is assumed to be open graded asphalt. Berrigan Drive is assumed to be dense graded asphalt with the on/off ramps transitioning between open and dense graded asphalt.

- Vehicle Speed – The existing and future posted speeds on Kwinana Freeway are assumed to be 100km/hr with Berrigan Drive at 60km/hr near the Freeway. Vehicle speeds on ramps transition between, with parts of the Roe Highway loop ramps reducing to 40km/hr.

- Traffic Volumes – Information used in the modelling is provided in *Table 3-2*. The information was provided by Main Roads Western Australia (MRWA) in a data request (Clare Yu, Traffic Modelling Analyst #40624 via email dated 22 August 2017) containing the 2016 volumes and percentage heavy vehicles (shown in brackets), 2016 calibration plot (modelled traffic volumes compared to counts) and the 2031 volumes.

  Differences in the calibration plot are applied for the future volumes. For instance, South of Farrington Road, the modelled existing traffic volume is 54,000 vehicles northbound, whereas the count indicates 44,200 vehicles northbound. In 2031, the forecast modelled volume is 78,400 vehicles northbound so this is reduced to 68,600 vehicles northbound in the noise model.

Table 3-2 Traffic Information Used in the Modelling

Road Name	Section	Traffic Volumes			
		Existing		Future	
		Northbound	Southbound	Northbound	Southbound
Kwinana Freeway	South of Farrington Road	44200 (11)	47900 (10)	68,600 (9)	63,400 (9)
	Roe Highway Interchange	36600 (12)	40700 (8)	56,805 (10)	53,870 (7)
	South of Roe Highway	59200 (13)	59150 (12)	109,100 (11)	92,450 (11)
	Berrigan Drive Interchange	49984 (13)	52092 (12)	9,2116 (11)	81,419 (11)
Ramps	Roe Hwy (West) to/from Kwinana Fwy	7600 (17)	7200 (18)	11,795 (6)	9,530 (20)
	Kwinana Fwy to/from Roe Hwy (East)	22600 (15)	18450 (21)	52,295 (12)	38,580 (16)
	Berrigan Dr to/from Kwinana Fwy	9,216 (13)	7,058 (11)	16,984 (10)	11,031 (10)
Berrigan Drive	West of Kwinana Freeway	16,582 (8)	14,380 (8)	30,559 (9)	22,476 (9)

Note: Numbers shown in bracket indicate percentage of heavy vehicles.

Note that for the existing scenario, there are two lanes northbound and 4 lanes southbound between Roe Highway and Berrigan Drive. In the future, the Kwinana Freeway will be 4 lanes in both directions.

3.2.3 Ground Attenuation

The ground attenuation has been assumed to be 0.0 (0%) for the road and 0.6 (60%) elsewhere. Note 0.0 represents hard reflective surfaces such as water and 1.00 represents absorptive surfaces such as grass.

3.2.4 Parameter Conversion

The CoRTN algorithms used in the *SoundPlan* modelling package were originally developed to calculate the $L_{A10,18hour}$ noise level. The WAPC Policy 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*.

4 RESULTS

4.1 Noise Monitoring

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

Table 4-1 Measured Average Noise Levels – 16 Virgilia Terrace, South Lake

Date	Average Weekday Noise Level, dB			
	$L_{A10,18hour}$	$L_{Aeq,24hour}$	$L_{Aeq\ (Day)}$	$L_{Aeq\ (Night)}$
18 November 2013	63.5	61.1	62.3	56.5
19 November 2013	65.3	63.0	64.3	57.4
20 November 2013	63.7	61.6	62.9	56.2
21 November 2013	62.4	60.6	61.6	57.6
22 November 2013	61.5	59.6	60.4	57.6
Average	**63.3**	**61.2**	**62.3**	**57.0**

The $L_{Aeq(Night)}$ is at least 5 dB less than the $L_{Aeq(Day)}$ so that it is the $L_{Aeq(Day)}$ that is more critical for compliance.

