HERRING STORER ACOUSTICS

NORTH ELLENBROOK (PRECINCT B)
DISTRICT STRUCTURE PLAN

ROAD TRAFFIC AND FREIGHT RAIL (SPP 5.4) AND ENVIRONMENTAL NOISE IMPACT ACOUSTIC ASSESSMENT

DECEMBER 2019

OUR REFERENCE: 25164-3-19245

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ACOUSTIC ASSESSMENT

NORTH ELLENBROOK (PRECINCT B) DISTRICT STRUCTURE PLAN

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APPENDICIES

1. INTRODUCTION

Herring Storer Acoustics was commissioned by Lendlease to undertake an acoustical assessment of noise received within the proposed North Ellenbrook (Precinct B) District Structure Plan (DSP) which is bounded by Warbrook and Maralla Road, Ellenbrook.

As part of the study, the following was carried out:

- Determine by noise modelling the noise levels that would be received within the DSP from vehicles travelling on the future Perth to Darwin Highway.
- Determine by noise modelling the noise levels that would be received within the DSP from freight trains travelling on the Perth to Geraldton Rail line.
- Assess the predicted noise levels received at residence for compliance with the requirements of the WAPC State Planning Policy 5.4 *"Road and Rail Noise"* (SPP 5.4).
- If exceedances are predicted, comment on possible noise amelioration options for compliance with the appropriate criteria.
- Provide comment on noise emissions associated with the Pearse Air Base and the Ellenbrook Speedway.

For information, the local structure plan is attached in Appendix A.

2. SUMMARY

Under the WAPC State Planning Policy 5.4, for this development, the appropriate "Noise Targets" to be achieved under SPP 5.4, external to a residence are:

External

Day	Maximum of 55 dB(A) L_{Aeq}
Night	Maximum of 50 dB(A) L_{Aeq}

The policy states that the "outdoor targets are to be met at all outdoor areas as far as reasonable and practical to do so using the various noise mitigation measures outlined in the guidelines". The Policy also states, under Section 6 – Policy Measures that "a reasonable degree of acoustic amenity for living areas on each residential lot". The policy recognises that "it may not be practicable to meet the outdoor noise targets".

The Policy states the following acceptable internal noise levels:

Internal

Living and Work Areas	$L_{Aeq(Day)}$ of 40 dB(A)
Bedrooms	$L_{Aeq(Night)}$ of 35 dB(A)

For this development, compliance with the requirements of SP 5.4, noise modelling and assessment are based on the day period for residence located adjacent to the Perth To Darwin Highway and the night period for the Perth to Geraldton rail line.

This assessment is provided to provide overall guidance for the DSP, once detailed information is available at subdivision stage, such as final heights, Lots placement etc, more detailed acoustic advice can be provided.

2.1 PERTH TO DARWIN HIGHWAY AND PERTH TO GERALDTON RAIL LINE

The results of the acoustic assessment indicate that noise received at residences located adjacent to the Highway and the rail line would exceed the "Noise Targets" as outlined in SPP 5.4.

As the construction of the highway and the rail line has already been undertaken, noise levels at the proposed development have not been considered by the infrastructure provider as the land is rural use. Therefore, no noise amelioration in the form of noise walls are likely to be implemented for this section of the highway.

Based on the concept plan for the DSP there are areas adjacent to the highway and rail line which do not contain residential development, due to hard constraints therefore, noise mitigation in these areas will not be required.

Other lots which are to contain residential development the possible noise amelioration options that are normally considered are Setbacks or Buffer areas, Noise bunds and / or Barriers. and "Quiet House" design. Example of these in relation to this development are detailed further in this report.

2.2 AIRCRAFT NOISE

Based on the ANEF for the Pearce RAAF base, the development is located outside the ANEF 20 contour. Hence, residential development (without any noise amelioration) is acceptable within the development.

2.3 SPEEDWAY NOISE

Based on the noise emissions from the speedway operations, the noise level at the boundary of the DSP would be less than 55 dB(A). For comparison, an individual 2-minute train pass at this same location would be around 75 dB(A). Therefore, noise levels for the train line would be considered higher than noise levels associated with the speedway, hence any acoustic mitigation for the train would also be sufficient for the speedway. However, it is recommended that notification on titles is made for lots which receive noise greater than 50 dB(A) from the speedway.

3. CRITERIA

3.1 ROAD AND RAIL TRAFFIC NOISE

The Western Australian Planning Commission (WAPC) released on 6th September 2019 State Planning Policy 5.4 *"Road and Rail Noise".* The requirements of State Planning Policy 5.4 are outlined below.

POLICY APPLICATION (Section 4)

When and where it applies (Section 4.1)

SPP 5.4 applies to the preparation and assessment of planning instruments, including region and local planning schemes; planning strategies, structure plans; subdivision and development proposals in Western Australia, where there is proposed:

*a) noise-sensitive land-use within the policy's trigger distance of a transport corridor as specified in **Table 1**;*

*b) New or major upgrades of roads as specified in **Table 1** and maps **(Schedule 1,2 and 3);** or*

*c) New railways or major upgrades of railways as specified in maps (**Schedule 1, 2 and 3);** or any other works that increase capacity for rail vehicle storage or movement and will result in an increased level of noise.*

Policy trigger distances (Section 4.1.2)

***Table 1** identifies the State's transport corridors and the trigger distances to which the policy applies.*

*The designation of land within the trigger distances outlined in **Table 1** should not be interpreted to imply that land is affected by noise and/or that areas outside the trigger distances are un-affected by noise.*

*Where any part of the lot is within the specified trigger distance, an assessment against the policy is required to determine the likely level of transport noise and management/ mitigation required. An initial screening assessment (**guidelines: Table 2: noise exposure forecast**) will determine if the lot is affected and to what extent."*

TABLE 1: TRANSPORT CORRIDOR CLASSIFICATION AND TRIGGER DISTANCES

Transport corridor classification	*Trigger distance*	*Distance measured from*
Roads		
Strategic freight and major traffic routes *Roads as defined by Perth and Peel Planning Frameworks and/or roads with either 500 or more Class 7 to 12 Austroads vehicles per day, and/or 50,000 per day traffic volume*	*300 metres*	*Road carriageway edge*
Other significant freight/traffic routes *These are generally any State administered road and/or local government road identified as being a future State administered road (red road) and other roads that meet the criteria of either >=23,000 daily traffic count (averaged equivalent to 25,000 vehicles passenger car units under region schemes)*	*200 metres*	*Road carriageway edge*
Passenger railways		
	100 metres	*Centreline of the closest track*
Freight railways		
	200 metres	*Centreline of the closest track*

Proponents are advised to consult with the decision making authority as site specific conditions (significant differences in ground levels, extreme noise levels) may influence the noise mitigation measures required, that may extend beyond the trigger distance.

POLICY MEASURES (Section 6)

The policy applies a performance-based approach to the management and mitigation of transport noise. The policy measures and resultant noise mitigation will be influenced by the function of the transport corridor and the type and intensity of the land-use proposed. Where there is risk of future land-use conflict in close proximity to strategic freight routes, a precautionary approach should be applied. Planning should also consider other broader planning policies. This is to ensure a balanced approach takes into consideration reasonable and practical considerations.

Noise Targets (Section 6.1)

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

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

- *indoor noise levels as specified in **Table 2** in noise sensitive areas (for example, 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 child care 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.

TABLE 2: NOISE TARGETS

Proposals	***New/Upgrade***	***Noise Targets***		
		Outdoor		***Indoor***
		Day (L_{Aeq}(Day) dB) (6 am-10 pm)	***Night (L_{Aeq}(Night)dB) (10 pm-6 am)***	***(L_{Aeq} dB)***
Noise-sensitive land-use and/or development	*New noise sensitive land use and/or development within the trigger distance of an existing/proposed transport corridor*	*55*	*50*	*L_{Aeq} (Day) 40(Living and work areas)* *L_{Aeq} (Night) 35 (bedrooms)*
Roads	*New*	*55*	*50*	*N/A*
	Upgrade	*60*	*55*	*N/A*
Railways	*New*	*55*	*50*	*N/A*
	Upgrade	*60*	*55*	*N/A*

Notes:

- *The noise target is to be measured at one metre from the most exposed, habitable façade of the proposed building, which has the greatest exposure to the noise-source. A habitable room has the same meaning as defined in State Planning Policy 3.1 Residential Design Codes.*

- *For all noise-sensitive land-use and/or development, indoor noise targets for other room usages may be reasonably 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.*

- *The 5dB difference in the criteria between new and upgrade infrastructure proposals acknowledges the challenges in achieving noise level reduction where existing infrastructure is surrounded by existing noise-sensitive development.*

- *Outdoor targets are to be met at all outdoor areas as far as is reasonable and practical to do so using the various noise mitigation measures outlined in the guidelines. For example, it is likely unreasonable for a transport infrastructure provider to achieve the outdoor targets at more than 1 or 2 floors of an adjacent development with direct line of sight to the traffic.*

Noise Exposure Forecast (Section 6.2)

*When it is determined that SPP 5.4 applies to a planning proposal as outlined in Section 4, proponents and/or decision makers are required to undertake a preliminary assessment using **Table 2**: noise exposure forecast in the guidelines. This will provide an estimate of the potential noise impacts on noise-sensitive land-use and/ or development within the trigger distance of a specified transport corridor. The outcomes of the initial assessment will determine whether:*

- *no further measures is required;*

- *noise-sensitive land-use and/or development is acceptable subject to deemed-to- comply mitigation measures; or*

- *noise-sensitive land-use and/or development is not recommended. Any noise-sensitive land-use and/ or development is subject to mitigation measures outlined in a noise management plan."*

3.2 AIRCRAFT NOISE

AS2021:2015 "Acoustics – Aircraft Noise Intrusion Building Siting and Construction" lists the building types compared to the acceptable ANEF contour in Table 2.1 of AS2021:2015. The applicable building types are reproduced in the Table below.

Building Type	ANEF zone of Site		
	Acceptable	Conditionally Acceptable	Unacceptable
House, home unit, flat	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF
Commercial Building	Less than 25 ANEF	25 to 35 ANEF	Greater than 35 ANEF
Light Industrial	Less than 30 ANEF	30 to 40 ANEF	Greater than 40 ANEF

AS2021:2015 also lists acceptable indoor design sound levels for determination of aircraft noise reductions, which are given as follows:

Houses, home units, flats

Sleeping Areas, dedicated lounges	-	50 dB(A)
Other habitable spaces	-	55 dB(A)
Bathrooms, toilets, laundries	-	60 dB(A)

We note that the above noise levels are maximum noise levels.

3.3 SPEEDWAY NOISE

In Western Australia, noise emissions are normally regulated by the *Environmental Protection (Noise) Regulations 1997*, however, it is understood that the Speedway operates under a noise management plan. Therefore, it has been assumed these Regulations are not applicable in this situation.

We believe guidance can be taken from Australian Standard *AS/NZS 2107:2000 "Acoustics – Recommended design sound levels and reverberation times for building interiors"*. The relevant design sound levels for the residences would be:

Sleeping areas	35 dB(A) L_{Aeq}
Living areas	40 dB(A) L_{Aeq}

4. MODELLING

4.1 ROAD TRAFFIC

The future Perth to Darwin road traffic volumes were based on information provided on the Northlink web site. This and other information relevant to the calculations are shown below in Table 4.1.

