Noise and Sound Services

Road Traffic Noise & Vibration Impact Assessment

Orchard Hills North – Planning Proposal
NSW 2748

October 2022

Report No. nss23793 – Final Rev. A

Prepared at the request of: -

Legacy Property
MLC Centre, Level 45
19 Martin Place, Sydney NSW 2000

Prepared by:-

NOISE AND SOUND SERVICES PTY LTD

Spectrum House, 3, Cassandra Avenue, St Ives, NSW 2075
Tel: (02) 9449 6499. Mob: 0411 648 153
E-mail: noiseandsound@optusnet.com.au Website: www.noiseandsound.com.au
A member firm of the Association of Australasian Acoustical Consultants
ABN: 25660 134 056

C O N T E N T S

EXECUTIVE SUMMARY

A road traffic noise and vibration assessment has been carried out regarding a greenfield site due to the proposed rezoning of approximately 151.9 hectares of rural land in Orchard Hills North (OHN), NSW 2748. This is to assess potential noise and vibration impacts resulting from two significant proposed roadways (subject roadways being the ultimate north-south roadway and the ultimate east-west roadway) within the OHN Precinct. Then to address preliminary mitigation measures for future residential dwellings surrounding the subject roadways. The study also advises on the preliminary sound insulation requirements from external noise in line with the NSW Road Noise Policy (2011), the NSW Government Department of Planning Development Near Rail Corridors and Busy Roads – Interim Guideline (December 2008), the State Environmental Planning Policy (Transport and Infrastructure) 2021, Clause 2.120 – *'Impact of road noise or vibration on non-road development'* and the Australian Standard AS 2107 – 2016, *'Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors'*.

The Orchard Hills North precinct (Structure Plan area) is bounded by Caddens Road to the north, Claremont Meadows residential lots to the east, the M4 Motorway to the south and the Northern Road to the west. The rezoning area, being the subject of the OHN Planning Proposal, is identified in Figure 1 of this report. The proposed ultimate north-south roadway is bounded by Caddens Road to the north and the M4 Motorway to the south, while the proposed ultimate east-west roadway is bounded by the entire precinct.

Road traffic data has been obtained from a Transport and Accessibility Management Plan prepared by *'SCT Consulting Pty Ltd'*, Titled: Orchard Hills North Rezoning – Transport and Accessibility Management Plan, Project No.: SCT_00051, Revision 10.2, Dated 21st April 2021. This data has been used to model the road traffic noise using the formulae as given in the Department of Transport, Welsh Office, Great Britain, *'Calculation of Road Traffic Noise'* (CoRTN 88) and the International Standard ISO 9613-2 (1996(E)) '*Acoustics – Attenuation of sound during propagation outdoors Part 2 General method of calculation'*.

Land use developers must meet internal noise goals in the State Environmental Planning Policy (Transport and Infrastructure) 2021 for sensitive developments near existing busy roads. However, it is good practice to limit outdoor area noise levels ($L_{Aeq,\ 15\ hour}$) to 60 dBA in line with that required for active recreation in the NSW Government's Road Noise Policy (2011). The results show that proposed dwellings at distances up to 10 metres, 50 metres and 100 metres from the subject roadways are predicted to experience external road-traffic-noise-levels $L_{Aeq,\ (1\ hour)}$ of 73 dBA, 57 dBA and 49 dBA, respectively at the nearest affected façade. Architectural design treatments for sound insulation of future proposed dwellings along and surrounding the subject roadways have been provided.

1. INTRODUCTION

Noise and Sound Services was requested by Legacy Property of MLC Centre, Level 45, 19 Martin Place, Sydney NSW 2000, on behalf of LegPro Orchard Hills Pty Ltd ATF LegPro Orchard Hills Unit Trust, to carry out a road traffic noise and vibration assessment. This is regarding a greenfield site due to the proposed rezoning of approximately 151.9 hectares of rural land in Orchard Hills North, NSW 2748 (Proposed Development Site) to permit residential development comprising approximately 1,729 dwellings.

The purpose of the study is to assess potential noise and vibration impacts resulting from two significant proposed roadways (subject roadways being the ultimate north-south roadway and the ultimate east-west roadway) within the proposed rezoned development site. Then to address preliminary mitigation measures for future residential dwellings surrounding the subject roadways. The study also advises on the preliminary sound insulation requirements without a noise barrier from external noise in line with the NSW Road Noise Policy (2011), the NSW Government Department of Planning Development Near Rail Corridors and Busy Roads – Interim Guideline (December 2008), the State Environmental Planning Policy (Transport and Infrastructure) 2021, Clause 2.120 – *'Impact of road noise or vibration on non-road development'* and the Australian Standard AS 2107 – 2016, *'Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors'*.

Summary Scope;

- Evaluate the current and future noise and vibration environment resulting from the proposed ultimate north-south and ultimate east-west roadways onto the proposed surrounding residential developments as part of the Orchard Hills North development site (traffic volumes).

- Model proposed indicative development scenario and discuss likely noise and vibration impacts against relevant guidelines.

This report considers: -

- An assessment using appropriate site-specific noise criteria based on NSW guidelines and Penrith City Council requirements;
- Acoustic modelling to determine noise impacts;
- Options to evaluate alternate mitigation measures e.g., Architectural Treatments;
- Recommendations to mitigate any noise and vibration impacts required to be implemented to achieve relevant statutory and policy standards to accompany the rezoning application;

- A Transport and Accessibility Management Plan prepared by *'SCT Consulting Pty Ltd'*, Titled: Orchard Hills North Rezoning – Transport and Accessibility Management Plan, Project No.: SCT_00051, Revision 10.2, Dated: 21st April 2021; and
- A Road Traffic Noise Impact Statement prepared by *'Noise and Sound Services'*, Titled: Road Traffic Noise Impact Statement at Orchard Hills North, NSW 2748, Report No.: nss23123 – Final, Dated: 20th December 2019.

2. SITE AND DEVELOPMENT DESCRIPTION

The OHN precinct is bounded by Caddens Road to the north Claremont Meadows residential lots to the east, the M4 Motorway to the south and the Northern Road to the west. The proposed rezoning area is shown bounded in red, in Figure 1 below. Full details are given in the outline drawings provided by Legacy Property.

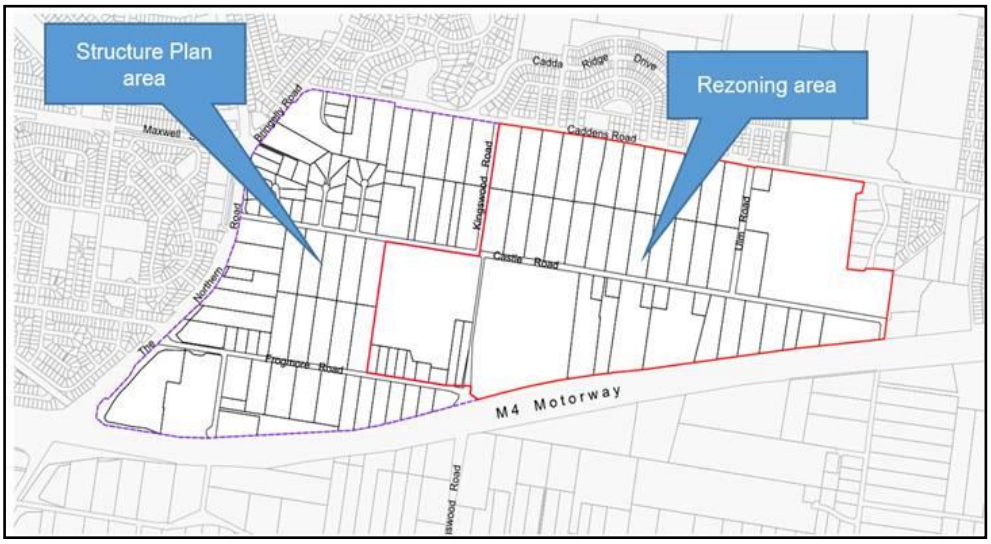

Figure 1. Outline Site Plan. Source: Legacy Property

The forecast population for the rezoning area is approximately 5,400 people. The balance of the Structure Plan area is 116 hectares, forecast population of 3,900 people. The areas shown outside of the red boundaries in Figure 1 above are not part of this scope of works, other than for the section of ultimate east-west roadway (up to The Northern Road).