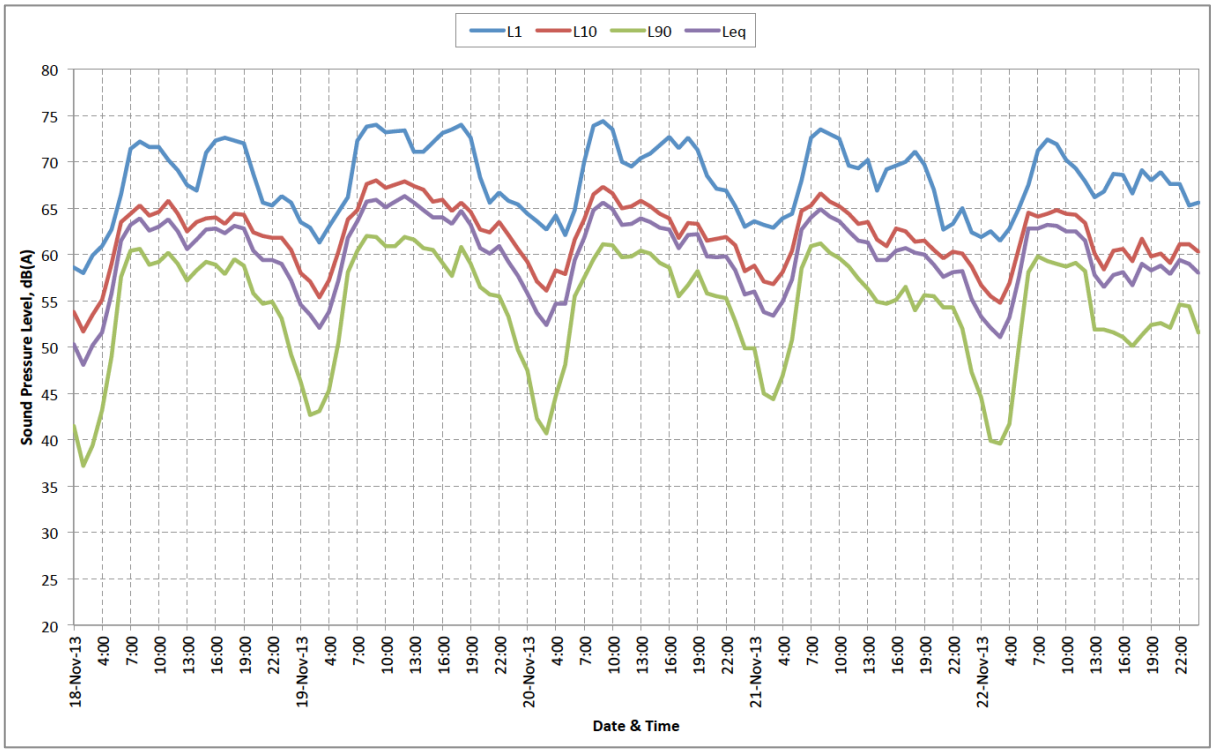
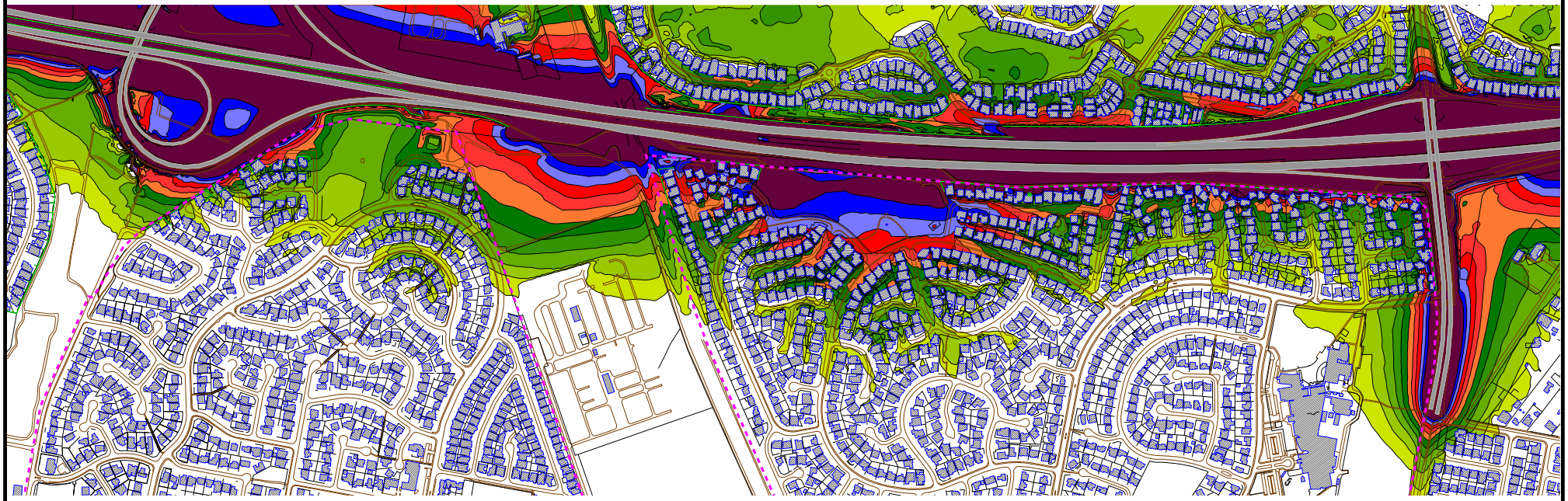


Figure 4-1 Noise Monitoring Results: 16 Virgilia Terrace, South Lake

4.2 Noise Modelling

From the previous study, the noise model had already been calibrated. As such, the same calibration was maintained for this study and the new future volumes incorporated. The results of this modelling is presented as noise contour plots in *Figures 4-2 to 4-5*, being for the ground, first, second and third floors respectively. Note that building heights are assumed to be unchanged from existing so that noise modelling to upper floors is effectively above the existing houses. As development occurs, then the noise contours will also vary, since a large building will screen noise to a building located behind.

The noise modelling to ground floor assumes the existing walls exist. In reality, noise levels to the ground floor and first floor may be less than the reported, once the northbound carriageway is widened. The reason for this is when MRWA undertake this widening project, they will most likely construct noise walls to achieve a level of no more than 60 dB $L_{Aeq(Day)}$ at the ground level of existing houses.



The Lakes Revitalisation Strategy - Kwinana Freeway

LAeq(Day) Noise Level Contours Based on Future Traffic Volumes
Ground Floor Level