TABLE 4.1 - NOISE MODELLING INPUT DATA

Parameter	North Bound 2031	South Bound 2031
Traffic flows VPD Perth to Darwin Highway	15,400	15,500
Heavy Vehicles (%)	19%	20%
Traffic Speed km/hr	110	110
Road Surface	Chip seal	Chip seal
Façade Correction	+2.5	+2.5

Other input data for the model included:

- Traffic data from MRWA (https://northlinkwamap.mainroads.wa.gov.au)
- Noise source heights for the three road source strings (Passenger Vehicles, Heavy Vehicles Engine and Heavy Vehicle Exhausts) are +0.5, +1.5 and +3.6m, with a noise correction of -0.8 and -8.0 applied to the heavy vehicles engine and exhaust noise sources.
- Topographical data, with the ground level within the development based on natural ground levels as per Google Earth.

- A +2.5 dB adjustment to allow for façade reflection.
- Development receiver heights at 1.4m above ground level.

To determine the noise that would be received within the development from the surrounding road network, acoustic modelling was carried out using the computer program 'SoundPlan'.

The following scenarios were modelled:

1. Future traffic volumes, without any noise amelioration.
2. Future traffic volumes, with a 2.4 metre wall at the development boundary.

The height of the noise wall relates to SPP 5.4 which states *"At least one outdoor living area located on the opposite side of the building from the corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum 2.4 metres height above ground level".* Given that for this development any housing will barrier premises behind, the height of the wall at 2.4 metres will be to the eves of any premise, hence protecting the outdoor living area, and reducing noise levels to a level where quiet house design can be implemented.

Based on the above, the noise contours plots for day periods for the above modelling scenarios are attached in Appendix B.

4.2 FREIGHT RAIL TRAFFIC

Based on previous assessments for this rail line (including measurement), a predictive noise model was constructed for the proposed development. Input for the train movements was calibrated against measured noise levels, as per Table 4.2.

Analysis of these time periods resulted in train passes which lasted approximately 70 to 90 seconds at each monitoring point. From these passes the L_{AeqT} noise level of each train pass has been determined. Table 4.2 details each train pass event for the monitoring period with Figure 4.2 showing a time history plot of a typical train event.

TABLE 4.2 – PREVIOUSLY MEASURED INDIVIDUAL TRAIN EVENT NOISE LEVELS

Event	Condition	Parameter	Time Seconds	Logger A 40m Overall dB(A)	Logger B 85m Overall dB(A)
Train 1	Loaded	L_{AeqT}	109	71	62
Train 2	Unloaded	L_{AeqT}	100	77	69
Train 3	Loaded	L_{AeqT}	96	72	63
Train 4	Unloaded	L_{AeqT}	76	79	74
Train 5	Loaded	L_{AeqT}	68	71	62
Train 6	Unloaded	L_{AeqT}	70	78	70
Train 7	Loaded	L_{AeqT}	81	71	62
Average			***86***	***75***	***69***

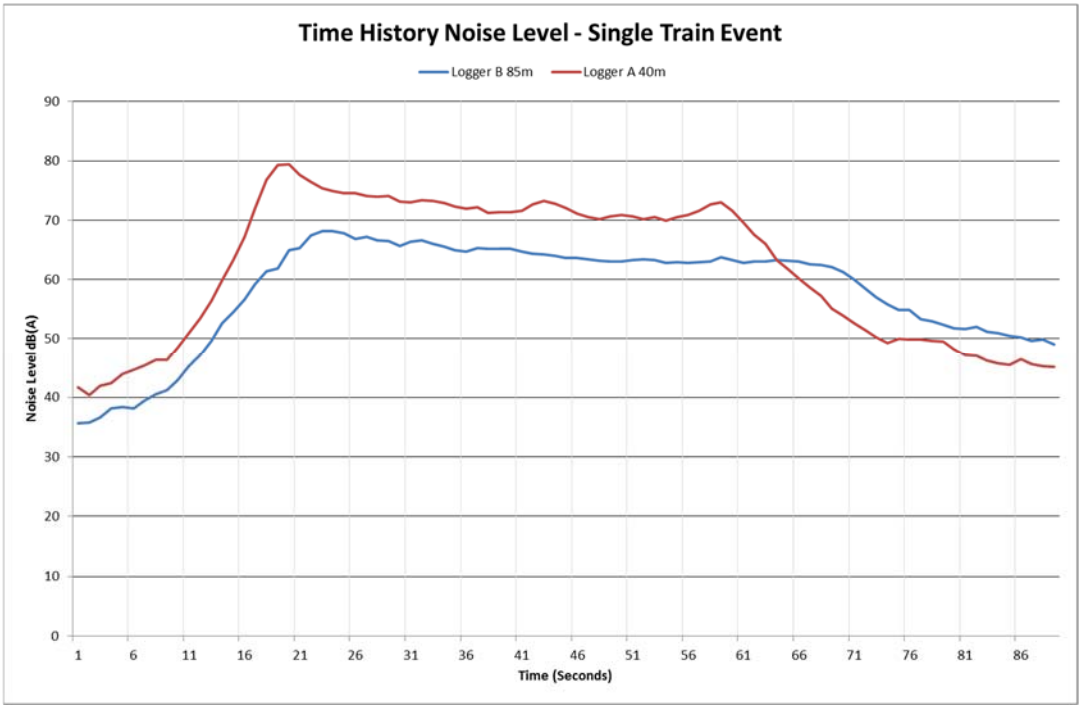


FIGURE 4.2 – TIME HISTORY NOISE LEVEL SINGLE TRAIN PASS

In accordance with the WAPC guidelines contained in SPP5.4, the noise that would be received within the development in the future (20 years hence) from trains travelling on the freight line, was determined by adjusting the train movements to a maximum of 1 per hour (24 per day) hence, due to the variations in criteria for day (55 dB(A)) and night (50 dB(A)), the night period becomes the more critical for compliance.

Based on the freight train pass-by noise level (at 40m) of $L_{Aeq(86\ seconds)}$ 75 dB(A), the calculated $L_{Aeq(1\ hour)}$ noise level at 40m is 59 dB(A).

Using the calibrated noise levels above, noise modelling was undertaken using SoundPlan. Noise modelling was undertaken for the following scenarios:

1. Current Train Movement for calibration.

2. Future noise level (1 train per hour).

3. Future noise levels with noise amelioration at the boundary.

Other input data for the model included:

- Nordic Rail Prediction Method (Kilde 130-1984)
- Noise source heights for the rail source strings (Locomotive and wagons) are +4.0, and +0.8m.
- Topographical data, with the ground level within the development based on natural ground levels as per Google Earth.
- A +2.5 dB adjustment to allow for façade reflection.
- Development receiver heights at 1.4m above ground level.

5. DISCUSSION / RECOMMENDATION

Under the WAPC State Planning Policy 5.4, for this development, the "Noise Target" as listed in Table 1 are the appropriate noise levels for to be achieved for this development. Under SPP 5.4, the "Noise Target" criteria which are applicable external to a residence are:

External

Day	Maximum of 55 dB(A) L_{Aeq}
Night	Maximum of 50 dB(A) L_{Aeq}

The policy states that the outdoor criteria apply to the ground floor level only, however, it also states that noise mitigation measures should be implemented with a view to achieving the “Noise Target” levels in least one outdoor living area. The Policy states the following acceptable internal noise levels:

Internal

Living and Work Areas	$L_{Aeq(Day)}$ of 40 dB(A)
Bedrooms	$L_{Aeq(Night)}$ of 35 dB(A)

For this development, compliance with the requirements of SP 5.4, noise modelling and assessment are based on the day period for residence located adjacent to the Perth to Darwin Highway and the night period for residential development adjacent to the freight rail line.

5.1 PERTH TO DARWIN HIGHWAY

The results of the acoustic assessment indicate that noise received at residences located adjacent to the Perth to Darwin Highway would exceed the “Noise Targets” as outlined in SPP 5.4.

As the construction of the highway has already been undertaken, noise levels at the proposed development have not been considered by the infrastructure provider as the land is rural use. Therefore, no noise amelioration in the form of noise walls are likely to be implemented for this section of the highway.

Based on the concept plan for the DSP there are areas adjacent to the highway which do not contain residential development, due to hard constraints therefore, noise mitigation in these areas will not be required.

Other lots which are to contain residential development the possible noise amelioration options that are normally considered are Setbacks or Buffer areas, Noise bunds and / or Barriers. and “Quiet House” design. Example of these in relation to this development are detailed below.

SETBACKS OR BUFFER AREAS

Using the above options, the distance for separation (buffer) of the highway and residential premises with no noise amelioration (wall or bund) would be as shown in Figure 5.1.

As can be seen, the minimum setback (with no noise wall) would be 45 metres. These dwellings would require the upper most quiet house design in the form of Package C. Given that the façade houses would barrier those behind it is likely the dwellings behind the first row would require lesser noise control, likely in the form of Package A and notification on titles.

The buffer would effectively isolate significant amounts of land, hence, not be practical for residential areas such as those proposed in Lot 116. However, as can be seen in Figure 5.1, for Lot 5 which has hard constraints, if development occurred in the light green areas, the setback would be appropriate, and no noise amelioration would be required.