The proposed ultimate north-south roadway is bounded by Caddens Road to the north and the M4 Motorway to the south, while the proposed ultimate east-west roadway is bounded by the entire precinct. The proposed subject roadways are shown in Figure 2 below.

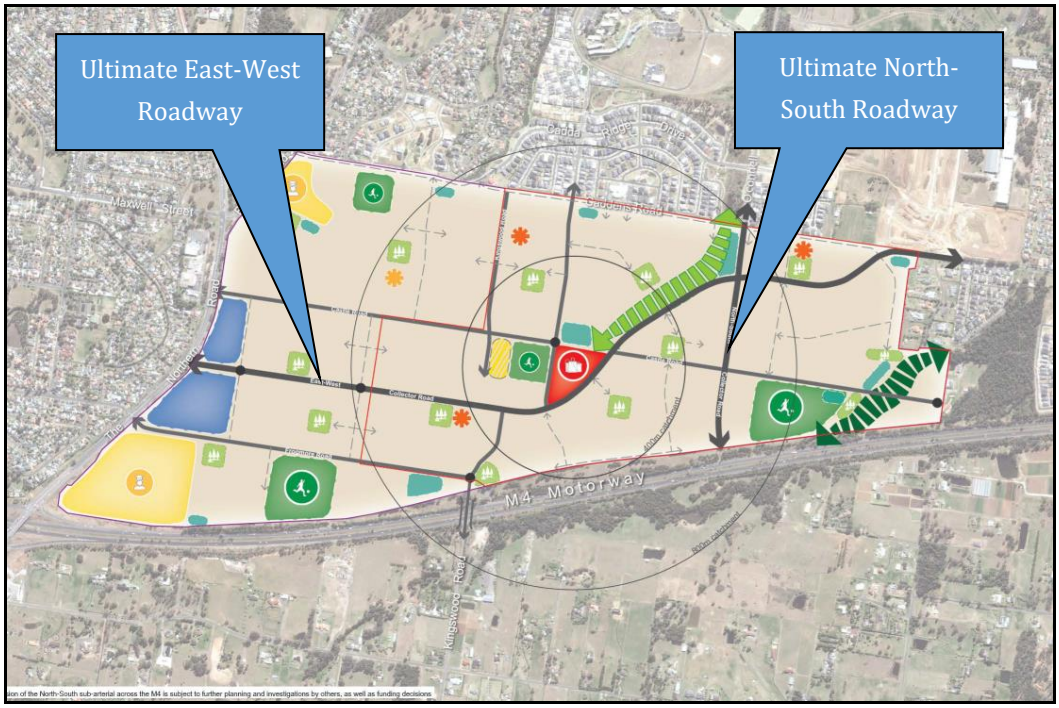

Figure 2. Site Plan Showing Proposed Ultimate Roadways. Source: Legacy Property

According to Section 4.3 of the project's respective Transport and Accessibility Management Plan;

The proposed North-South Road corridor:

- Forms a connection between O'Connell Street and terminates at the M4 Motorway. This may be continued in the future, subject to further planning, investigations and funding decisions, to link Orchard Hills North via a bridge across the M4 Motorway and to the southern expansion area / Orchard Hills South;
- Long term road reservation for 4 lanes, median and cycleway;
- No driveway access in short or long term;
- Can be built in the interim with 2 lanes and reservation to provide ultimate 4 lanes (sections of the four-lane corridor within Orchard Hills North may need to be brought forward dependent on the outcome of the TMAP exercise);
- Serve as a major collector / distributor road;

- Corridor would likely have an intersection with Cadda Ridge Drive, the east-west road corridor, and Castle Road (subject to topography); and

- Existing bridge at Kingswood Road over M4 to remain as a local link, and potential for this to be a shared path over the M4 explored at a later stage (closed to vehicular traffic).

The proposed East-West Road corridor:

- Connects a new signalised intersection at The Northern Road (mid-location intersection between M4 and Bringelly Road) with Caddens Road to the east, that generally follows an appropriate alignment in response to topography;

- Intersections at The Northern Road with Castle Road and Frogmore Road restricted to left-in, left-out ultimately;

- Road to provide 4 lanes and serves as a local collector road, while retaining Cadda Ridge Drive as a 2-lane road with parking on both sides; and

- Access restrictions applied near the new intersection with The Northern Road in anticipation of surrounding business/commercial uses and capacity associated with the new intersection. Could be partially access restricted in Precinct 1 of the proposed development site.

Table 5-10 *'Midblock capacity evaluation –2036 Orchard Hills North Precinct (Precincts 1 & 2)'* of Section 5.3 of the project's respective Transport and Accessibility Management Plan provides future projected road traffic flow volume data for the year 2036 for surrounding roadways within the development site. The applicable data for this assessment given in Table 5-10, regarding the proposed east-west road corridor is;

- 944 vehicles for the 2 eastbound lanes and 753 vehicles for the 2 westbound lanes during the AM peak period; and

- 535 vehicles for the 2 eastbound lanes and 1,386 vehicles for the 2 westbound lanes during the PM peak period.

No road traffic volume data has been provided for the proposed north-south road corridor; however, it is understood that the traffic volumes along this proposed roadway will be significantly less than the volumes produced along the east-west road corridor.

In accordance with Section 5.1.3 of the respective Transport and Accessibility Management Plan, it is noted that the that the north-south and east-west corridors are assumed to be posted at a speed of 70 km/h.

Approximate distances (metres) between the proposed ultimate roadway and its intersection with the respective sub-arterial road are presented in Figure 3 below.

Collector Road / Sub-Arterial Roads	
East West Road - Section 1 Sub-Arterial (The Northern Road to Area A/B Boundary)	650
East West Road - Section 2 Sub-Arterial (Area A/B Boundary to Village Centre)	760
East West Road - Section 3/4 Sub-Arterial (Village Centre to North South Road)	710
East West Road - Section 5 Collector Road (North South Road to Caddens Road)	650
North South Road - Section 1 Sub-Arterial Road (Caddens Road to East-West Road) Partial Construction Only (as Collector Road)	190
North South Road - Section 2 Sub-Arterial Road (East-West Road to Castle Road) Partial Construction Only (half width)	310
North South Road - Section 3 Sub-Arterial Road (Castle Road to Precinct Boundary) Partial Construction Only (half width)	285

Figure 3. Approximate distances (metres) between the proposed ultimate roadway and its intersection with the respective sub-arterial road Source: Legacy Property.