SoundPlan v7.4
CoRTN Algorithms

5 September 2017

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Length Scale 1:12000

0 50 100 200 300 400 m

Figure 4-2

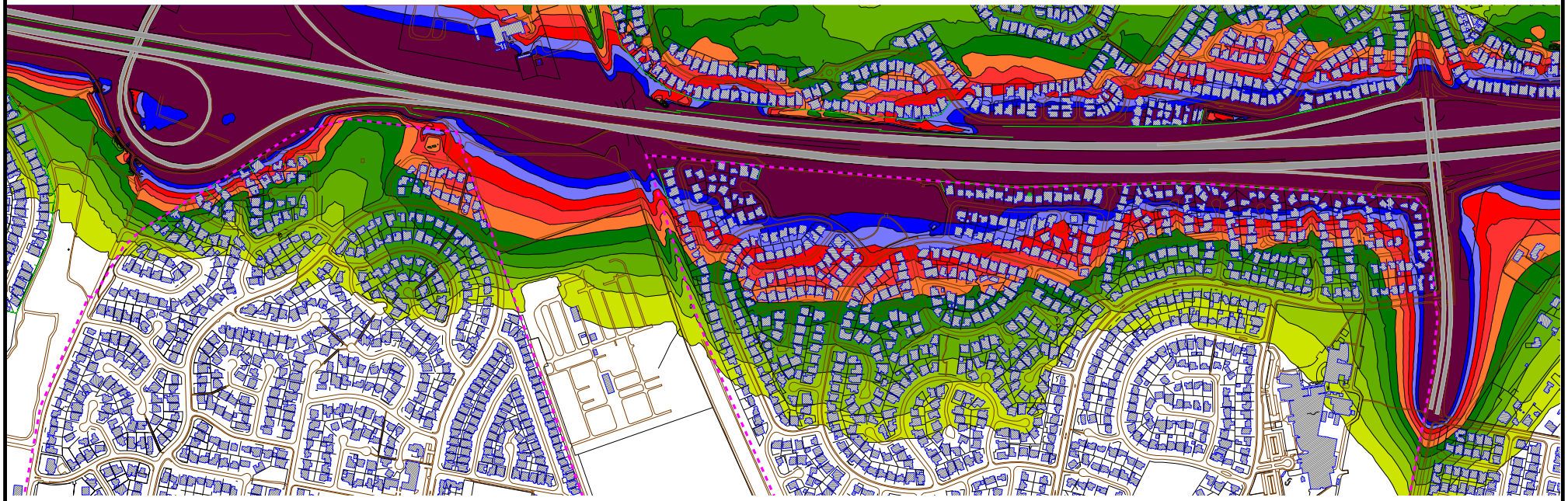
Signs and symbols

- Road
- Existing Building
- Elevation line
- Study Area

N

Noise levels
LAeq,Day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	< 61
61 <=	< 62
62 <=	< 63
63 <=	< 64
64 <=	< 65
65 <=	



The Lakes Revitalisation Strategy - Kwinana Freeway

LAeq(Day) Noise Level Contours Based on Future Traffic Volumes
First Floor Level

SoundPlan v7.4
CoRTN Algorithms

5 September 2017

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Length Scale 1:12000

0 50 100 200 300 400 m

Figure 4-3

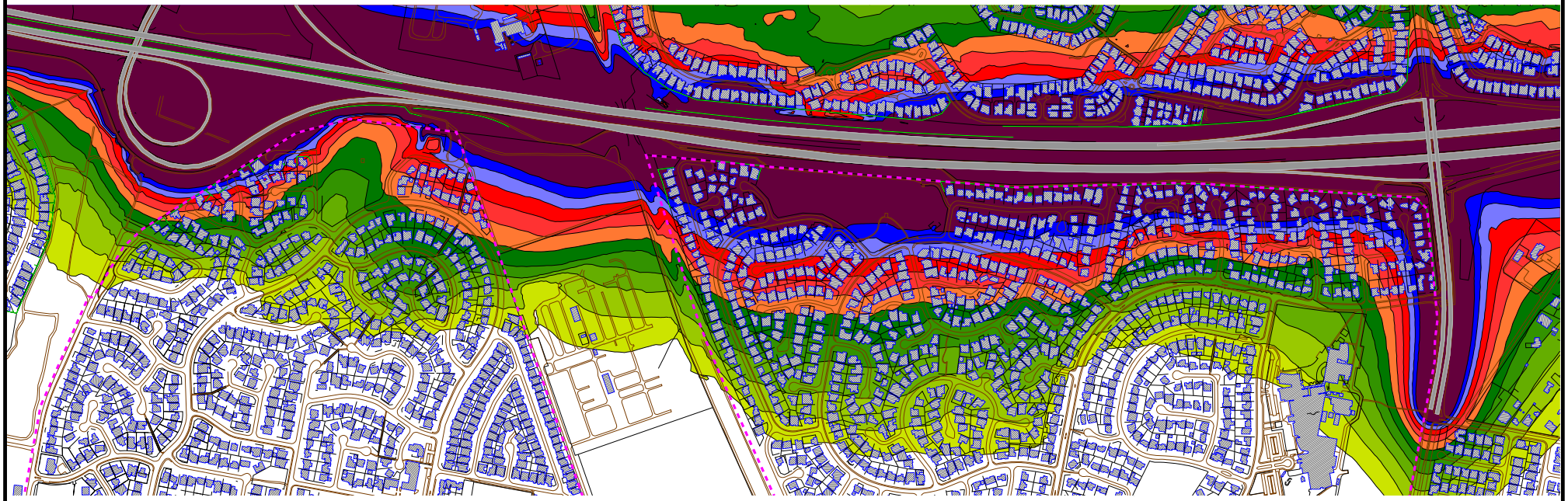
Signs and symbols

- Road
- Existing Building
- Elevation line
- Study Area

N

Noise levels
LAeq,Day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	< 61
61 <=	< 62
62 <=	< 63
63 <=	< 64
64 <=	< 65
65 <=	



The Lakes Revitalisation Strategy -
Kwinana Freeway

LAeq(Day) Noise Level Contours Based on Future Traffic Volumes
Second Floor Level