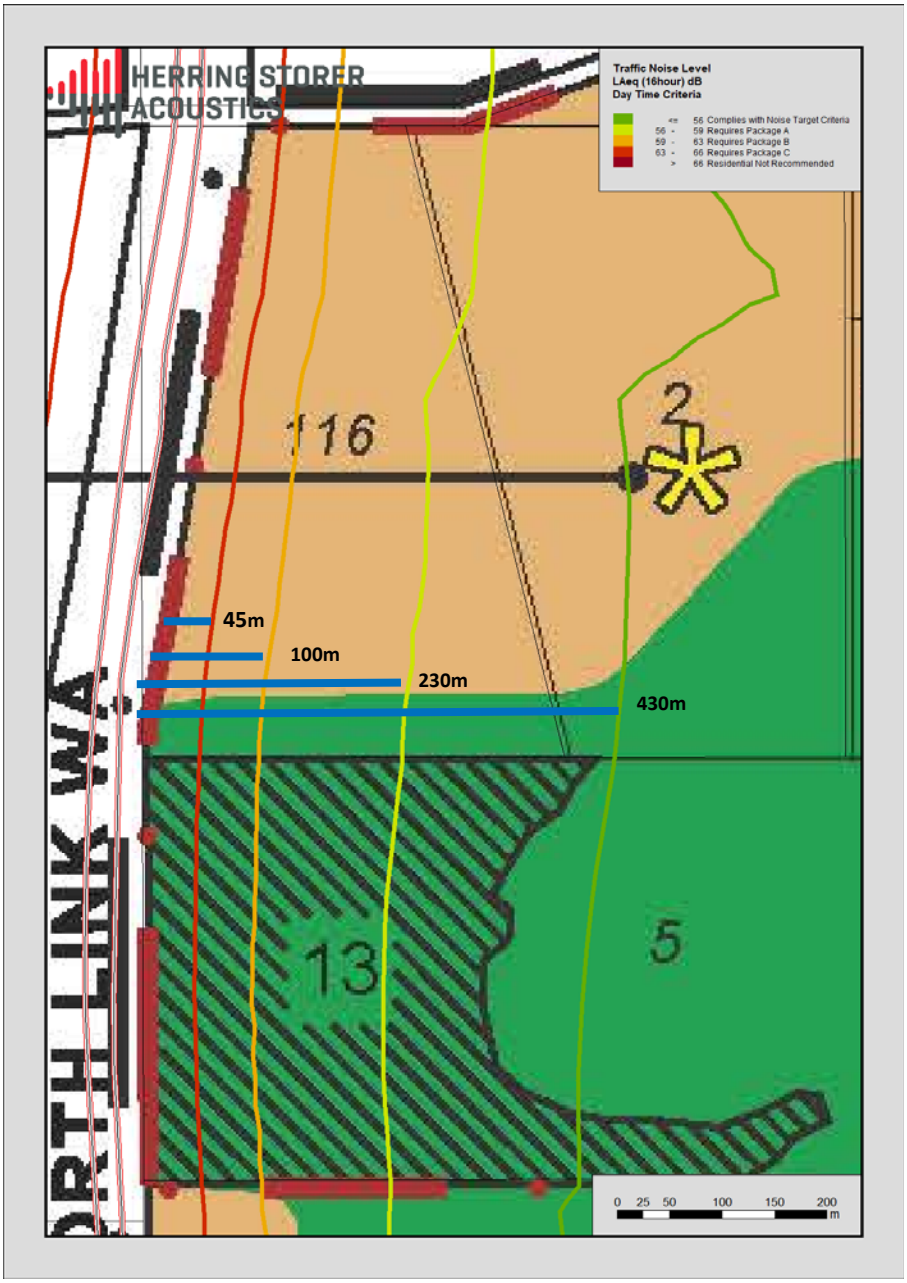


FIGURE 5.1 - PERTH TO DARWIN NOISE CONTOUR – NO NOISE CONTROL BUFFER DISTANCES

NOISE BUNDS AND / OR BARRIERS

Noise control in the form of barriers, such as noise wall or earthen bunds have been investigated as a way of ameliorating the noise levels for future development.

Details the noise contour plot for a 2.4 metre noise wall at the western boundary of the development is contain within Appendix B as Figure B2.

It is noted that due to the distance of the highway from the boundary of the development, the effectiveness of barriers such as noise walls is greatly reduced. The most efficient use of walls is incorporated into the road design, hence are located close to the traffic noise source.

Modelling has been undertaken with 2.4 metre noise walls at the boundary of the development. Resultant noise levels for the entire DSP are shown in the noise contour plot contained in Appendix B, figure B2. A more detailed example of the noise levels for this scenario are shown below in Figure 5.2. For this example, a section of existing residential development along the Perth to Darwin Highway (located in Ellenbrook to the south) has been overlaid onto Lot 116. Using this example details the layout of the noise wall with the inclusion of future residential housing at the façade Lots.

With the inclusion of a barrier, noise levels are attenuated sufficiently to enable residential development behind the wall. Whilst there is a reduction in noise levels by the barrier, there would still be the requirement for these premises to incorporate quiet house design (likely in the form of Package A to B) and notifications on titles.

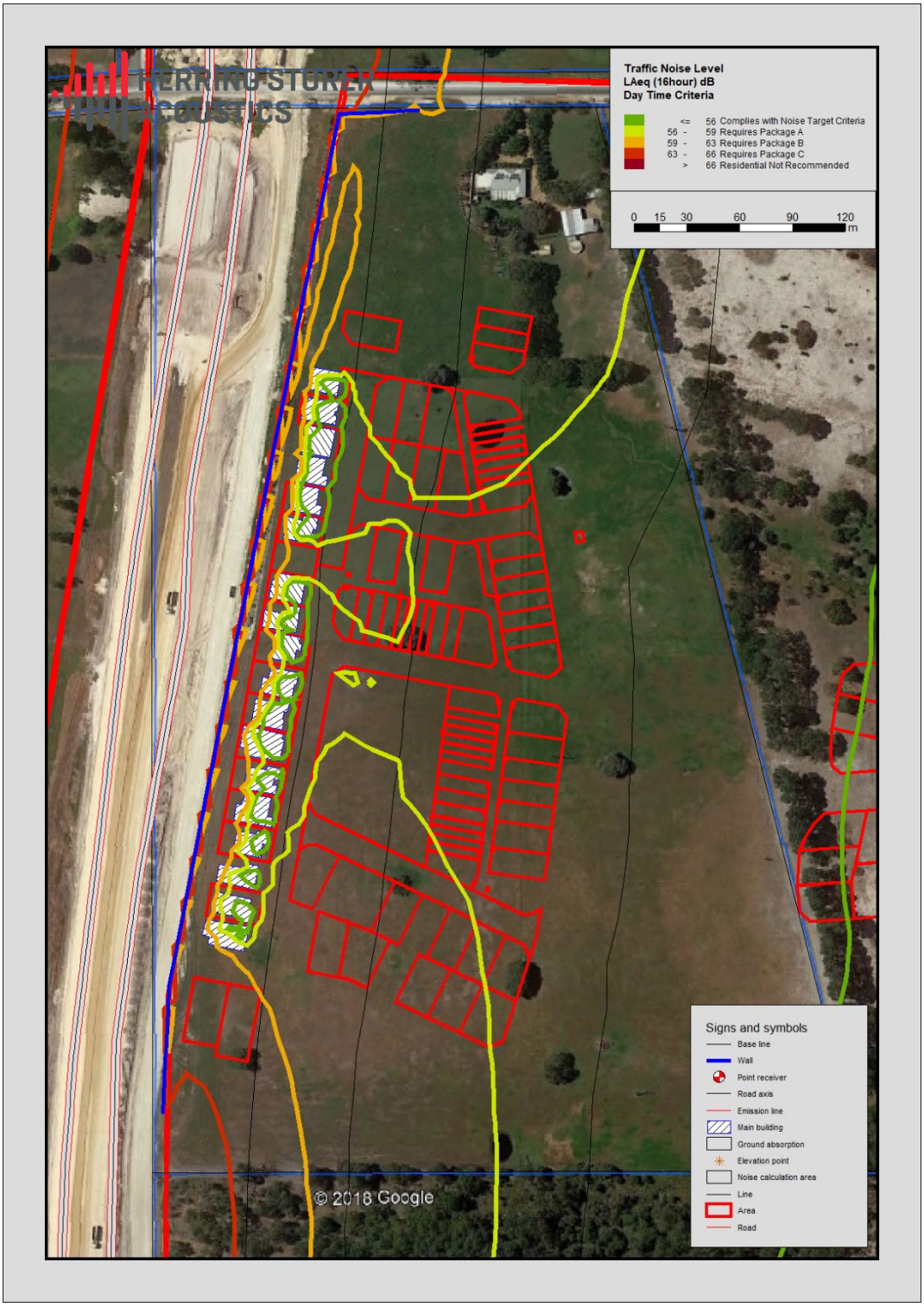


FIGURE 5.2 - PERTH TO DARWIN NOISE CONTOUR – 2.4M NOISE WALL AND FUTURE HOUSING EXAMPLE

QUIET HOUSE DESIGN

If considering residential development within areas above 55 dB(A) as per the previous two scenarios, quiet house design as outlined in SPP 5.4 guidance would be required to further ameliorate noise levels to meet internal noise level criteria.

The package requirement depends on the external noise levels, however, for guidance Figure 5.4 details the quiet house design for the future noise levels associated with the highway and rail line, without any noise control in the form of barriers, with a summary contained in Table 5.1 below.

TABLE 5.1 ROAD AND RAIL NOISE GUIDELINES SEPTEMBER 2019 (TABLE 2) : NOISE EXPOSURE FORECAST

Forecast Excess Noise Level, dB	Exposure Category	Policy requirements for noise-sensitive land-use and/or development
0 or less	**-**	No further measures Noise-sensitive land-use and/or development is acceptable, subject to: Mitigation measures in accordance with an approved noise management plan; Or quiet house package as specified
1 to 3	**A**	
-	***A+**	
4 to 7	**B**	
-	***B+**	
8 to 11	**C**	
-	***C+**	
12 to 15	**D**	Noise-sensitive land-use and /or development is not recommended. There is no default quiet house option due to excessive forecast noise: Professional design input is required in order to achieve compliance with relevant criteria. If noise-sensitive land-use and/or development is unavoidable, an approved noise management plan is required to demonstrate compliance with the noise target (see Table 1).
16+	**E**	

*Assists to mitigate short term noise events from freight rail.

Information on the deemed to satisfy constructions for the various "Quiet House Design" packages are contained in Appendix D.

5.2 PERTH TO GERALDTON FREIGHT RAIL LINE

SETBACKS OR BUFFER AREAS

The distance for separation (buffer) of the rail line and residential premises with no noise amelioration (wall or bund) would be as shown in Figure 5.3.

As can be seen, the setback of the rail reserve and the road between (railway parade) provides a separation of around 55 metres from the boundary of the development. If no barrier was considered at the development boundary, these dwellings would require the quiet house design in the form of Package B+. Given that the façade houses would barrier those behind it is likely the dwellings behind the first row would require lesser noise control, likely in the form of Package A and notification on titles.

It is noted the distance from the boundary where residential development would be acceptable (i.e. below 50 dB(A) night) with no Quiet house design would be around 70 metres.