Potential vibration emission by vehicles along these subject roadways are not expected to be of concern to its surrounding environment due to the fact that the roadways are sub-arterial and generally would not produce high vibration levels based on the data provided. Therefore, no further assessment regarding road traffic vibration is required.

3. CRITERIA

3.1 Penrith Development Control Plan 2014

Part C12 of Penrith Development Control Plan 2014 Noise and Vibration States:-

"12.1. Road Traffic Noise

A. Background currently; road traffic is the most widespread source of environmental noise. The controls below seek to minimise the impact of road traffic noise. This Section of the DCP applies to all developments that generate a significant level of traffic noise (as determined by Council) that has potential to impact upon residential and other sensitive land uses. This Section is also applicable to any residential development, subdivision or other sensitive land uses, which propose to locate near existing areas of significant road traffic noise.
B. Objectives

- *a) To ensure that the amenity of all residential development and other sensitive land uses is not significantly affected by road traffic noise;*
- *b) To ensure that the traffic associated with development does not significantly impact upon the amenity of surrounding land uses;*

c) To ensure that the traffic associated with development does not have a significant noise impact on the existing road network; and
d) To ensure that any subdivisions are designed to minimise the impact of road traffic noise on any residential development or other sensitive land uses.

Penrith Development Control Plan 2014 C12 Noise and Vibration C12-4 C. Controls 1) Road traffic noise criteria including sensitive land uses

a) Council will not grant consent to development, particularly residential development, including subdivisions, unless the impact of traffic noise from freeway, arterial, designated or collector roads complies with the standards and guidelines for road traffic noise prepared by the relevant State Government authorities or agencies, as well as relevant Australian Standards.
b) Council will not grant consent to development for sensitive land uses unless it complies with the provisions and standards for road traffic noise prepared by the relevant State Government authorities or agencies, as well as relevant Australian Standards.
c) Sensitive land uses subject to road traffic noise criteria referred to in:-
    i. above include educational establishments (including schools), places of public worship, hospitals, and passive and active recreation areas. Noise Impact Statements - Specific Requirements
    ii. Where a site is likely to be affected by unacceptable levels of road traffic noise, the applicant is required to provide a Noise Impact Statement prepared by a qualified acoustic consultant in accordance with the requirements set out in the DA Submission Requirements Appendix of this DCP.

B.The Noise Impact Statement should demonstrate acoustic protection measures necessary to achieve an indoor environment meeting residential standards, in accordance with EPA and Department of Planning Criteria, as well as relevant Australian Standards.

NOTE: To determine whether your site is likely to be exposed to levels of road traffic noise that exceed residential standards:
a) Contact Council regarding main road frontages known to exceed residential noise standards; and
b) Obtain detailed advice from a qualified acoustic consultant regarding appropriate planning".

3.2 Development Near Rail Corridors and Busy Roads – Interim Guideline (2008)

The NSW Government Department of Planning Development Near Rail Corridors and Busy Roads – Interim Guideline (December 2008), provides guidance for planning, design and assessment of development in or adjacent to rail corridors and busy roads. It provides advice to councils, state agencies, proponents and the community on ways to avoid and manage the impact of road and rail operations on surrounding land uses and the impact of surrounding land uses on road and rail infrastructure**.** Objective noise criteria are given in the State Environmental Planning Policy (Transport and Infrastructure) 2021.

3.3 State Environmental Planning Policy (Transport and Infrastructure) 2021 Clause 2.120 - Impact of road noise or vibration on non-road development

The State Environmental Planning Policy (Transport and Infrastructure) 2021, Subdivision 2,

2.120 Impact of road noise or vibration on non-road development, Impact of road noise or vibration on non-road development provides the following: -

2.120 Impact of road noise or vibration on non-road development

(1) This section applies to development for any of the following purposes that is on land in or adjacent to the road corridor for a freeway, a tollway or a transitway or any other road with an annual average daily traffic volume of more than 20,000 vehicles (based on the traffic volume data published on the website of TfNSW) and that the consent authority considers is likely to be adversely affected by road noise or vibration –

(a) residential accommodation,
(b) a place of public worship,
(c) a hospital,
(d) an educational establishment or centre-based child care facility.

(2) Before determining a development application for development to which this section applies, the consent authority must take into consideration any guidelines that are issued by the Secretary for the purposes of this section and published in the Gazette.

(3) If the development is for the purposes of residential accommodation, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded —

(a) in any bedroom in the residential accommodation - **35 dB(A**) at any time between 10 pm and 7 am,
(b) anywhere else in the residential accommodation (other than a garage, kitchen, bathroom or hallway) - **40 dB(A)** at any time.

(4) In this section, freeway, tollway and transitway have the same meanings as they have in the Roads Act 1993.

3.4 Australian Standards AS 3671 and AS 2107

The Australian Standard AS 3671-1989 *'Acoustics - Road traffic noise intrusion - building siting and construction'* refers to guideline limits in Australian Standard AS 2107. Australian Standard AS 2107 – 2016 *'Acoustic – Recommended Design Sound Levels and Reverberation Times for Building Interiors'* provides recommended design sound levels for different areas of occupancy in buildings. This includes recommended internal design sound levels from continuous road traffic noise for houses near major roads as shown in Table 1 below.

TABLE 1 - RECOMMENDED DESIGN SOUND LEVEL FOR RESIDENTIAL BUILDINGS. FROM AS/NZS 2107 (2016).

Type of Occupancy	**Design Sound Level Range ($L_{Aeq, t}$) dBA**
Houses and Apartments Near Major Roads	
Living Areas	35 to 45
Sleeping Areas (night time)	35 to 40
Work Areas	35 to 45

3.5 Site Specific Internal Noise Goals

Site-specific internal road traffic noise goals ($L_{Aeq, period}$) in line with the State Environmental Planning Policy (Transport and Infrastructure) 2021 and Australian Standard AS/NZS 2107 are set at **35 dBA** for sleeping areas and **40 dBA** for living/work areas.

3.6 Outdoor Noise Goals

Target outdoor noise levels for existing freeways, arterial and sub arterial roads as given in the NSW Government's Road Noise Policy (2011) are: $L_{Aeq, (15\ hour)}$ **60 dBA** during day time hours (7:00 am to 10:00 pm) and $L_{Aeq, (9\ hour)}$ **55 dBA** during night time hours (10:00 pm to 7:00 am**).** This is for existing residences.

Land use developers must meet internal noise goals in the State Environmental Planning Policy (Transport and Infrastructure) 2021 for sensitive developments near busy roads (see Section 3.2 above). For active recreation use of open space, the target outdoor noise level for existing freeways, arterial and sub arterial roads as given in the NSW Government's Road Noise Policy (2011) is $L_{Aeq,\ (15\ hour)}$ **60 dBA** during day time hours (7:00 am to 10:00 pm), when the outdoor space is in use.

4. DISCUSSION AND CALCULATIONS

This section of the report discusses the modelled results at the surrounding site of the proposed residential dwellings which are likely to be single storey or double storey homes with three or four bedrooms. Detailed formula is used to predict external and internal noise levels for various rooms of the proposed residences.

4.1 External Noise Levels

Noise models and calculations have been prepared for the occurrence of noise emissions from the proposed ultimate roadways. This section provides details of the models and calculations applicable to the development.