SoundPlan v7.4
CoRTN Algorithms

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Length Scale 1:12000

0 50 100 200 300 400 m

Figure 4-4

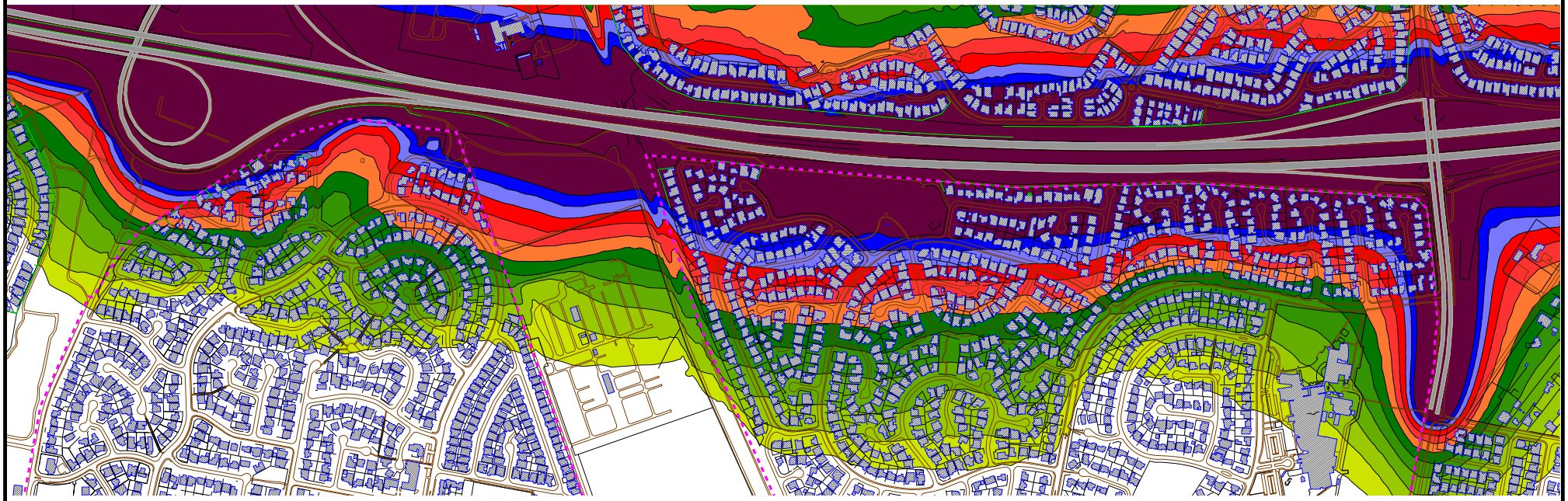
Signs and symbols

- Road
- Existing Building
- Elevation line
- Study Area

N

Noise levels
LAeq,Day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	< 61
61 <=	< 62
62 <=	< 63
63 <=	< 64
64 <=	< 65
65 <=	



The Lakes Revitalisation Strategy - Kwinana Freeway

LAeq(Day) Noise Level Contours Based on Future Traffic Volumes
Third Floor Level

SoundPlan v7.4
CoRTN Algorithms

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Length Scale 1:12000

0 50 100 200 300 400 m

Figure 4-5

Signs and symbols

- Road
- Existing Building
- Elevation line
- Study Area

N

Noise levels
LAeq,Day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	< 61
61 <=	< 62
62 <=	< 63
63 <=	< 64
64 <=	< 65
65 <=	

5 ASSESSMENT

The objectives of the Policy are for noise at all houses to be no more than the *limit* and preferably no more than the *target* criteria. Where the *target* is achieved, no further controls are required. Where the *target* is exceeded, further controls are necessary.

The SPP 5.4 Guidelines provide architectural deemed-to-satisfy packages depending on the external noise level as follows:

- Package A – External noise level up to 60 dB $L_{Aeq(Day)}$
- Package B – External noise level up to 63 dB $L_{Aeq(Day)}$; and
- Package C – External noise level up to 65 dB $L_{Aeq(Day)}$.

The above packages are provided in *Appendix A* as well as the notification on title that would also be required, once a site is to be redeveloped. The locations where each is applicable is provided in *Figures 5-1 to 5-4*.

In some cases, noise levels are predicted to be above 65 dB $L_{Aeq(Day)}$ in the future and are noted as 'Specialist Advice' required. This advice, or any alternatives to the deemed-to-satisfy packages, is to be provided by a suitably qualified acoustical consultant, being a member firm of the Association of Australasian Acoustical Consultants (AAAC), based on a site specific assessment and analysis of the proposed building plans.

In order to minimise potential noise impacts and also costs of noise mitigation, the following should be considered during the design stage:

- Locate habitable rooms away from the transport corridor and conversely, locate non-habitable rooms (entry, bathrooms, laundries, garage, storerooms etc.) on the same side of the building as the transport corridor;
- Locate outdoor living areas on the opposite side of the building to the transport corridor or within an alcove type area so that there is limited direct line of sight.
- Where habitable rooms are on the same side of the building as the transport corridor:
    - Locate windows/doors on the side (perpendicular) of the building or where possible, the opposite side of the building to the transport corridor;
    - Keep window/door sizes as small as practicable;
    - Select awning/casement style windows over sliding windows;
    - Do not have sliding door access from a bedroom to balcony;
    - Do not locate balconies on the same side of the building as the transport corridor.

It should be noted that a similar study has been undertaken for the noise and vibration from the freight rail line[1]. Some lots are affected by both the freight railway and Kwinana Freeway. In these cases, *Table 5-1* shows the priority of the Packages.

Table 5-1 Package Priority

Package Priority	Package
1	CF
2	C*
3	BF
4	B*
5	AF
6	A

* With the clay roof tile requirement of the freight packages where Package BF or CF is nominated.

Therefore, if we take a lot that is identified as requiring Package BF from the freight train study and Package C from the Kwinana Freeway study, Package C is to be adopted, with the inclusion of clay roof tiles as described in the freight train study.

[1] *Freight Train Noise & Vibration Assessment, Bibra Lake (North), Bibra Lake (North-East) & South Lake (North)*; Reference: 16073652-02, 12 January 2017.