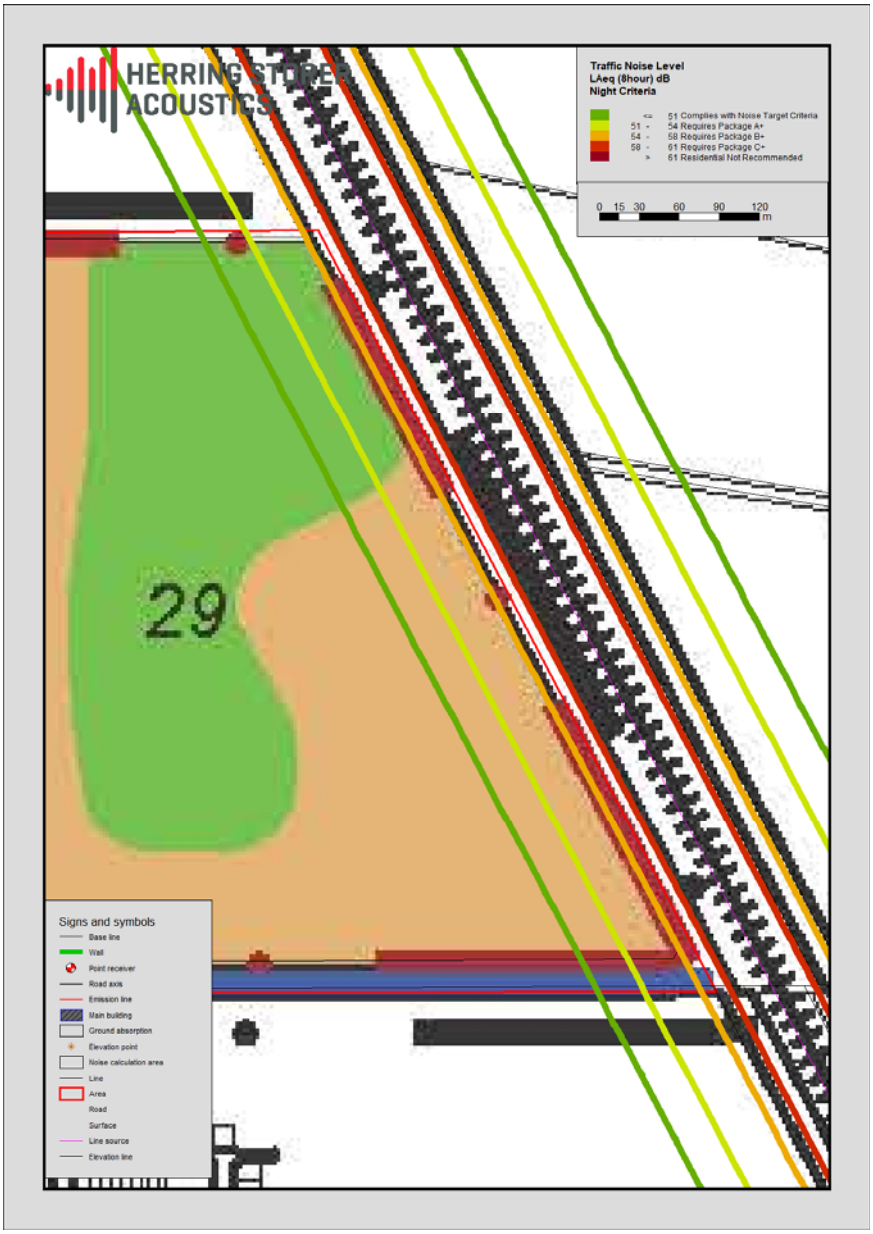


FIGURE 5.3 - PERTH TO GERALDTON FREIGHT RAIL LINE NOISE CONTOUR – NO NOISE CONTROL BUFFER DISTANCES

NOISE BUNDS AND / OR BARRIERS

Noise control in the form of barriers, such as noise wall or earthen bunds have been investigated as a way of ameliorating the noise levels for future development for residential development next to the rail line.

Details the noise contour plot for a 2.4 metre noise wall at the western and eastern boundary of the development is contain within Appendix C as Figure C2.

Modelling has been undertaken with 2.4 metre noise wall at the boundary of the development. Resultant noise levels for this scenario at Lot 29 are shown below in Figure 5.4. For this example, a section of existing residential development along the Perth to Geraldton Rail Line (located in Ellenbrook to the south) has been overlaid onto Lot 29. Using this example details the layout of the noise wall with the inclusion of future residential housing at the façade Lots.

With the inclusion of a barrier, noise levels are attenuated sufficiently to enable residential development behind the wall. Whilst there is a reduction in noise levels by the barrier, there would still be the requirement for these premises to incorporate quiet house design (likely in the form of Package A) and notifications on titles.

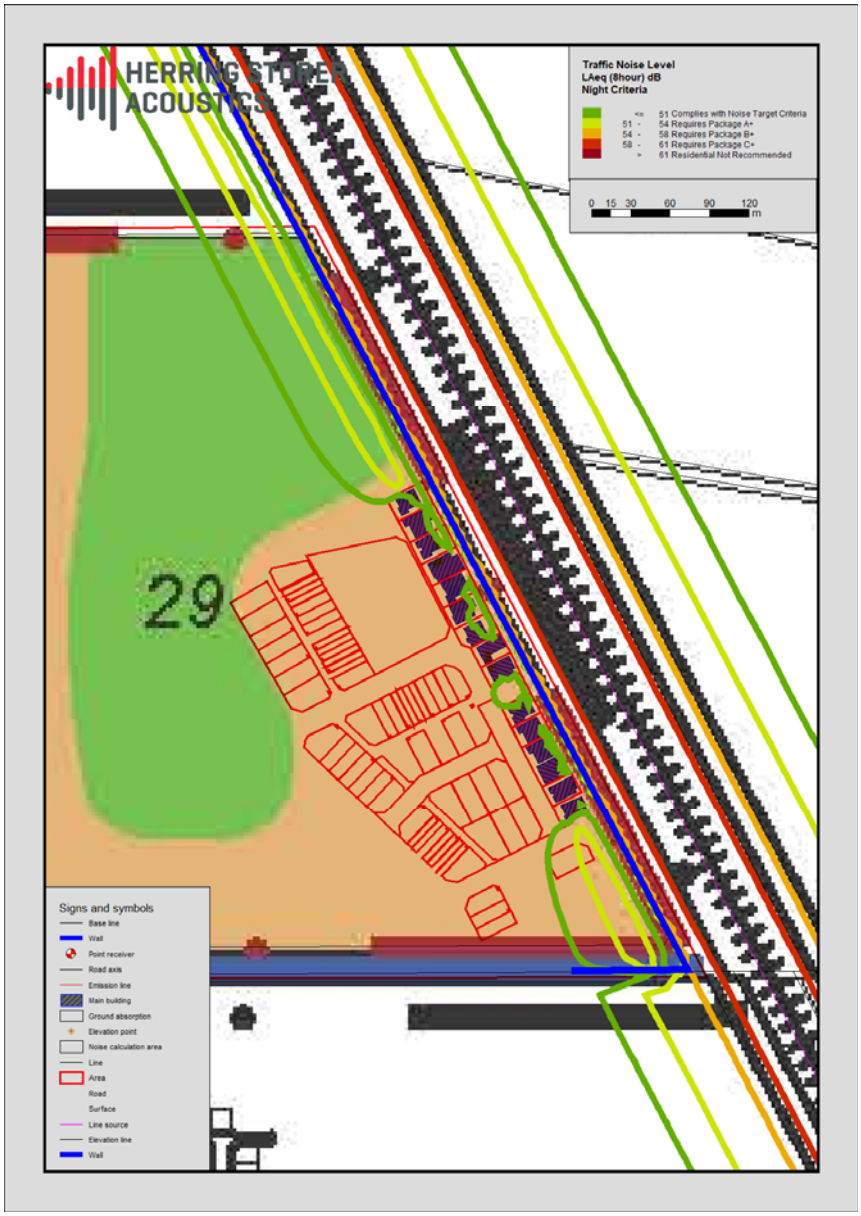


FIGURE 5.4 - GERALDTON FREIGHT RAIL LINE NOISE CONTOUR – 2.4 METRE WALL AND FUTURE HOUSING

Notes:

1 Given the location of the development and the projected market, we understand that 2 storey residences are unlikely, hence the Quiet House Design is for single storey residence only. If double storey residences are proposed, then it is recommended that specialist acoustic advice be sought by the proponent.

2 We understand that the development is a District Structure Plan stage, hence the information contained in Appendix D regarding areas requiring “Quiet House” design will need to be refined once the lots have been defined and final heights are established. Additionally, any modifications to the Structure Plan, would vary the noise mitigation requirements relating to barriers and “Quiet House” design outlined in Appendix C.

3 The summary of the Quiet House Design Packages attached in Appendix D, are "Deemed to Satisfy" constructions. Alternative constructions would be acceptable, provided they are supported by an acoustic report prepared by a suitably qualified acoustic consultant.

4 For residence with access roads between the residence and the Perth Darwin Highway (i.e. front of residence facing the highway) incorporate "Quiet House" design into the design of each residence. In these cases, the residence itself provides a barrier to the back yard, thus noise received at the outdoor area would comply with the required acoustic criteria.

5 Quiet House Design requirements are likely to lessen for residential premises set back from the highway, as the façade residences will barrier those behind.

6 Additionally, these residences also require Notifications on Titles.

5.3 AIRCRAFT NOISE

From *AS2021:2015 "Acoustics – Aircraft Noise Intrusion Building Siting and Construction"* residential development is acceptable outside the ANEF 20 contour.

Based on the ANEF for the Pearce RAAF base (see Figure 5.5 below), the development is located outside the ANEF 20 contour. Hence, residential development without any requirement for noise amelioration, is acceptable within this development.

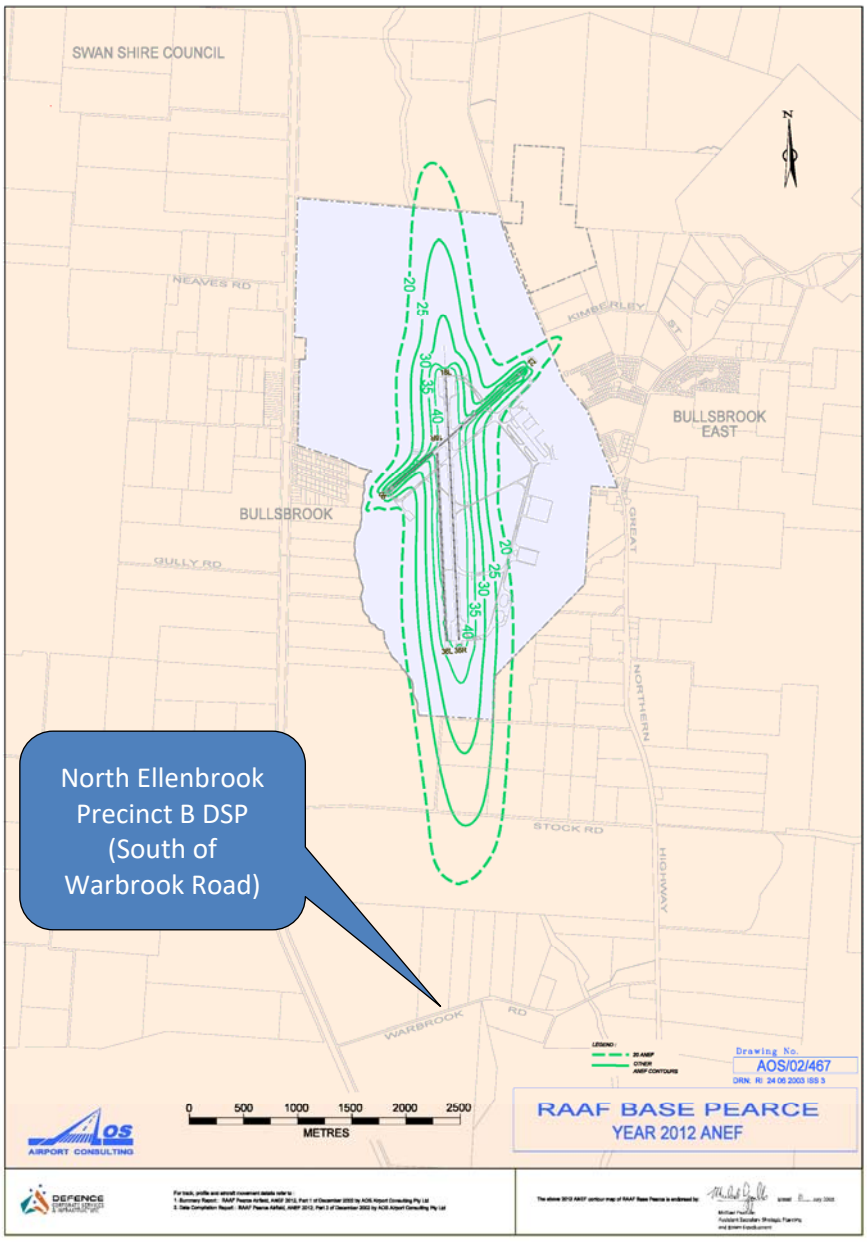


FIGURE 5.4 – PEARCE AIR BASE ANEF NOISE CONTOURS

5.4 SPEEDWAY NOISE

Based on the AS2107, we recommend that the acoustic criteria be set at an external L_{Aeq} noise level of 50 dB(A). This relates to an internal L_{Aeq} level of 40 dB(A) within living and work area during the day with windows open, and an internal L_{Aeq} of 35 dB(A) within bedrooms during the night with windows closed.