4.1.1 Noise Modelling Specifications

The sound pressure level from a line source noise has been modelled using the formulae as given in the Department of Transport, Welsh Office, Great Britain, *'Calculation of Road Traffic Noise'* (CoRTN 88) and the International Standard ISO 9613-2 (1996(E)), '*Acoustics – Attenuation of sound during propagation outdoors Part 2 General method of calculation'*. This Standard specifies methods for the description of noise outdoors in community environments. The method described in the Standard is general in the sense that it may be applied to a wide variety of noise sources and covers the major mechanism of attenuation. The method allows for downwind propagation conditions within an angle of ± 45° of the direction connecting the centre of the dominant sound source and the centre of the specified receiver region with the wind blowing from source to receiver, and wind speed between approximately 1 m/s and 5 m/s measured at a height of 3 to 11 metres above the ground.

4.1.2 Basic Noise Modelling Equation

The equivalent continuous downwind sound pressure level (L_{Aeq}) at each receiver point can be calculated for each noise source using the equation below: -

$$\mathbf{L_{Aeq} = L_w + D_c - \mathit{A}}$$

Where:

L_w is the sound power level of the noise source;
D_c is directivity correction; and
A is the attenuation that occurs during the propagation from source to receiver.

The attenuation term A in the equation above is given by: -

$$\boldsymbol{A = A_{div} + A_{atm} + A_{gr} + A_{bar} + A_{misc}}$$

Where:
A_{div} is the attenuation due to geometric divergence;
A_{atm} is the attenuation due to atmospheric absorption;
A_{gr} is the attenuation due to the ground effects;
A_{bar} is the attenuation due to a barrier; and
A_{misc} is the attenuation due to miscellaneous other effects.

The last term (A_{misc}) generally refers to miscellaneous propagation through foliage, industrial sites and areas of houses. Due to the vicinity of the development to the neighbouring dwellings the attenuation due to atmospheric absorption, ground effects and other miscellaneous effects are of minor significance at this site.

4.2 Projected Road Traffic Flow Results

Road traffic data obtained from the project's respective Transport and Accessibility Management Plan have been used to model the road traffic noise with unobstructed line-of-sight for distances up to 100 metres from the proposed roadways. The distances are the assumed positioning of the nearest noise affected facades of the proposed dwellings.

As mentioned previously;

Table 5-10 *'Midblock capacity evaluation – 2036 Orchard Hills North Precinct (Precincts 1 & 2)'* of Section 5.3 of the project's respective Transport and Accessibility Management Plan provides future projected road traffic flow volume data for the year 2036 for surrounding roadways within the development site. The applicable data for this assessment given in Table 5-10, regarding the proposed east-west road corridor is;

- 944 vehicles for the 2 eastbound lanes and 753 vehicles for the 2 westbound lanes during the AM peak period; and

- 535 vehicles for the 2 eastbound lanes and 1,386 vehicles for the 2 westbound lanes during the PM peak period.

No road traffic volume data has been provided for the proposed north-south road corridor; however, it is understood that the traffic volumes along this proposed roadway will be significantly less than the volumes produced along the east-west road corridor. Therefore, this will be taken into consideration throughout this assessment.

In accordance with Section 5.1.3 of the respective Transport and Accessibility Management Plan, it is noted that the north-south and east-west corridors are assumed to be posted at a speed of 70 km/h. No data is given for heavy vehicle use along the proposed roadways, however an assumption of 5 % heavy vehicle use will be adopted for this assessment.

Based on this data and the noise model as described in Section 4.1 above, the future projected $L_{Aeq,\ (1\ hour)}$ noise level for the year 2036 produced at the respective distances during AM and PM peak periods by road traffic using the east-west road corridor are as follows:

- AM Peak $L_{Aeq,\ (1\ hour)}$ noise level at 10 metres: **73 dBA**
- AM Peak $L_{Aeq,\ (1\ hour)}$ noise level at 50 metres: **66 dBA**
- AM Peak $L_{Aeq,\ (1\ hour)}$ noise level at 100 metres: **64 dBA**

- PM Peak $L_{Aeq,\ (1\ hour)}$ noise level at 10 metres: **73 dBA**
- PM Peak $L_{Aeq,\ (1\ hour)}$ noise level at 50 metres: **67 dBA**
- PM Peak $L_{Aeq,\ (1\ hour)}$ noise level at 100 metres: **64 dBA**

The higher noise level at the respective distance, regardless of the AM or PM period will be adopted for this assessment.

The results show that proposed dwellings at distances up to 10 metres from the proposed east-west roadway will be highly noise affected (i.e., 73 dBA), during peak traffic periods. The results also show that proposed dwellings at distances from 50 to 100 metres from the proposed east-west roadway will also be noise affected (i.e., between 64 dBA and 67 dBA).

The prediction for the residences at distances between 50 and 100 metres from the proposed roadway does not allow for the noise reduction due to acoustic shielding from any proposed dwellings closer to the proposed roadway or the use of any acoustic barriers. Any proposed dwelling which is not directly positioned along the east-west roadway or the north-south roadway (i.e., at distances of 50 metres to 100 metres) will incur a further noise reduction. For purposes of this assessment, a conservative attenuation level of 10 dB for dwellings at 50 metres away and 15 dB for dwellings at 100 metres away will be allowed for during this assessment.

This therefore gives:

AM Peak $L_{Aeq,\ (1\ hour)}$ noise level at 50 metres: **56 dBA**

AM Peak $L_{Aeq, (1\ hour)}$ noise level at 100 metres: **49 dBA**
PM Peak $L_{Aeq, (1\ hour)}$ noise level at 50 metres: **57 dBA**
PM Peak $L_{Aeq, (1\ hour)}$ noise level at 100 metres: **49 dBA**

The outdoor noise goal of $L_{Aeq, (15\ hour)}$ **60 dBA** will be met for all proposed dwellings, this is based on the assumption that the proposed outdoor recreation areas will be positioned to the rear of the subject sites, this therefore incorporates sufficient noise reduction from shielding due to the dwellings and the use of acoustic barriers along lot boundaries of the subject site. Therefore, no further assessment regarding the outdoor open space is required. See Appendix B for data on typical Acoustic Barriers.

5. RECOMMENDATIONS - ARCHITECTURAL TREATMENTS FOR SOUND INSULATION

This section provides the minimum construction requirements to meet the noise goals. Further assessment for future projects will be required during the detailed design phase. Individual, site-specific assessment, within the development, will be required for dwellings, depending upon habitable room location, size and glazing size within the development site.

Note: All proposed dwellings which are surrounding the proposed east-west and north-south roadways and which are also within proximity to the nearby M4 Motorway should take into consideration the recommendations as outlined in the Road Traffic Noise Impact Statement prepared by *'Noise and Sound Services'*, Titled: Road Traffic Noise Impact Statement at Orchard Hills North, NSW 2748, Report No.: nss23123 – Final, Dated: 20th December 2019, which deals with specific road traffic noise and vibration resulting from the M4 Motorway itself.

5.1 Planning of Dwellings

Where reasonable and practicable, sleeping areas and other habitable areas should be placed on the side of the building furthest away from the subject roadways. Rooms which are less sensitive to noise (i.e., laundries, bathrooms, storage rooms, corridors, stairwells, etc.) should be placed on the more noise affected sector of the building to act as a noise buffer. An additional way of minimising the intrusion of noise is to minimise the number and the area of doors and windows (particularly openable windows), especially along the nearest noise affected façade of the dwelling.