The Lakes Revitalisation Strategy - Kwinana Freeway

Deemed to Comply Architectural Packages
Ground Floor Level

Refer Implementation Guidelines for State Planning Policy 5.4

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Length Scale 1:12000

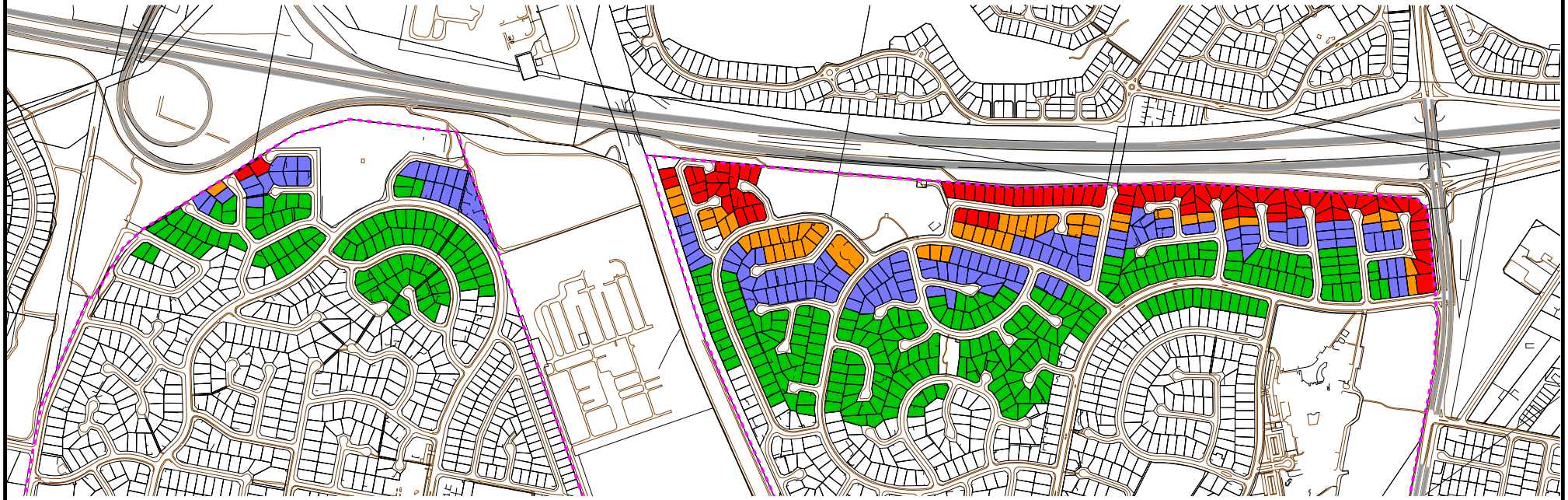
0 50 100 200 300 400 m

Figure 5-1

Signs and symbols

- Road
- Elevation line
- Study Area
- Specialist Advice & Notification
- Package C & Notification
- Package B & Notification
- Package A & Notification

N



The Lakes Revitalisation Strategy - Kwinana Freeway

Deemed to Comply Architectural Packages
First Floor Level

Refer Implementation Guidelines for State Planning Policy 5.4

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Length Scale 1:12000

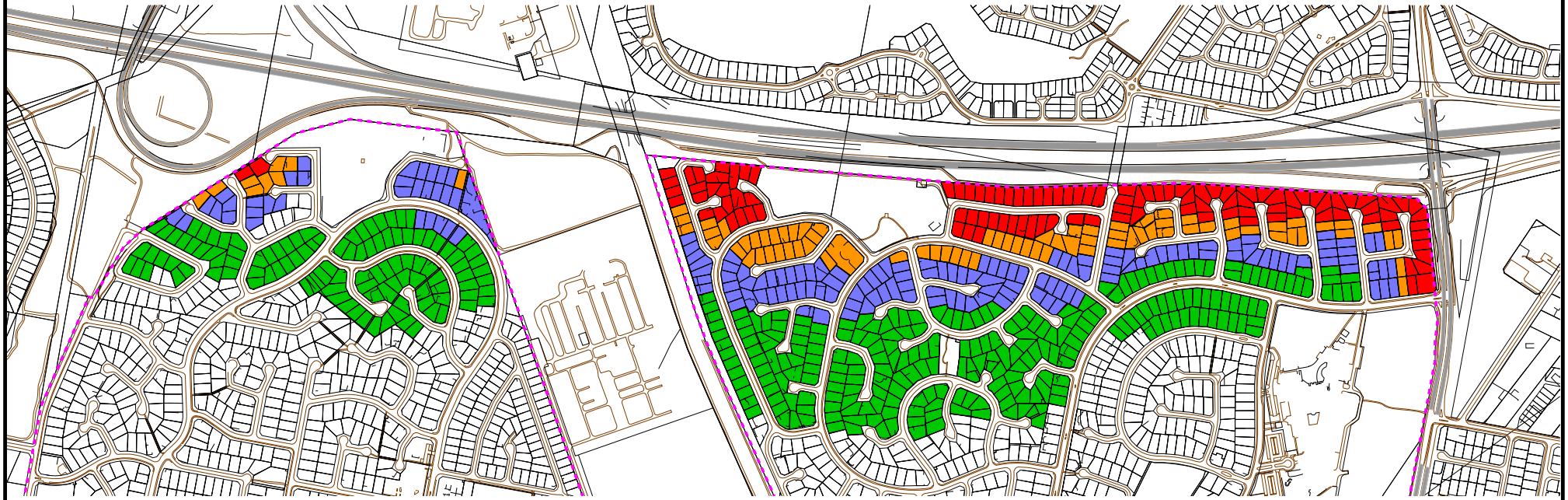
0 50 100 200 300 400 m

Figure 5-2

Signs and symbols

- Road
- Elevation line
- Study Area
- Specialist Advice & Notification
- Package C & Notification
- Package B & Notification
- Package A & Notification