Additionally, As the operating times of the speedway do not exceed 21:00 the recommended criteria level of 50 dB(A) for the day period is considered applicable.

Based on previous assessment for residential development to the south of Precinct B, the noise level contour plot for the worst case speedway operations are shown in Figure 5.5 below.

Based on the noise emissions from the speedway operations, the noise level at the boundary of the DSP would be less than 55 dB(A). For comparison, an individual 2-minute train pass at this same location would be around 75 dB(A). Therefore, noise levels for the train line would be considered higher than noise levels associated with the speedway, hence acoustic mitigation for the train would also be sufficient for the speedway. However, it is recommended that notification on titles is made for lots which receive noise greater than 50 dB(A) from the speedway.

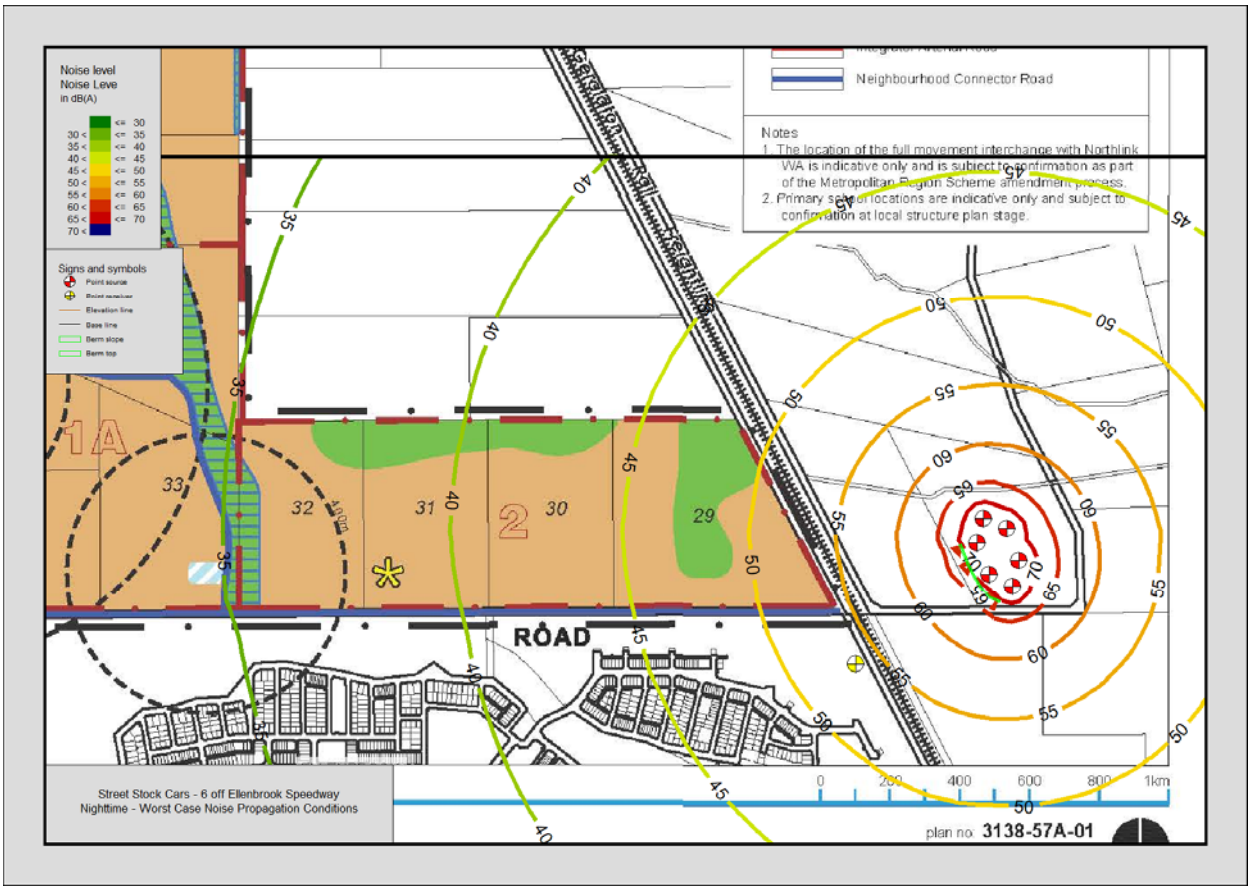
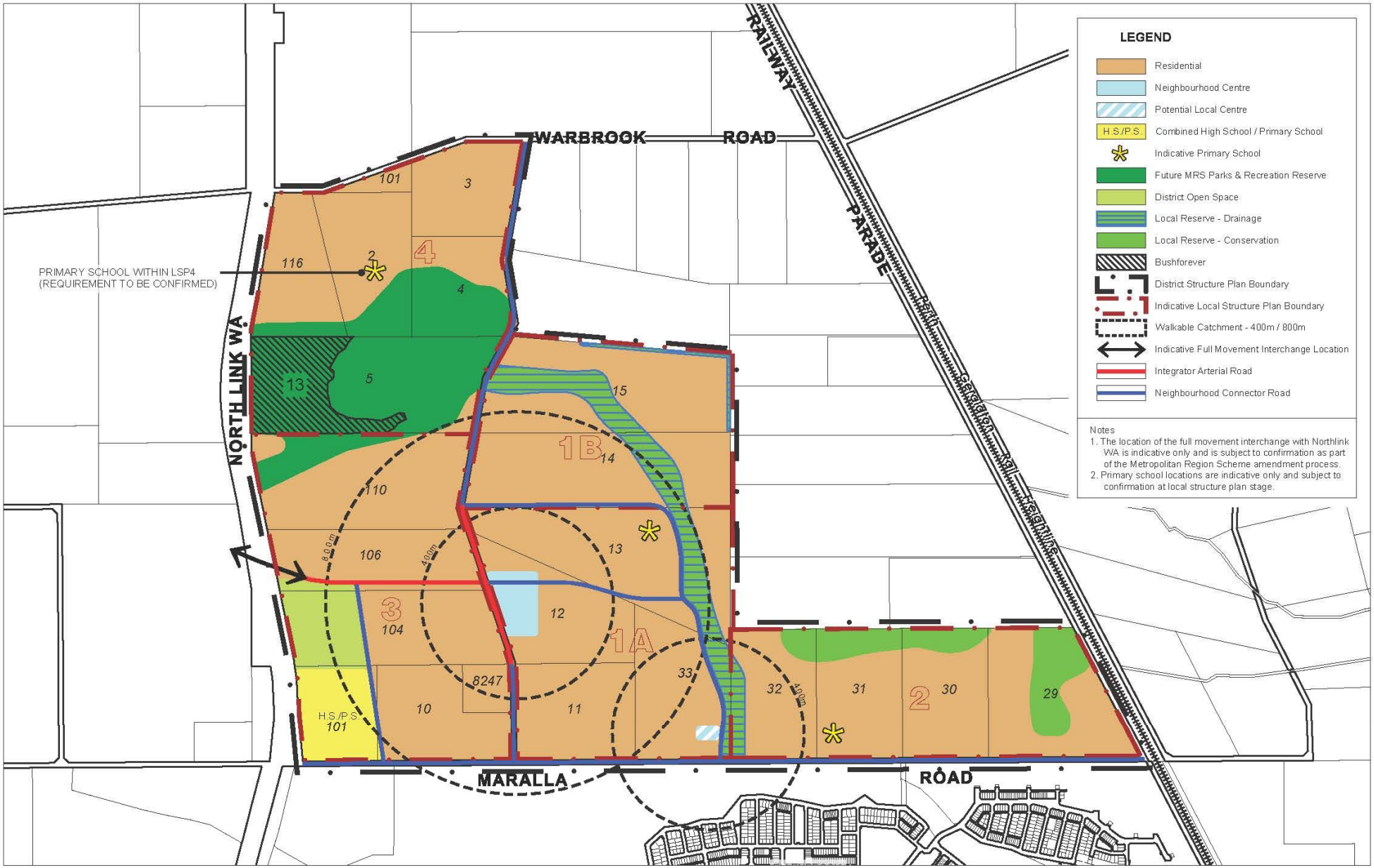


FIGURE 5.5 – ELLENBROOK SPEEDWAY NOISE CONTOURS

APPENDIX A

DISTRICT STRUCTURE PLAN



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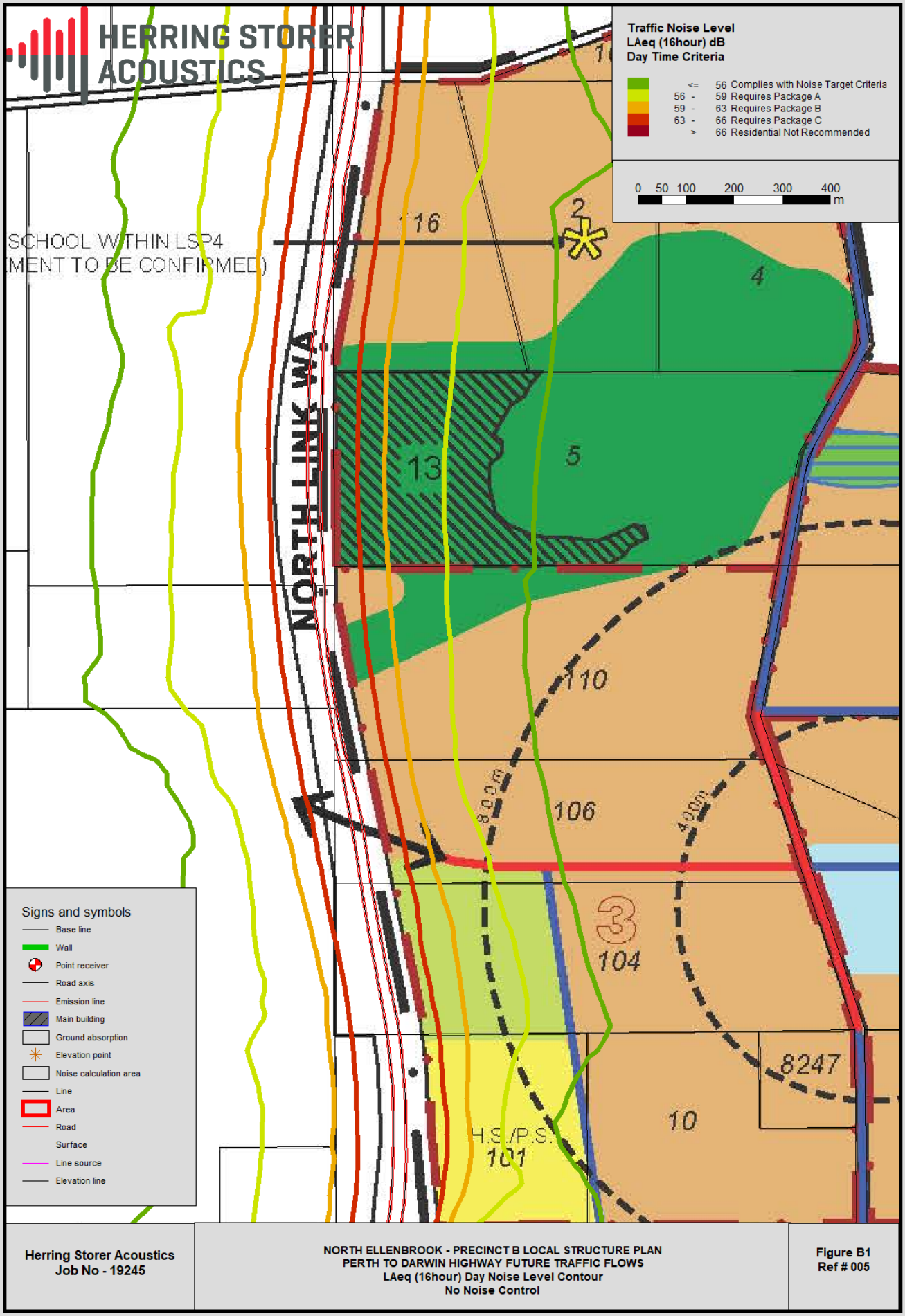
DISTRICT STRUCTURE PLAN MAP