5.2 Internal Noise Levels

In addition to distance attenuation, the internal noise level (L_{p2}) in various rooms for the proposed residences to be constructed in the development, is determined from the following formula:

$$L_{p2} = L_{p1} - R_w + 10\ Log_{10}\ (S/A) - K + 6\ dBA$$

Where: L_{p1} is the external noise level;
R_w is the weighted sound reduction index of the partition;
S is the area of the partition (window or glazed door);
A is the room acoustic absorption; and
K is an angle of view correction.

By applying this formula, the selection of the weighted sound reduction index (R_w) for the windows and glazed doors in the external façades for the proposed residential dwellings can be found. The glazed areas are normally the weakest acoustic partition in the room façades.

5.3 External Constructions for Residences at Distances of 10 Metres from the East-West Roadway.

5.3.1 External Wall Construction

The external walls must achieve a minimum R_w of 52 dB, which is standard for: -

- Brick veneer consisting of 110 mm thick exterior face brick, with 90 mm deep timber stud or 92 mm metal stud, at least 40 mm clearance between the masonry and stud frame and 10 mm thick plasterboard (e.g., *'Soundcheck™'*) internal wall construction; or

- Double brick of 110 mm brickwork separated by at least a 40 mm gap.

- Minimum 6 mm fibre cement sheeting or weatherboards or plank cladding externally, 90 mm deep timber stud or 92 mm metal stud and two layers of 13 mm sound rated plasterboard (e.g., *'Soundcheck™'*) internally with R2 insulation in the wall cavity.

5.3.2 Roof / Ceiling Construction

The roof/ceiling must achieve a minimum R_w of 50 dB, which is standard for a concrete/terracotta tiled roof or a metal roof (e.g., *'Colorbond™'*), with sarking, above two layers of 10 mm thick sound rated plasterboard ceiling (e.g., *'Soundcheck™'*) fixed to the ceiling joists with acoustic absorption to be laid in the roof cavity. The acoustic absorption material should be at least 50 mm thick with a Noise Reduction Coefficient (NRC) of at least 0.7. Thermal rating of R2 would be suitable to meet the acoustic requirements; however, the NRC should be checked with the relevant supplier before purchase to ensure it is at least 0.7. It is essential for sound insulation that plasterboard walls and ceilings are well sealed.

For example, the joint between the wall and the ceiling can be sealed with a resilient layer such as mastic and then covered with a plasterboard cornice; or it can be sealed with tape and cornice cement.

5.3.3 Minimum Glazing Thicknesses and R_w Ratings

Detailed designs for the proposed dwellings have not yet been finalised, hence assumptions have been made for typical glazing sizes, types and locations for the residences. To meet the internal design goals and based on assumptions of typical constructions, the glazing for habitable rooms will require the glass thicknesses as produced in Table 2 below. Once specific architectural plans have been produced, a final specification for window thicknesses will need to be provided as this is dependent upon room sizes, room orientations, room uses and window areas.

TABLE 2 – MINIMUM GLAZING THICKNESSES AND R_W RATINGS

Room	Assumed Size/Type of Glazing (H x W) (mm)	Recommended Minimum Type and Thickness of Glazing	Minimum Required R_w or STC Rating (dB)
Typical Double Storey Dwelling			
Lounge / Family / Dining Room	2100 x 2700 Sliding Door	10.38 mm laminated sliding door with acoustic seals	34
	2 x 1000 x 1500 Awning Windows	10.38 mm laminated awning windows with acoustic seals	35
Bedroom 1	2100 x 1800 Awning Window	10.38 mm laminated awning window with acoustic seals	35
Bedrooms 2, 3 and 4	1800 x 1200 Awning Window	10.38 mm laminated awning window with acoustic seals	35
Typical Single Storey Dwelling			
Lounge / Family / Dining Room	2100 x 2700 Sliding Door	10.38 mm laminated sliding door with acoustic seals	34
	2 x 1000 x 1500 Awning Windows	10.38 mm laminated awning windows with acoustic seals	35
Bedroom 1	2100 x 1800 Awning Window	10.38 mm laminated awning window with acoustic seals	35
Bedrooms 2, 3 and 4	1800 x 1200 Awning Windows	10.38 mm laminated awning window with acoustic seals	35

Table 2 Notes:

- *All glazing, given in Table 2 above must be constructed in solid timber (or aluminium) frames and well-sealed when closed;*

- *R_w = Weighted Sound Reduction Index, covers a frequency range from 100 Hz to 3.15 kHz;*
- *STC = Sound Transmission Class, is similar to R_w but covers a frequency range from 120 Hz to 4 kHz;*
- *Alternative types of glazing are acceptable provided the R_w values as given in the tables above are met;*
- *Glazing systems recommended are minimum requirements for acoustic purposes. In some cases, thicker glass may be preferred or required for safety or other reasons.*

5.3.4 Entry Doors

All external entry doors (including doors from garages to habitable rooms) should be at least 40 mm thick and of solid-core construction. The doors should also be fitted with acoustic seals (e.g., *'Lorient™'* IS7025 and IS8011si or *'Raven™' RP47* frame and *RP38* bottom seals) to give a certified R_w rating of at least 32 dB.

5.4 External Constructions for Residences at Distances of 50 Metres from the East-West Roadway.

5.4.1 External Wall Construction

The external walls must achieve a minimum R_w of 45 dB, which is standard for: -

- Brick veneer consisting of 110 mm thick exterior face brick, with 90 mm deep timber stud or 92 mm metal stud, at least 40 mm clearance between the masonry and stud frame, R2 Insulation batts in the wall cavity and 10 mm thick plasterboard internal wall constructions; or

- Double brick of 2 leaves of 110 mm brickwork separated by at least a 40 mm gap; or

- Timber frame or cladding construction consisting of 6 mm fibre cement sheeting or weatherboards or plank cladding or metal cladding externally, 90 mm deep timber stud or 92 mm metal stud, 13 mm thick standard plasterboard lined internally with R2 insulation in wall cavity.

5.4.2 Roof / Ceiling Construction

The roof/ceiling must achieve a minimum R_w of 43 dB, which is standard for a concrete/terracotta tiled roof or a metal roof (e.g., *'Colorbond™'*), with sarking, above a single layer of 10 mm thick plasterboard ceiling fixed to the ceiling joists with acoustic absorption to be laid in the roof cavity. The acoustic absorption material should be at least 50 mm thick with a Noise Reduction Coefficient (NRC) of at least 0.7.

Thermal rating of R2 would be suitable to meet the acoustic requirements; however, the NRC should be checked with the relevant supplier before purchase to ensure it is at least 0.7. It is essential for sound insulation that plasterboard walls and ceilings are well sealed. For example, the joint between the wall and the ceiling can be sealed with a resilient layer such as mastic and then covered with a plasterboard cornice; or it can be sealed with tape and cornice cement.

5.4.3 Minimum Glazing Thicknesses and R_w Ratings

Detailed designs for the proposed dwellings have not yet been finalised, hence assumptions have been made for typical glazing sizes, types and locations for the residences. To meet the internal design goals and based on assumptions of typical constructions, the glazing for habitable rooms will require the glass thicknesses as produced in Table 3 below. Once specific architectural plans have been produced, a final specification for window thicknesses will need to be provided as this is dependent upon room sizes, room orientations, room uses and window areas.