N



The Lakes Revitalisation Strategy - Kwinana Freeway

Deemed to Comply Architectural Packages
Second Floor Level

Refer Implementation Guidelines for State Planning Policy 5.4

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Length Scale 1:12000

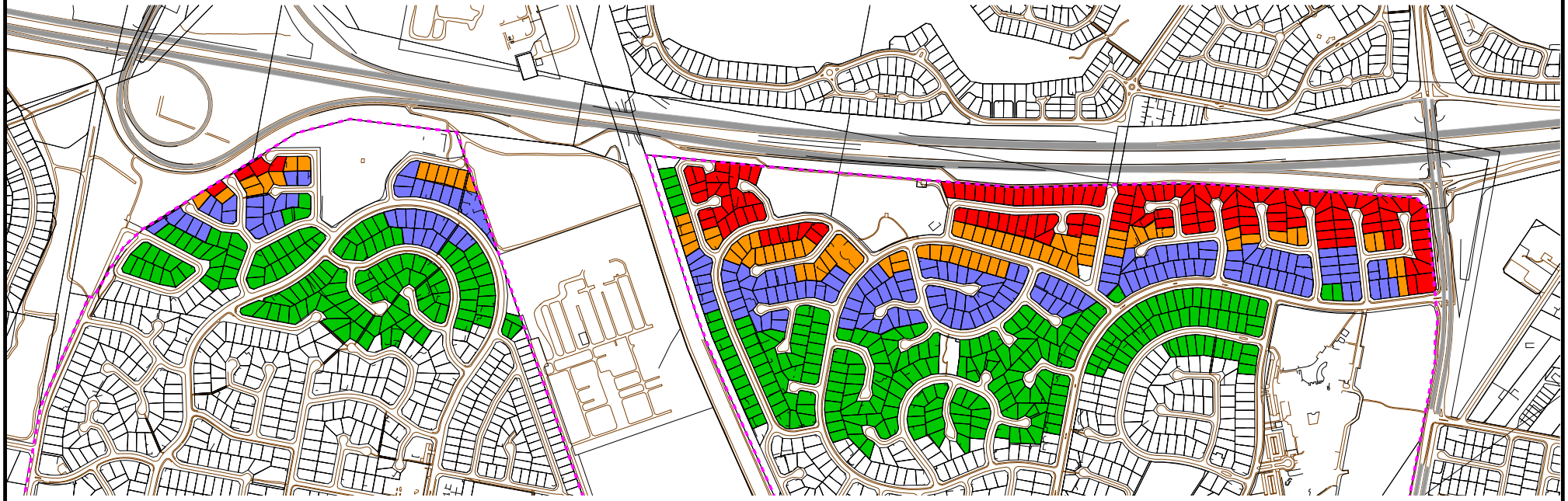
0 50 100 200 300 400 m

Figure 5-3

Signs and symbols

- Road
- Elevation line
- Study Area
- Specialist Advice & Notification
- Package C & Notification
- Package B & Notification
- Package A & Notification

N



The Lakes Revitalisation Strategy - Kwinana Freeway

Deemed to Comply Architectural Packages
Third Floor Level

Refer Implementation Guidelines for State Planning Policy 5.4

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Length Scale 1:12000

0 50 100 200 300 400 m

Figure 5-4

Signs and symbols

- Road
- Elevation line
- Study Area
- Specialist Advice & Notification
- Package C & Notification
- Package B & Notification
- Package A & Notification

N

Appendix A

ACCEPTABLE TREATMENT PACKAGES

The packages and information provided on the following pages are taken from *ImplementationGuidelines for State Planning Policy 5.4 Road and Rail Transport Noise and freight Considerations in Land Use Planning*; December 2014.

Where outdoor noise levels are above the ***target*** level, excluding the effect of any boundary fences, the Guidelines propose acceptable treatment packages that may be implemented without requiring detailed review. The packages are also intended for residential development only. At higher noise levels or for other building usages, specialist acoustic advice will be needed.

The acceptable treatment packages are intended to simplify compliance with the noise criteria, and the relevant package should be required as a condition of development in lieu of a detailed assessment.

Transition between each package should be made on the basis of the highest incident $L_{Aeq(Day)}$ or $L_{Aeq(Night)}$ value to the nearest whole number determined for the building development under assessment.

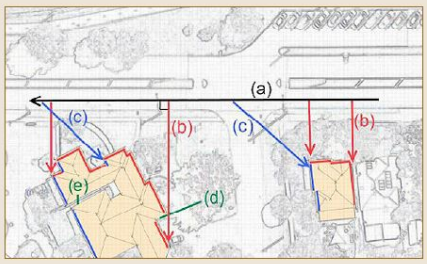
Any departures from the acceptable treatment specifications need to be supported by professional advice from a competent person that the proposal will achieve the requirements of the Policy.

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

- **Facing** the transport corridor: Any part of a building façade is 'facing' the transport corridor if any straight line drawn perpendicular to its nearest road lane or railway line intersects that part of the façade without obstruction (ignoring any fence).
- **Side-on** to transport corridor: Any part of a building façade that is not 'facing' is 'side-on' to the transport corridor if any straight line can be drawn from it to intersect the nearest road lane or railway line without obstruction (ignoring any fence).
- **Opposite** to transport corridor: Neither 'side on' nor 'facing', as defined above.

Determining building face orientation

The following sketch shows two residences in proximity to a road.



'Facing' façades are identified by drawing straight lines (b) perpendicular (at a 90 degree angle) to the road (a). Where these lines intersect a façade – without obstruction – the façades are shown in red as 'facing' the road.

Façades shown in blue are not 'facing' but have clear lines (c) that intersect the road at any angle, and are therefore classed as 'side on' to the road.

The remaining façades are 'opposite' to the road.