North Ellenbrook (east)

plan no: **3138-57A-01**
date: 9 December 2019
scale: 1:20,000 @ A4

APPENDIX B

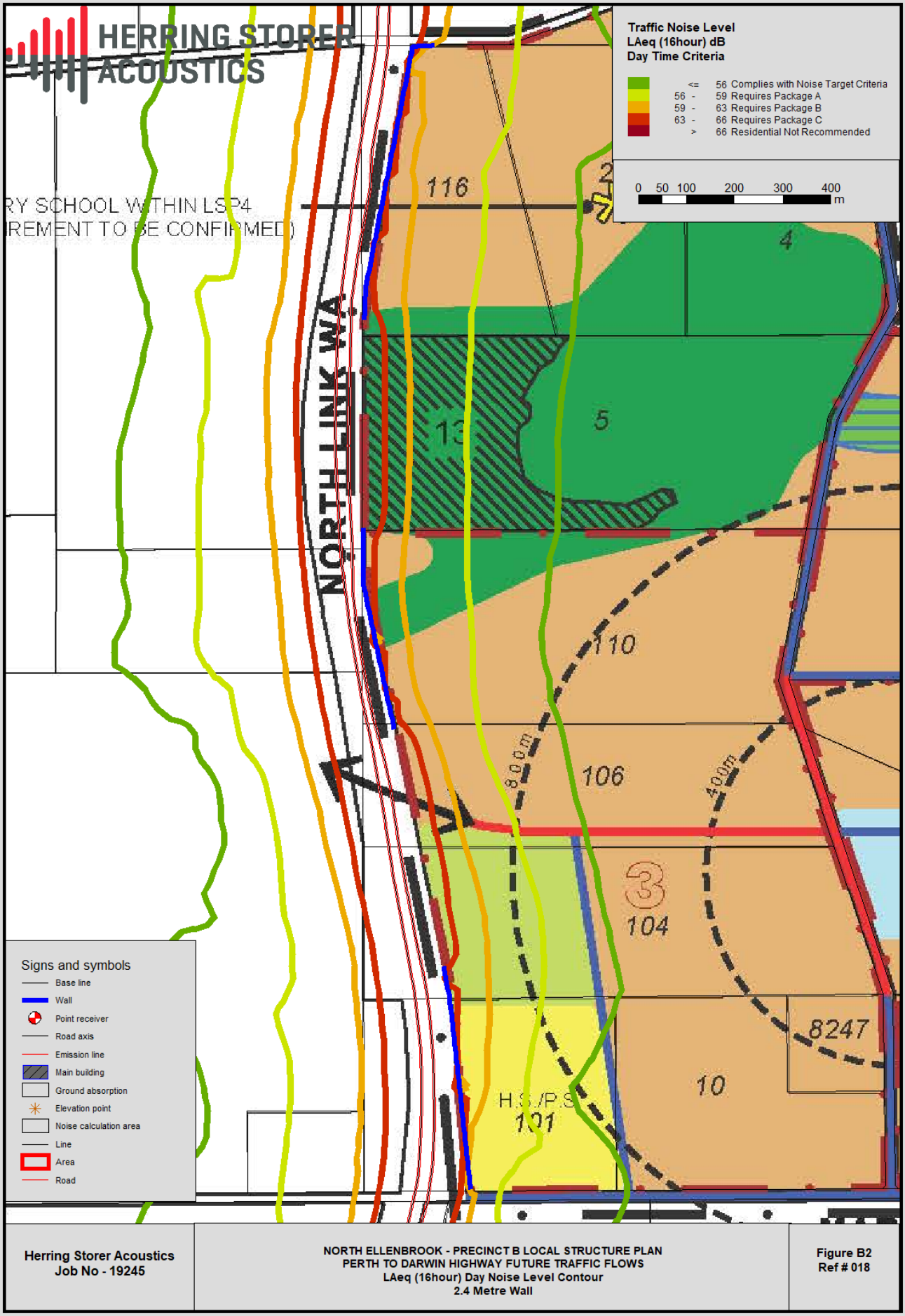
FIGURES B1 and B2
$L_{Aeq(16hr)}$ DAY
NOISE CONTOURS FOR PERTH – DARWIN HIGHWAY



Herring Storer Acoustics
Job No - 19245

NORTH ELLENBROOK - PRECINCT B LOCAL STRUCTURE PLAN
PERTH TO DARWIN HIGHWAY FUTURE TRAFFIC FLOWS
LAeq (16hour) Day Noise Level Contour
No Noise Control

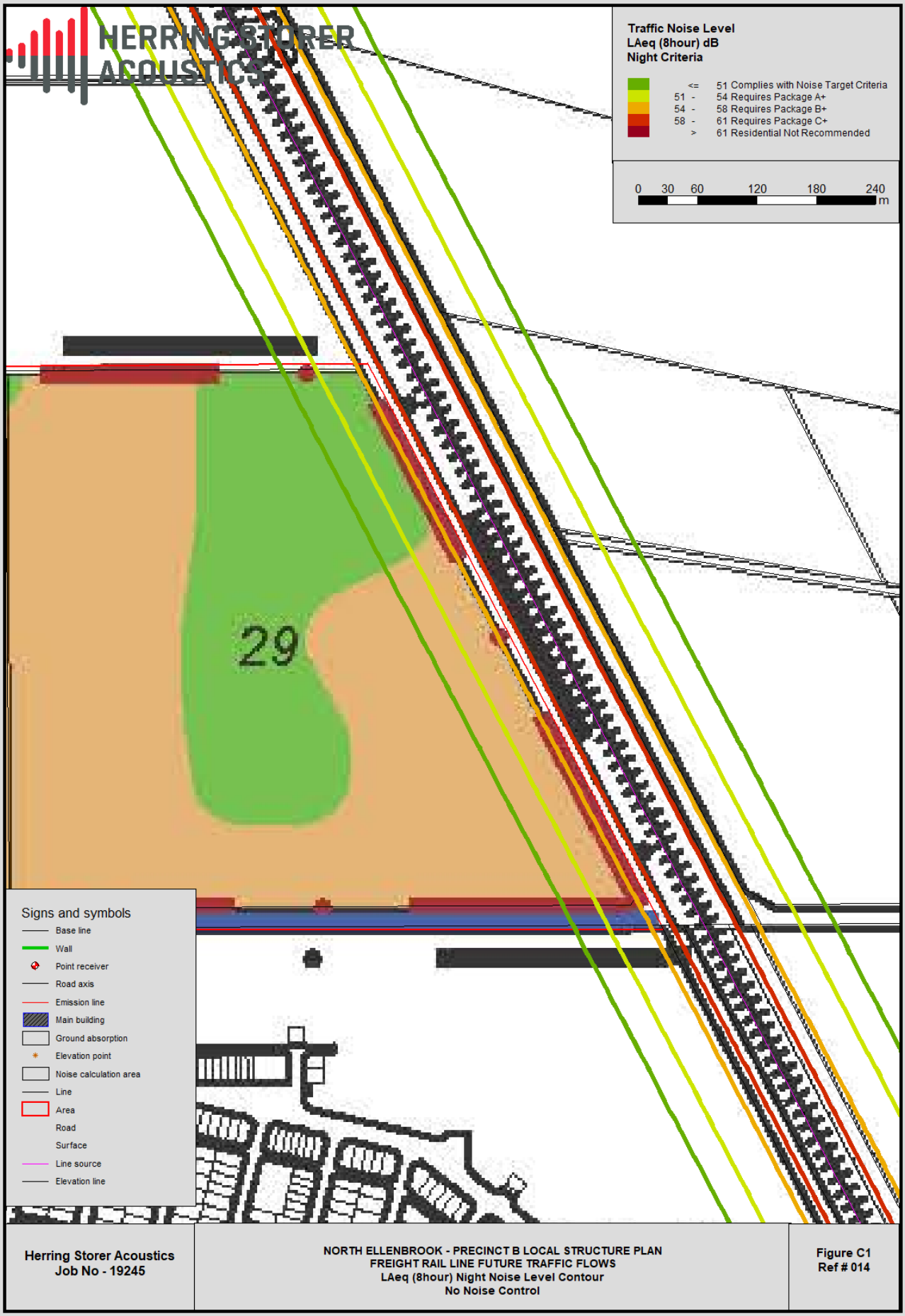
Figure B1
Ref # 005



Herring Storer Acoustics **Job No - 19245**	**NORTH ELLENBROOK - PRECINCT B LOCAL STRUCTURE PLAN** **PERTH TO DARWIN HIGHWAY FUTURE TRAFFIC FLOWS** **LAeq (16hour) Day Noise Level Contour** **2.4 Metre Wall**	**Figure B2** **Ref # 018**