TABLE 3 – MINIMUM GLAZING THICKNESSES AND R_W RATINGS

Room	Assumed Size/Type of Glazing (H x W) (mm)	Recommended Minimum Type and Thickness of Glazing	Minimum Required R_w or STC Rating (dB)
Typical Double Storey Dwelling			
Lounge / Family / Dining Room	2100 x 2700 Sliding Door	6.38 mm laminated sliding door with acoustic seals	30
	2 x 1000 x 1500 Awning Windows	4 mm float awning windows with standard seals	24
Bedroom 1	2100 x 1800 Awning Window	6.38 mm laminated awning window with acoustic seals	33
Bedrooms 2, 3 and 4	1800 x 1200 Awning Window	6.38 mm laminated awning window with acoustic seals	33
Typical Single Storey Dwelling			
Lounge / Family / Dining Room	2100 x 2700 Sliding Door	6.38 mm laminated sliding door with acoustic seals	30
	2 x 1000 x 1500 Awning Windows	4 mm float awning windows with standard seals	24
Bedroom 1	2100 x 1800 Awning Window	6.38 mm laminated awning window with acoustic seals	32
Bedrooms 2, 3 and 4	1800 x 1200 Awning Windows	6.38 mm laminated awning window with acoustic seals	32

Table 3 Notes:

- *All glazing, given in Table 3 above must be constructed in solid timber (or aluminium) frames and well-sealed when closed;*
- *R_w = Weighted Sound Reduction Index, covers a frequency range from 100 Hz to 3.15 kHz;*
- *STC = Sound Transmission Class, is similar to R_w but covers a frequency range from 120 Hz to 4 kHz;*
- *Alternative types of glazing are acceptable provided the R_w values as given in the tables above are met;*
- *Glazing systems recommended are minimum requirements for acoustic purposes. In some cases, thicker glass may be preferred or required for safety or other reasons.*

5.4.4 Entry Doors

All external entry doors should be at least 35 mm thick and of solid-core construction. Acoustic door seals are optional.

5.5 External Constructions for Residences at Distances of 100 Metres from the East-West Roadway.

5.5.1 External Wall Construction

The external walls must achieve a minimum R_w of 38 dB, which is standard for: -

- Brick veneer consisting of 110 mm thick exterior face brick, with 90 mm deep timber stud or 92 mm metal stud, at least 40 mm clearance between the masonry and stud frame, R2 Insulation batts in the wall cavity and 10 mm thick plasterboard internal wall constructions; or

- Double brick of 2 leaves of 110 mm brickwork separated by at least a 40 mm gap; or

- Timber frame or cladding construction consisting of 6 mm fibre cement sheeting or weatherboards or plank cladding or metal cladding externally, 90 mm deep timber stud or 92 mm metal stud, 13 mm thick standard plasterboard lined internally with R2 insulation in wall cavity.

5.5.2 Roof / Ceiling Construction

The roof/ceiling must achieve a minimum R_w of 40 dB, which is standard for a concrete/terracotta tiled roof or a metal roof (e.g., *'Colorbond™'*), with sarking, above a single layer of 10 mm thick plasterboard ceiling fixed to the ceiling joists with acoustic absorption to be laid in the roof cavity. The acoustic absorption material should be at least 50 mm thick with a Noise Reduction Coefficient (NRC) of at least 0.7. Thermal rating of R2 would be suitable to meet the

acoustic requirements; however, the NRC should be checked with the relevant supplier before purchase to ensure it is at least 0.7. It is essential for sound insulation that plasterboard walls and ceilings are well sealed. For example, the joint between the wall and the ceiling can be sealed with a resilient layer such as mastic and then covered with a plasterboard cornice; or it can be sealed with tape and cornice cement.

5.5.3 Minimum Glazing Thicknesses and R_w Ratings

Detailed designs for the proposed dwellings have not yet been finalised, hence assumptions have been made for typical glazing sizes, types and locations for the residences. To meet the internal design goals and based on assumptions of typical constructions, the glazing for habitable rooms will require the glass thicknesses as produced in Table 4 below. Once specific architectural plans have been produced, a final specification for window thicknesses will need to be provided as this is dependent upon room sizes, room orientations, room uses and window areas.

TABLE 4 – MINIMUM GLAZING THICKNESSES AND R_W RATINGS

Room	Assumed Size/Type of Glazing (H x W) (mm)	Recommended Minimum Type and Thickness of Glazing	Minimum Required R_w or STC Rating (dB)
Typical Double Storey Dwelling			
Lounge / Family / Dining Room	2100 x 2700 Sliding Door	5 mm toughened sliding door with standard seals	23
	2 x 1000 x 1500 Awning Windows	4 mm float awning windows with standard seals	23
Bedroom 1	2100 x 1800 Awning Window	6.38 mm laminated awning window with acoustic seals	32
Bedrooms 2, 3 and 4	1800 x 1200 Awning Window	6.38 mm laminated awning window with acoustic seals	32
Typical Single Storey Dwelling			
Lounge / Family / Dining Room	2100 x 2700 Sliding Door	5 mm toughened sliding door with standard seals	22
	2 x 1000 x 1500 Awning Windows	4 mm float awning windows with standard seals	22
Bedroom 1	2100 x 1800 Awning Window	6.38 mm laminated awning window with acoustic seals	32
Bedrooms 2, 3 and 4	1800 x 1200 Awning Windows	6.38 mm laminated awning window with acoustic seals	32

Table 4 Notes:

- *All glazing, given in Table 4 above must be constructed in solid timber (or aluminium) frames and well-sealed when closed;*
- *R_w = Weighted Sound Reduction Index, covers a frequency range from 100 Hz to 3.15 kHz;*
- *STC = Sound Transmission Class, is similar to R_w but covers a frequency range from 120 Hz to 4 kHz;*
- *Alternative types of glazing are acceptable provided the R_w values as given in the tables above are met;*
- *Glazing systems recommended are minimum requirements for acoustic purposes. In some cases, thicker glass may be preferred or required for safety or other reasons.*

5.5.4 Entry Doors

All external entry doors should be at least 35 mm thick and of solid-core construction. Acoustic door seals are optional.

5.6 External Constructions for Residences at Distances of 10 Metres from the North-South Roadway.

5.6.1 External Wall Construction

The external walls must achieve a minimum R_w of 49 dB, which is standard for: -

- Brick veneer consisting of 110 mm thick exterior face brick, with 90 mm deep timber stud or 92 mm metal stud, at least 40 mm clearance between the masonry and stud frame and 10 mm thick plasterboard internal wall construction; or

- Double brick of 110 mm brickwork separated by at least a 40 mm gap; or

- Timber frame or cladding construction consisting of one layer of 6 mm compressed fibre cement sheeting **plus** weatherboards or plank cladding externally, 90mm deep timber stud or 92mm metal stud, one layer of 13 mm thick sound rated plasterboard internally (e.g., *Soundcheck™)* with R2 insulation laid within wall cavity.