Package A

Area	Orientation to Road or Rail Corridor	Package A (up to 60 dB $L_{Aeq(Day)}$ and 55 dB $L_{Aeq(Night)}$)
Bedrooms	Facing	• Windows systems: Glazing up to 40% of floor area (minimum $R_w + C_{tr}$ 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings.
	Side	• Windows systems: As above.
	Opposite	No requirements
Other Habitable Rooms Including Kitchens	Facing	• Windows and external door systems: Glazing up to 60% of floor area (minimum $R_w + C_{tr}$ 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 35mm thick solid timber core door with full perimeter acoustic seals. Glazed inserts to match the above. Sliding glass doors to be same performance including brush seals.
	Side	• Windows and external door systems: As above.
	Opposite	No requirements
General	Any	• Walls (minimum $R_w + C_{tr}$ 45) – Two leaves of 90mm thick brick with minimum 50mm cavity • Roof and ceiling (minimum $R_w + C_{tr}$ 35) – Standard roof construction with 10mm plasterboard ceiling and minimum R2.5 insulation between ceiling joists. • Eaves to be closed using 4mm compressed fibre cement sheet. • Mechanical ventilation – Refer following pages.
Outdoor Living Area		• Locate on the side of the building that is opposite to the corridor if practicable; or • Locate within alcove area so that the house shields it from corridor if practicable.

Note: Any penetrations in a part of the building envelope must be acoustically treated so as to not downgrade the performance of the building elements affected. Most penetrations in external walls such as pipes, cables or ducts can be sealed through caulking gaps with non-hardening mastic or suitable mortar.

Package B

Area	Orientation to Road or Rail Corridor	Package B (up to 63 dB $L_{Aeq(Day)}$ and 58 dB $L_{Aeq(Night)}$)
Bedrooms	Facing	• Windows systems: Glazing up to 40% of floor area (minimum $R_w + C_{tr}31$) – 10mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings.
	Side	• Windows systems: As above.
	Opposite	• Windows systems: Glazing up to 40% of floor area (minimum $R_w + C_{tr}$ 25) – 4mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Alternatively, 6mm thick glass (monolithic, toughened or laminated) in sliding frame.
Other Habitable Rooms Including Kitchens	Facing	• Windows and external door systems: Glazing up to 60% of floor area (minimum $R_w + C_{tr}31$) – 10mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 35mm thick solid timber core door with full perimeter acoustic seals. Glazed inserts to match the above. Sliding glass doors to have laboratory certificate confirming $R_w + C_{tr}$ 31 performance. Alternative, change to hinged door with perimeter acoustic seals and 10mm thick glass.
	Side	• Windows and external door systems: Glazing up to 60% of floor area (minimum $R_w + C_{tr}$ 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 35mm thick solid timber core door with full perimeter acoustic seals. Glazed inserts to match the above. Glass doors to be same performance ($R_w + C_{tr}$ 28) including brush seals.
	Opposite	No requirements
General	Any	• Walls (minimum $R_w + C_{tr}$ 50) – Two leaves of 90mm thick brick with minimum 50mm cavity. Cavity to include 25mm thick, 24kg/m^3 insulation and where wall ties are required, these are to be anti-vibration/resilient type. • Roof and ceiling (minimum $R_w + C_{tr}$ 35) – Standard roof construction with 10mm plasterboard ceiling and minimum R2.5 insulation between ceiling joists. • Eaves to be closed using 4mm thick compressed fibre cement sheet. • Mechanical ventilation – Refer following pages.
Outdoor Living Area		• Locate on the side of the building that is opposite to the corridor; or • Locate within alcove area so that the house shields it from corridor.

Note: Any penetrations in a part of the building envelope must be acoustically treated so as to not downgrade the performance of the building elements affected. Most penetrations in external walls such as pipes, cables or ducts can be sealed through caulking gaps with non-hardening mastic or suitable mortar.

Package C

Area	Orientation to Road or Rail Corridor	Package C (up to 65 dB $L_{Aeq(Day)}$ and 60 dB $L_{Aeq(Night)}$)
Bedrooms	Facing	• Windows systems: Glazing up to 40% of floor area (minimum $R_w + C_{tr}$ 34) – 10.5mm thick VLam Hush glass in fixed sash, awning or casement opening with seals to openings.
	Side	• Windows systems: • Glazing up to 40% of floor area (minimum $R_w + C_{tr}$ 31) – 10mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings.
	Opposite	• Windows systems: Glazing up to 40% of floor area (minimum $R_w + C_{tr}$ 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings.
Other Habitable Rooms Including Kitchens	Facing	• Windows and external door systems: Glazing up to 40% of floor area (minimum $R_w + C_{tr}$ 31) – 10mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 40mm thick solid timber core door with full perimeter acoustic seals. Glazed inserts to match the above. Sliding glass doors to have laboratory certificate confirming $R_w + C_{tr}$ 31 performance. Alternatively, change to fully glazed hinged door with perimeter acoustic seals and 10mm thick glass.
	Side	• Windows and external door systems: Glazing up to 60% of floor area (minimum $R_w + C_{tr}$ 31) – 10mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 35mm thick solid timber core door with full perimeter acoustic seals certified to R_w 30. Glazed inserts to match the above. Sliding glass doors to have laboratory certificate confirming $R_w + C_{tr}$ 31 performance. Alternatively, change to hinged door with perimeter acoustic seals and 10mm thick glass.
	Opposite	• Windows systems: Glazing up to 60% of floor area (minimum $R_w + C_{tr}$ 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings.
General	Any	• Walls (minimum $R_w + C_{tr}$ 50) – Two leaves of 90mm thick brick with minimum 50mm cavity. Cavity to include 25mm thick, 24kg/m^3 insulation and where wall ties are required, these are to be anti-vibration/resilient type. • Roof and ceiling (minimum $R_w + C_{tr}$ 40) – Standard roof construction with 2 x 10mm plasterboard ceiling and minimum R3.0 insulation between ceiling joists. • Eaves to be closed using 6mm thick compressed fibre cement sheet. • Mechanical ventilation – Refer following pages.
Outdoor Living Area		• Locate on the side of the building that is opposite to the corridor; or • Locate within alcove area so that the house shields it from corridor.