APPENDIX C

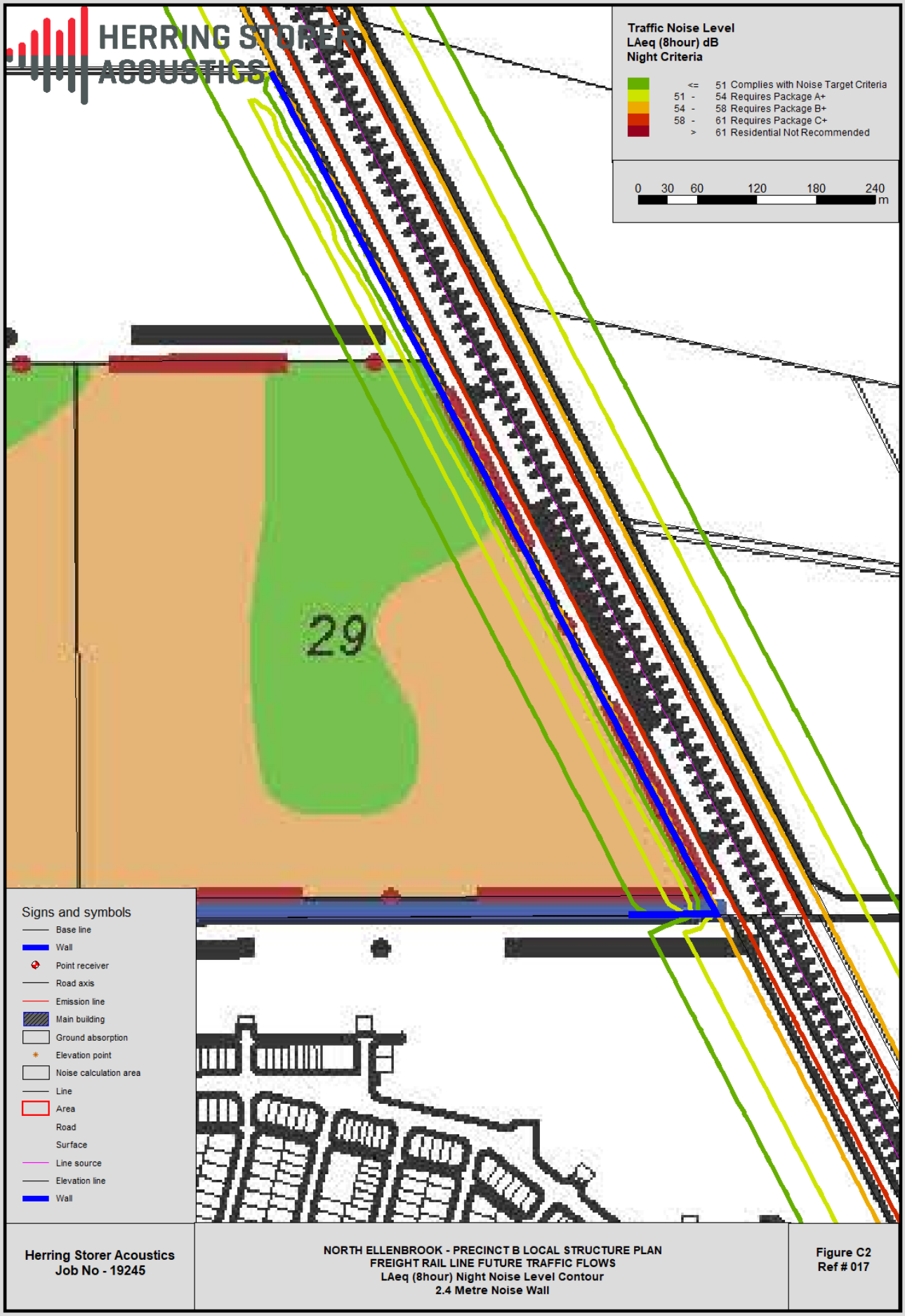
FIGURES C1 and C2
$L_{Aeq(8hr)}$ NIGHT
NOISE CONTOURS FOR FREIGHT RAIL LINE



Herring Storer Acoustics
Job No - 19245

NORTH ELLENBROOK - PRECINCT B LOCAL STRUCTURE PLAN
FREIGHT RAIL LINE FUTURE TRAFFIC FLOWS
LAeq (8hour) Night Noise Level Contour
No Noise Control

Figure C1
Ref # 014



Herring Storer Acoustics
Job No - 19245

NORTH ELLENBROOK - PRECINCT B LOCAL STRUCTURE PLAN
FREIGHT RAIL LINE FUTURE TRAFFIC FLOWS
LAeq (8hour) Night Noise Level Contour
2.4 Metre Noise Wall

Figure C2
Ref # 017

APPENDIX D

"QUIET HOUSE" DESIGN INFORMATION

Road Traffic and Passenger Rail
Quiet House Requirements
(*Based on Table 3 of State Planning Policy 5.4 2019*)

Exposure Category	Orientation to corridor	Acoustic rating and example constructions					Mechanical ventilation/air conditioning considerations
		Walls	**External doors**	**Windows**	**Roofs and ceilings of highest floors**	**Outdoor Living areas**	
A **Quiet House A**	**Facing**	**Bedroom and Indoor Living and work areas to Rw + Ctr 45dB** **Stud Frame Walls** ➢ One row of 92mm studs at 60mm centres with: ➢ Resilient steel channels fixed to the outside of the studs; and ➢ 9.5mm hardboard or 9mm fibre cement weatherboards or one layer of 19mm board cladding fixed to the outside of the channels; and ➢ 75mm glass wool (11kg/m3) or 75mm polyester (14kg/m3) insulation, positioned between the studs; and ➢ -Two layers of 16mm fire-protective grade plasterboard fixed to the inside face of the studs. **Brick Walls** ➢ Single leaf of 150mm brick masonry with 13mm cement render on each face: **OR** ➢ Double brick: two leaves of 90 mm clay brick masonry with a 20mm cavity between leaves.	**Bedrooms**: ➢ Fully glazed hinged door with certified R_w+C_{tr} **28dB** rated door and frame including seals and 6mm glass **Indoor Living and work areas:** ➢ 35mm solid core timber hinged door and frame system certified to **Rw 28dB** including seals**: OR** ➢ Glazed sliding door with 10 mm glass and weather seals	**Bedrooms**: ➢ Total external door and window system area up to 40% of room floor area: Sliding or double hung with minimum 10 mm single or 6mm-12mm-10mm double insulted glazing (R_w+C_{tr} **28 dB**). Sealed awning or casement windows may use 6 mm glazing instead**: OR** ➢ Up to 60% floor area: as per above but must be sealed awning or casement type windows (R_w+C_{tr} **31dB**). **Indoor Living and work areas** ➢ Up to 40% floor area: Sliding, awning, casement or double hung with minimum 6mm single pane or 6mm-12mm-6mm double insulted glazing (R_w+C_{tr} **25dB**)**: OR** ➢ Up to 60% floor area: As per Bedrooms at up to 40% area (**Rw+Ctr28 dB : OR** ➢ Up to 80% floor area: As per Bedrooms at up to 60% area (R_w+C_{tr} **31 dB**).	**To R_w+C_{tr} 35dB** ➢ Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard ceiling	➢ At least one outdoor living area located on the opposite side of the building from the transport corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum **2 metres** height above ground level	➢ Acoustically rated openings and ductwork to provide a minimum sound reduction performance of **Rw 40dB** 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
	Side On		As per "Facing" above, except R_w+C_{tr} values may be 3dB less, e.g. glazed sliding door with 10 mm glass and weather seals for bedrooms	As above, except R_w+C_{tr} values may be 3dB less, or max % area increased by 20%			
	Opposite		No specific requirements	No specific requirements			

Freight Rail
Quiet House Requirements
(*Based on Table 3 of State Planning Policy 5.4 2019*)

Exposure Category	Orientation to corridor	Acoustic rating and example constructions					Mechanical ventilation/air conditioning considerations
		Walls	**External doors**	**Windows**	**Roofs and ceilings of highest floors**	**Outdoor Living areas**	
A+ **Quiet House A+**	**All Facades**	**Brick Walls Only** ➢ Double brick: two leaves of 90 mm clay brick masonry with a 20mm cavity between leaves.	**Bedrooms**: ➢ No external doors for bedrooms with entry facing rail corridor and for other facades, fully glazed hinged door with certified **R_w+C_{tr} 28dB** rated door and frame including seals and 6mm glass **Indoor Living and work areas:** ➢ 35mm solid core timber hinged door and frame system certified to **Rw 28dB** including seals**: OR** ➢ Glazed sliding door with 10 mm glass and weather seals	**Bedrooms**: ➢ All windows comprise minimum 6mm thick laminated or toughened glass in sealed awning or casement type frames. Polymer (e.g. uPVC) window framing should be used (**R_w+C_{tr} 31dB**). **Indoor Living and work areas** ➢ Up to 40% floor area: Sliding, awning, casement or double hung with minimum 6mm single pane or 6mm-12mm-6mm double insulted glazing (**R_w+C_{tr} 25dB**). **: OR** ➢ Up to 60% floor area: As per Bedrooms at up to 40% area (**Rw+Ctr28 dB**) **: OR** ➢ Up to 80% floor area: As per Bedrooms at up to 60% area (**R_w+C_{tr} 31 dB**).	**To R_w+C_{tr} 35dB** ➢ Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard ceiling	➢ At least one outdoor living area located on the opposite side of the building from the transport corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum **2 metres** height above ground level	➢ Acoustically rated openings and ductwork to provide a minimum sound reduction performance of **Rw 40dB** into sensitive spaces ➢ Evaporative systems not recommended ➢ 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

Road Traffic and Passenger Rail
Quiet House Requirements
(*Based on Table 3 of State Planning Policy 5.4 2019*)

Exposure Category	Orientation to corridor	Acoustic rating and example constructions					Mechanical ventilation/air conditioning considerations
		Walls	**External doors**	**Windows**	**Roofs and ceilings of highest floors**	**Outdoor Living areas**	
B **Quiet House B**	**Facing**	**Bedroom and indoor living and work areas to R_w+C_{tr} 50dB** **Single leaf of 90 mm clay brick masonry with:** ➢ A row of 70 mm x 35 mm timber studs or 64 mm steel studs at 600 mm centres; ➢ A cavity of 25 mm between leaves; ➢ 50 mm glass wool or polyester cavity insulation (R2.0+) insulation between studs; and ➢ One layer of 10mm plasterboard fixed to the inside face ➢ 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 **Double brick: two leaves of 90mm clay brick masonry with:** ➢ A 50mm cavity between leaves ➢ 50mm glass wool or polyester cavity insulation (R2.0+) ➢ Resilient ties where required to connect leaves **Double brick: two leaves of 110mm clay brick masonry with** ➢ 50mm cavity between leaves and R2.0+ cavity insulation	**Bedrooms** ➢ Fully glazed hinged door with certified **R_w+C_{tr} 31dB** rated door and frame including seals and 10mm glass **Indoor Living and work areas** ➢ 35mm solid core timber hinged door and frame system certified to **Rw 28dB** including seals**: OR** ➢ Glazed sliding door with 10 mm glass and weather seals	**Bedrooms**: ➢ Total external door and window system area up to 40% of room floor areas: Fixed sash, awning or casement with minimum 6mm single or 6mm-12mm-6mm double insulted glazing (**Rw+Ctr 31dB**). ➢ Up to 60% floor area: as per above but must be minimum10mm single or 6mm-12mm-10mm double insulated glazing (**Rw+Ctr 34dB**) **Indoor Living and work areas** ➢ Up to 40% floor area; Sliding or double hung with minimum 6mm single pane or 6mm-12mm-6mm double insulted glazing (R_w+C_{tr} 28dB). Sealed awning or casement windows may use 6mm glazing instead. **: OR** ➢ Up to 60% floor area: As per Bedrooms at up to 40% area (**R_w+C_{tr} 31dB**). **: OR** ➢ Up to 80% floor area: As per Bedrooms at up to 60% area (**R_w+C_{tr} 34dB).**	**To R_w+C_{tr} 35dB** ➢ Concrete or terracotta tile sarking and at least 10mm plasterboard ceiling, R3.0+ insulation **OR** ➢ Metal sheet roof, sarking and at least 10mm plasterboard ceiling, R3.0+ insulation	➢ At least one outdoor living area located on the opposite side of the building from the corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum **2.4 metres** height above ground level	➢ Acoustically rated openings and ductwork to provide a minimum sound reduction performance of **Rw 40dB** 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
	Side-On		**Bedrooms**: ➢ Fully glazed hinged door with certified **R_w+C_{tr} 28dB** rated door and frame including seals and 6mm glass **Indoor Living and work areas:** ➢ 35mm solid core timber hinged door and frame system certified to **Rw 28dB** including seals**: OR** ➢ Glazed sliding door with 10 mm glass and weather seals	**Bedrooms**: ➢ Total external door and window system area up to 40% of room floor area: Sliding or double hung with minimum 10 mm single or 6mm-12mm-10mm double insulted glazing (**R_w+C_{tr} 28 dB**). Sealed awning or casement windows may use 6 mm glazing instead. **: OR** ➢ Up to 60% floor area: as per above but must be sealed awning or casement type windows (**R_w+C_{tr} 31dB**). **Indoor Living and work areas** ➢ Up to 40% floor area: Sliding, awning, casement or double hung with minimum 6mm single pane or 6mm-12mm-6mm double insulted glazing (**R_w+C_{tr} 25dB**). **: OR** ➢ Up to 60% floor area: As per Bedrooms at up to 40% area (**Rw+Ctr28 dB**) **: OR** ➢ Up to 80% floor area: As per Bedrooms at up to 60% area (**R_w+C_{tr} 31 dB**).			
	Opposite		As above, except R_w+C_{tr} values may be 3dB less, or max % area increased by 20%	As above, except R_w+C_{tr} values may be 3dB less, or max % area increased by 20%			