5.6.2 Roof / Ceiling Construction

The roof/ceiling must achieve a minimum R_w of 45 dB, which is standard for a concrete/terracotta tiled roof or a metal roof (e.g., *'Colorbond™'*), with sarking, above one layer of 13 mm thick sound rated plasterboard ceiling (e.g., *'Soundcheck™'*) fixed to the ceiling joists with acoustic absorption to be laid in the roof cavity. The acoustic absorption material should be at least 50 mm thick with a Noise Reduction Coefficient (NRC) of at least 0.7. Thermal rating of R2 would be suitable to meet the acoustic requirements; however, the NRC should

be checked with the relevant supplier before purchase to ensure it is at least 0.7. It is essential for sound insulation that plasterboard walls and ceilings are well sealed. For example, the joint between the wall and the ceiling can be sealed with a resilient layer such as mastic and then covered with a plasterboard cornice; or it can be sealed with tape and cornice cement.

5.6.3 Minimum Glazing Thicknesses and R_w Ratings

Detailed designs for the proposed dwellings have not yet been finalised, hence assumptions have been made for typical glazing sizes, types and locations for the residences. To meet the internal design goals and based on assumptions of typical constructions, the glazing for habitable rooms will require the glass thicknesses as produced in Table 5 below. Once specific architectural plans have been produced, a final specification for window thicknesses will need to be provided as this is dependent upon room sizes, room orientations, room uses and window areas.

TABLE 5 – MINIMUM GLAZING THICKNESSES AND R_W RATINGS

Room	Assumed Size/Type of Glazing (H x W) (mm)	Recommended Minimum Type and Thickness of Glazing	Minimum Required R_w or STC Rating (dB)
Typical Double Storey Dwelling			
Lounge / Family / Dining Room	2100 x 2700 Sliding Door	8.38 mm laminated sliding door with acoustic seals	33
	2 x 1000 x 1500 Awning Windows	8.38 mm laminated awning windows with acoustic seals	34
Bedroom 1	2100 x 1800 Awning Window	10.38 mm laminated awning window with acoustic seals	35
Bedrooms 2, 3 and 4	1800 x 1200 Awning Window	10.38 mm laminated awning window with acoustic seals	35
Typical Single Storey Dwelling			
Lounge / Family / Dining Room	2100 x 2700 Sliding Door	8.38 mm laminated sliding door with acoustic seals	33
	2 x 1000 x 1500 Awning Windows	8.38 mm laminated awning windows with acoustic seals	34
Bedroom 1	2100 x 1800 Awning Window	10.38 mm laminated awning window with acoustic seals	35
Bedrooms 2, 3 and 4	1800 x 1200 Awning Windows	10.38 mm laminated awning window with acoustic seals	35

Table 5 Notes:

- *All glazing, given in Table 5 above must be constructed in solid timber (or aluminium) frames and well-sealed when closed;*
- *R_w = Weighted Sound Reduction Index, covers a frequency range from 100 Hz to 3.15 kHz;*
- *STC = Sound Transmission Class, is similar to R_w but covers a frequency range from 120 Hz to 4 kHz;*
- *Alternative types of glazing are acceptable provided the R_w values as given in the tables above are met;*
- *Glazing systems recommended are minimum requirements for acoustic purposes. In some cases, thicker glass may be preferred or required for safety or other reasons.*

5.6.4 Entry Doors

All external entry doors (including doors from garages to habitable rooms) should be at least 35 mm thick and of solid-core construction. The doors should also be fitted with acoustic seals (e.g., *'Lorient™'* IS7025 and IS8011si or *'Raven™' RP47* frame and *RP38* bottom seals) to give a certified R_w rating of at least 30 dB.

5.7 External Constructions for Residences at Distances of 50 Metres from the North-South Roadway.

5.7.1 External Wall Construction

The external walls must achieve a minimum R_w of 43 dB, which is standard for: -

- Brick veneer consisting of 110 mm thick exterior face brick, with 90 mm deep timber stud or 92 mm metal stud, at least 40 mm clearance between the masonry and stud frame, R2 Insulation batts in the wall cavity and 10 mm thick plasterboard internal wall constructions; or
- Double brick of 2 leaves of 110 mm brickwork separated by at least a 40 mm gap; or
- Timber frame or cladding construction consisting of 6 mm fibre cement sheeting or weatherboards or plank cladding or metal cladding externally, 90 mm deep timber stud or 92 mm metal stud, 13 mm thick standard plasterboard lined internally with R2 insulation in wall cavity.

5.7.2 Roof / Ceiling Construction

The roof/ceiling must achieve a minimum R_w of 41 dB, which is standard for a concrete/terracotta tiled roof or a metal roof (e.g., *'Colorbond™'*), with sarking, above a single layer of 10 mm thick plasterboard ceiling fixed to the ceiling joists with acoustic absorption to be laid in the roof cavity. The acoustic absorption material should be at least 50 mm thick with a Noise Reduction Coefficient

(NRC) of at least 0.7. Thermal rating of R2 would be suitable to meet the acoustic requirements; however, the NRC should be checked with the relevant supplier before purchase to ensure it is at least 0.7. It is essential for sound insulation that plasterboard walls and ceilings are well sealed. For example, the joint between the wall and the ceiling can be sealed with a resilient layer such as mastic and then covered with a plasterboard cornice; or it can be sealed with tape and cornice cement.

5.7.3 Minimum Glazing Thicknesses and R_w Ratings

Detailed designs for the proposed dwellings have not yet been finalised, hence assumptions have been made for typical glazing sizes, types and locations for the residences. To meet the internal design goals and based on assumptions of typical constructions, the glazing for habitable rooms will require the glass thicknesses as produced in Table 6 below. Once specific architectural plans have been produced, a final specification for window thicknesses will need to be provided as this is dependent upon room sizes, room orientations, room uses and window areas.

TABLE 6 – MINIMUM GLAZING THICKNESSES AND R_W RATINGS

Room	Assumed Size/Type of Glazing (H x W) (mm)	Recommended Minimum Type and Thickness of Glazing	Minimum Required R_w or STC Rating (dB)
Typical Double Storey Dwelling			
Lounge / Family / Dining Room	2100 x 2700 Sliding Door	5 mm toughened sliding door with acoustic seals	25
	2 x 1000 x 1500 Awning Windows	5 mm float awning windows with standard seals	25
Bedroom 1	2100 x 1800 Awning Window	6.38 mm laminated awning window with acoustic seals	32
Bedrooms 2, 3 and 4	1800 x 1200 Awning Window	6.38 mm laminated awning window with acoustic seals	32
Typical Single Storey Dwelling			
Lounge / Family / Dining Room	2100 x 2700 Sliding Door	5 mm toughened sliding door with acoustic seals	25
	2 x 1000 x 1500 Awning Windows	5 mm float awning windows with standard seals	25
Bedroom 1	2100 x 1800 Awning Window	6.38 mm laminated awning window with acoustic seals	32
Bedrooms 2, 3 and 4	1800 x 1200 Awning Windows	6.38 mm laminated awning window with acoustic seals	32

Table 6 Notes:

- *All glazing, given in Table 6 above must be constructed in solid timber (or aluminium) frames and well-sealed when closed;*
- *R_w = Weighted Sound Reduction Index, covers a frequency range from 100 Hz to 3.15 kHz;*
- *STC = Sound Transmission Class, is similar to R_w but covers a frequency range from 120 Hz to 4 kHz;*
- *Alternative types of glazing are acceptable provided the R_w values as given in the tables above are met;*
- *Glazing systems recommended are minimum requirements for acoustic purposes. In some cases, thicker glass may be preferred or required for safety or other reasons.*

5.7.4 Entry Doors

All external entry doors should be at least 35 mm thick and of solid-core construction. Acoustic door seals are optional.