Note: Any penetrations in a part of the building envelope must be acoustically treated so as to not downgrade the performance of the building elements affected. Most penetrations in external walls such as pipes, cables or ducts can be sealed through caulking gaps with non-hardening mastic or suitable mortar.

Mechanical Ventilation requirements

It is noted that natural ventilation must be provided in accordance with F4.6 and F4.7 of Volume One and 3.8.5.2 of Volume Two of the National Construction Code.Where the noise *limit* is likely to be exceeded, a mechanical ventilation system is usually required.Mechanical ventilation systems will need to comply with AS 1668.2 – *The use of mechanical ventilation and air-conditioning in buildings*.

In implementing the acceptable treatment packages, the following must be observed:

- Evaporative air conditioning systems will meet the requirements for Packages A and B provided attenuated air vents are provided in the ceiling space and designed so that windows do not need to be opened.
- Refrigerant based air conditioning systems need to be designed to achieve fresh air ventilation requirements.
- External openings (e.g. air inlets, vents) need to be positioned facing away from the transport corridor where practicable.
- Ductwork needs to be provided with adequate silencing to prevent noise intrusion.

Notification

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

The area of land for which notification is required should be identified in the noise management plan and contain a description of major noise sources nearby (e.g. 24-hour freight rail).

Notification should be provided to prospective purchasers, and required as a condition of subdivision (including strata subdivision) for the purposes of noise sensitive development or planning approval involving noise sensitive development, where external noise levels are forecast or estimated to exceed the 'target' criteria as defined by the Policy.

In the case of subdivision and development, conditions of approval should include a requirement for registration of a notice on title, which is provided for under Section 165 of the Planning and Development Act 2005 and Section 70A of the Transfer of Land Act 1893. An example of a suitable notice is:

Notice: This lot is situated in the vicinity of a transport corridor and is currently affected, or may in the future be affected, by transport noise. Transportation noise controls and Quiet House design strategies at potential cost to the owner may be required to achieve an acceptable level of noise reduction. Further information is available on request from the relevant local government offices.

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 $L_{A10,18hour}$.

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.

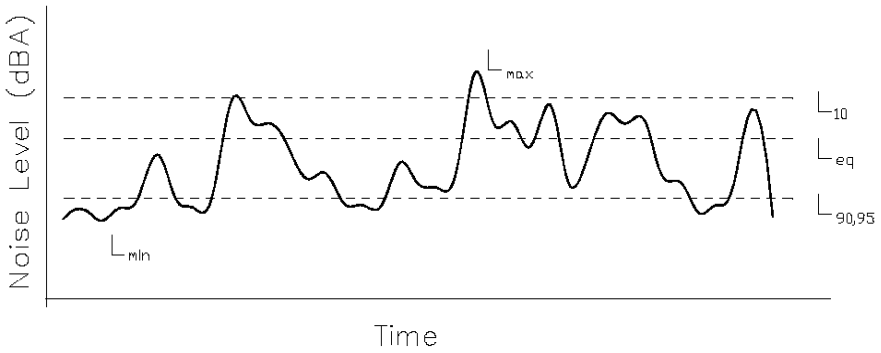
Satisfactory Design Sound Level

The level of noise that has been found to be acceptable by most people for the environment in question and also to be not intrusive.

Maximum Design Sound Level

The level of noise above which most people occupying the space start to become dissatisfied with the level of noise.

Chart of Noise Level Descriptors



Austroads Vehicle Class

AUSTROADS Vehicle Classification System

Level 1 Length (indicative) Type	Level 2 Axles and Axle Groups Axles	Groups	Level 3 Vehicle Type Typical Description	AUSTROADS Classification Class	Parameters	Typical Configuration
			LIGHT VEHICLES			
Short up to 5.5m		1 or 2	**Short** Sedan, Wagon, 4WD, Utility, Light Van, Bicycle, Motorcycle, etc	1	d(1) < 3.2m and axles = 2	
	3, 4 or 5	3	**Short - Towing** Trailer, Caravan, Boat, etc	2	groups = 3 d(1) ≥ 2.1m, d(1) < 3.2m, d(2) ≥ 2.1m and axles = 3, 4 or 5	
			HEAVY VEHICLES			
Medium 5.5m to 14.5m	2	2	**Two Axle Truck or Bus**	3	d(1) > 3.2m and axles = 2	
	3	2	**Three Axle Truck or Bus**	4	axles = 3 and groups = 2	
	> 3	2	**Four Axle Truck**	5	axles > 3 and groups = 2	
Long 11.5m to 19.0m	3	3	**Three Axle Articulated** Three axle articulated vehicle, or Rigid vehicle and trailer	6	d(1) > 3.2m, axles = 3 and groups = 3	
	4	> 2	**Four Axle Articulated** Four axle articulated vehicle, or Rigid vehicle and trailer	7	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 4 and groups > 2	
	5	> 2	**Five Axle Articulated** Five axle articulated vehicle, or Rigid vehicle and trailer	8	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 5 and groups > 2	
	≥ 6	> 2	**Six Axle Articulated** Six axle articulated vehicle, or Rigid vehicle and trailer	9	axles = 6 and groups > 2 or axles = 6 and groups = 3	
Medium Combination 17.5m to 36.5m	> 6	4	**B Double** B Double, or Heavy truck and trailer	10	groups = 4 and axles > 6	
	> 6	5 or 6	**Double Road Train** Double road train, or Medium articulated vehicle and one dog trailer (M.A.D.)	11	groups = 5 or 6 and axles > 6	
Large Combination Over 33.0m	> 6	> 6	**Triple Road Train** Triple road train, or Heavy truck and three trailers	12	groups > 6 and axles > 6	

Definitions: Group: Axle group, where adjacent axles are less than 2.1m apart
Groups: Number of axle groups
Axles: Number of axles (maximum axle spacing of 10.0m)
d(1): Distance between first and second axle
d(2): Distance between second and third axle

Typical Noise Levels