Freight Rail
Quiet House Requirements
(*Based on Table 3 of State Planning Policy 5.4 2019*)

Exposure Category	Orientation to corridor	Acoustic rating and example constructions					Mechanical ventilation/air conditioning considerations
		Walls	**External doors**	**Windows**	**Roofs and ceilings of highest floors**	**Outdoor Living areas**	
B+ **Quiet House B**	**All Facades**	**Double brick: two leaves of 90mm clay brick masonry with:** ➢ A 50mm cavity between leaves ➢ 50mm glass wool or polyester cavity insulation (R2.0+) ➢ Resilient ties where required to connect leaves **Double brick: two leaves of 110mm clay brick masonry with** ➢ 50mm cavity between leaves and R2.0+ cavity insulation	**Bedrooms** **Bedrooms**: ➢ No external doors for bedrooms with entry facing or side on to rail corridor and for other facades, fully glazed hinged door with certified **R_w+C_{tr} 31dB** rated door and frame including seals and 10mm glass **Indoor Living and work areas** ➢ 35mm solid core timber hinged door and frame system certified to **Rw 28dB** including seals**: OR** ➢ Glazed sliding door with 10 mm glass and weather seals	**Bedrooms**: ➢ All windows comprise minimum 6mm thick laminated or toughened glass in sealed awning or casement type frames. Polymer (e.g. uPVC) window framing should be used (**R_w+C_{tr} 31dB**). **Indoor Living and work areas** ➢ Up to 40% floor area: Sliding, awning, casement or double hung with minimum 6mm single pane or 6mm-12mm-6mm double insulted glazing (**R_w+C_{tr} 28dB**) **: OR** ➢ Up to 60% floor area: As per Bedrooms at up to 40% area (**Rw+Ctr31 dB**) **: OR** ➢ Up to 80% floor area: As per Bedrooms at up to 60% area (**R_w+C_{tr} 34 dB**).	**To R_w+C_{tr} 40dB** ➢ To all bedrooms, 2 layers of 10mm plasterboard, or one layer 13mm high density sealed plasterboard (minimum surface density of 12.5 kg/m2), affixed using steel furring channels beneath ceiling rafters/supports**: and** ➢ R3.0+ insulation batts laid in cavity**: and** ➢ Concrete or terracotta tile roof with sarking, or metal sheet roof with foil backed R2.0+ fibre insulation between steel sheeting and roof battens	➢ At least one outdoor living area located on the opposite side of the building from the corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum **2.4 metres** height above ground level	➢ Acoustically rated openings and ductwork to provide a minimum sound reduction performance of **Rw 40dB** into sensitive spaces ➢ Evaporative systems not recommended ➢ 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

Road Traffic and Passenger Rail
Quiet House Requirements
(*Based on Table 3 of State Planning Policy 5.4 2019*)

Exposure Category	Orientation to corridor	Acoustic rating and example constructions					
		Walls	**External doors**	**Windows**	**Roofs and ceilings of highest floors**	**Outdoor Living areas**	**Mechanical ventilation/air conditioning considerations**
C **Quiet House C**	**Facing**	**Bedroom and indoor living and work areas to R_w+C_{tr} 50dB** **Single leaf of 90 mm clay brick masonry with:** ➢ A row of 70 mm x 35 mm timber studs or 64 mm steel studs at 600 mm centres; ➢ A cavity of 25 mm between leaves; ➢ 50 mm glass wool or polyester cavity insulation (R2.0+) insulation between studs; and ➢ One layer of 10mm plasterboard fixed to the inside face	**Bedrooms** ➢ External doors to bedrooms facing the corridor are not recommended. **Indoor Living and work areas** ➢ Fully glazed hinged door with certified **Rw+Ctr 31dB** rated door and frame including seals and 10mm glass**: OR** 40mm solid core timber frame and door (without glass or with glass inserts not less than 6mm), side hinged with certified **Rw 32dB** acoustically rated door and frame system including seals	**Bedrooms**: ➢ Total external door and window system area up to 20% of room floor area: Fixed sash, awning or casement with minimum 6mm single or 6mm-12mm-6mm double insulted glazing (**R_w+C_{tr} 31dB): OR** ➢ Up to 40% floor area; as per above but must be minimum 10mm single or 6mm-12mm-10mm double insulted glazing (**R_w+C_{tr} 34dB**). **Indoor Living and work areas** ➢ Up to 40% floor area: Sliding or double hung with minimum 6mm single pane or 6mm-12mm-6mm double insulated glazing (**R_w+C_{tr} 31dB**). Sealed awning or casement windows may use 6mm glazing instead**: OR** ➢ Up to 60% floor area: As per Bedrooms at up to 40% area (**Rw+Ctr 34dB)**	**To R_w+C_{tr} 40dB** ➢ To al bedrooms, 2 layers of 10mm plasterboard, or one layer 13mm high density sealed plasterboard (minimum surface density of 12.5 kg/m2), affixed using steel furring channels beneath ceiling rafters/supports**: and** ➢ R3.0+ insulation batts laid in cavity **: and** ➢ Concrete or terracotta tile roof with sarking, or metal sheet roof with foil backed R2.0+ fibre insulation between steel sheeting and roof battens	➢ At least one outdoor living area located on the opposite side of the building from the corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum **2.4 metres** height above ground level	➢ Acoustically rated openings and ductwork to provide a minimum sound reduction performance of Rw 40dB into sensitive spaces. ➢ Evaporative systems require attenuated ceiling air cents 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, close or relocated to building sides facing away from the corridor where practicable.
	Side-on	➢ 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 **Double brick: two leaves of 90mm clay brick masonry with:** ➢ A 50mm cavity between leaves ➢ 50mm glass wool or polyester cavity insulation (R2.0+) ➢ Resilient ties where required to connect leaves	**Bedrooms** ➢ Fully glazed hinged door with certified **R_w+C_{tr} 31dB** rated door and frame including seals and 10mm glass **Indoor Living and work areas** ➢ 35mm solid core timber hinged door and frame system certified to **Rw 28dB** including seals**: OR** ➢ Glazed sliding door with 10 mm glass and weather seals				
	Opposite	**Double brick: two leaves of 110mm clay brick masonry with** ➢ 50mm cavity between leaves and R2.0+ cavity insulation	**Bedrooms**: ➢ Fully glazed hinged door with certified **R_w+C_{tr} 28dB** rated door and frame including seals and 6mm glass **Indoor Living and work areas:** ➢ 35mm solid core timber hinged door and frame system certified to **Rw 28dB** including seals**: OR** ➢ Glazed sliding door with 10 mm glass and weather seals	**Bedrooms**: ➢ Total external door and window system area up to 40% of room floor area: Sliding or double hung with minimum 10 mm single or 6mm-12mm-10mm double insulted glazing (**R_w+C_{tr} 28 dB**). Sealed awning or casement windows may use 6 mm glazing instead**: OR** ➢ Up to 60% floor area: as per above but must be sealed awning or casement type windows (**R_w+C_{tr} 31dB**). **Indoor Living and work areas** ➢ Up to 40% floor area: Sliding, awning, casement or double hung with minimum 6mm single pane or 6mm-12mm-6mm double insulted glazing (**R_w+C_{tr} 25dB): OR** ➢ Up to 60% floor area: As per Bedrooms at up to 40% area (**Rw+Ctr28 dB : OR** ➢ Up to 80% floor area: As per Bedrooms at up to 60% area (**R_w+C_{tr} 31 dB**).			

Freight Rail
Quiet House Requirements
(*Based on Table 3 of State Planning Policy 5.4 2019*)

Exposure Category	Orientation to corridor	Acoustic rating and example constructions					
		Walls	**External doors**	**Windows**	**Roofs and ceilings of highest floors**	**Outdoor Living areas**	**Mechanical ventilation/air conditioning considerations**
C+ **Quiet House C+**	**All Facades**	**Double brick: two leaves of 90mm clay brick masonry with:** ➢ A 50mm cavity between leaves ➢ 50mm glass wool or polyester cavity insulation (R2.0+) ➢ Resilient ties where required to connect leaves **Double brick: two leaves of 110mm clay brick masonry with** ➢ 50mm cavity between leaves and R2.0+ cavity insulation	**Bedrooms** ➢ External doors to bedrooms facing or side onto the corridor are not recommended. **Indoor Living and work areas** ➢ Fully glazed hinged door with certified **Rw+Ctr 31dB** rated door and frame including seals and 10mm glass**: OR** ➢ 40mm solid core timber frame and door (without glass or with glass inserts not less than 6mm), side hinged with certified **Rw 32dB** acoustically rated door and frame system including seals	**Bedrooms**: ➢ All windows comprise minimum 6mm thick laminated or toughened glass in sealed awning or casement type frames. Polymer (e.g. uPVC) window framing should be used (**R_w+C_{tr} 31dB**). **Indoor Living and work areas** ➢ Up to 40% floor area: Sliding, awning, casement or double hung with minimum 6mm single pane or 6mm-12mm-6mm double insulted glazing (**R_w+C_{tr} 31dB**) **: OR** ➢ Up to 60% floor area: As per Bedrooms at up to 40% area (**Rw+Ctr34 dB**)	**To R_w+C_{tr} 45dB** ➢ To al bedrooms, 2 layers of 10mm plasterboard, affixed using steel furring channels beneath ceiling rafters/supports**: and** ➢ R3.0+ insulation batts laid in cavity **: and** ➢ Concrete or terracotta tile roof with sarking, (No metal sheet roofing)	➢ At least one outdoor living area located on the opposite side of the building from the corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum **2.4 metres** height above ground level	➢ Acoustically rated openings and ductwork to provide a minimum sound reduction performance of Rw 40dB into sensitive spaces. ➢ Evaporative systems require attenuated ceiling air cents 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, close or relocated to building sides facing away from the corridor where practicable.