5.8 External Constructions for Residences at Distances of 100 Metres from the North-South Roadway.

5.8.1 External Wall Construction

The external walls must achieve a minimum R_w of 38 dB, which is standard for: -

- Brick veneer consisting of 110 mm thick exterior face brick, with 90 mm deep timber stud or 92 mm metal stud, at least 40 mm clearance between the masonry and stud frame, R2 Insulation batts in the wall cavity and 10 mm thick plasterboard internal wall constructions; or

- Double brick of 2 leaves of 110 mm brickwork separated by at least a 40 mm gap; or

- Timber frame or cladding construction consisting of 6 mm fibre cement sheeting or weatherboards or plank cladding or metal cladding externally, 90 mm deep timber stud or 92 mm metal stud, 13 mm thick standard plasterboard lined internally with R2 insulation in wall cavity.

5.8.2 Roof / Ceiling Construction

The roof/ceiling must achieve a minimum R_w of 40 dB, which is standard for a concrete/terracotta tiled roof or a metal roof (e.g., *'Colorbond™'*), with sarking, above a single layer of 10 mm thick plasterboard ceiling fixed to the ceiling joists with acoustic absorption to be laid in the roof cavity. The acoustic absorption material should be at least 50 mm thick with a Noise Reduction Coefficient (NRC) of at least 0.7. Thermal rating of R2 would be suitable to meet the

acoustic requirements; however, the NRC should be checked with the relevant supplier before purchase to ensure it is at least 0.7. It is essential for sound insulation that plasterboard walls and ceilings are well sealed. For example, the joint between the wall and the ceiling can be sealed with a resilient layer such as mastic and then covered with a plasterboard cornice; or it can be sealed with tape and cornice cement.

5.8.3 Minimum Glazing Thicknesses and R_w Ratings

Detailed designs for the proposed dwellings have not yet been finalised, hence assumptions have been made for typical glazing sizes, types and locations for the residences. To meet the internal design goals and based on assumptions of typical constructions, the glazing for habitable rooms will require the glass thicknesses as produced in Table 7 below. Once specific architectural plans have been produced, a final specification for window thicknesses will need to be provided as this is dependent upon room sizes, room orientations, room uses and window areas.

TABLE 7 – MINIMUM GLAZING THICKNESSES AND R_W RATINGS

Room	Assumed Size/Type of Glazing (H x W) (mm)	Recommended Minimum Type and Thickness of Glazing	Minimum Required R_w or STC Rating (dB)
Typical Double Storey Dwelling			
Lounge / Family / Dining Room	2100 x 2700 Sliding Door	5 mm toughened sliding door with standard seals	21
	2 x 1000 x 1500 Awning Windows	4 mm float awning windows with standard seals	21
Bedroom 1	2100 x 1800 Awning Window	6.38 mm laminated awning window with acoustic seals	32
Bedrooms 2, 3 and 4	1800 x 1200 Awning Window	6.38 mm laminated awning window with acoustic seals	32
Typical Single Storey Dwelling			
Lounge / Family / Dining Room	2100 x 2700 Sliding Door	5 mm toughened sliding door with standard seals	20
	2 x 1000 x 1500 Awning Windows	4 mm float awning windows with standard seals	20
Bedroom 1	2100 x 1800 Awning Window	6.38 mm laminated awning window with acoustic seals	32
Bedrooms 2, 3 and 4	1800 x 1200 Awning Windows	6.38 mm laminated awning window with acoustic seals	32

Table 7 Notes:

- *All glazing, given in Table 7 above must be constructed in solid timber (or aluminium) frames and well-sealed when closed;*
- *R_w = Weighted Sound Reduction Index, covers a frequency range from 100 Hz to 3.15 kHz;*
- *STC = Sound Transmission Class, is similar to R_w but covers a frequency range from 120 Hz to 4 kHz;*
- *Alternative types of glazing are acceptable provided the R_w values as given in the tables above are met;*
- *Glazing systems recommended are minimum requirements for acoustic purposes. In some cases, thicker glass may be preferred or required for safety or other reasons.*

5.8.4 Entry Doors

All external entry doors should be at least 35 mm thick and of solid-core construction. Acoustic door seals are optional.

5.9 Glazing Manufacturers

Glazing manufacturers, as listed in Appendix A below, have provided attenuation data for their glazed windows and doors and will be able to meet the requirements as outlined in this report. Should other suppliers be used, laboratory test data to support the glazed system ratings must be provided.

5.10 Ventilation

An acoustically insulated building must be kept virtually air tight to exclude external noise. Therefore, any windows of the residences requiring laminated glazing must be kept closed to achieve the required R_w ratings. Hence there is a requirement for mechanical ventilation or air-conditioning to provide fresh air to control odours. Specific ventilation requirements are outside of our scope of expertise, however requirements for indoor-air quality are given in Australian Standard AS 1668.2 - 2012, *"The use of ventilation and air-conditioning in buildings - Ventilation design for indoor air contaminant control".* Internal noise levels from mechanical ventilation or air-conditioning should not exceed 35 dBA for bedroom areas and 40 dBA for all other habitable areas. External noise levels from mechanical ventilation or air-conditioning should not exceed 5 dB over the lowest existing background noise level (L_{A90}) when in day time use and when measured at the neighbouring boundary. Night time noise levels must meet the requirements of the Protection of the Environment Operations (Noise Control) Regulation 2017.

6. SUMMARY AND CONCLUSIONS

An acoustic investigation assessing future projected potential noise and vibration impacts for the year 2036 resulting from the road traffic movements using the two significant proposed roadways (being the ultimate north-south roadway and the ultimate east-west roadway) within the proposed rezoned development site at Orchard Hills North, NSW 2748 has been carried out. The future predicted noise levels to the year 2036 have been used to predict internal noise levels for potential residential developments along and surrounding the subject roadways.

These predictions have been assessed in accordance with criteria given in the NSW Road Noise Policy (2011), the NSW Government Department of Planning Development Near Rail Corridors and Busy Roads – Interim Guideline (December 2008), the State Environmental Planning Policy (Transport and Infrastructure) 2021, Clause 2.120 – *'Impact of road noise or vibration on non-road development'* and the Australian Standard AS 2107 – 2016, *'Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors'*.

It is concluded that no noise or vibration exceedances are predicted from road traffic using the proposed subject roadways, provided the recommendations given in section 5 above are adhered to.

Status	**Date**	**Prepared by:**	**Position**
Draft	8th October 2022	Anthony Nachar B.Eng. MAAS	Acoustician
Status	**Date**	**Checked by:**	**Position**
Draft	10th October 2022	Ken Scannell MSc MAAS	Acoustician
Status	**Date**	**Issued by:**	**Position**
Final	17th October 2022	Ken Scannell MSc MAAS	Acoustician
Status	**Date**	**Issued by:**	**Position**
Final Rev. A	18th October 2022	Anthony Nachar B.Eng. MAAS	Acoustician

Important Note. *All products and materials suggested by 'Noise and Sound Services' are selected for their acoustical properties only. All other properties such as airflow, aesthetics, chemical, corrosion, combustion, construction details, decomposition, expansion, fire rating, grout or tile cracking, loading, shrinkage, ventilation, etc are outside of 'Noise and Sound Services' field of expertise and* ***must be*** *checked with the supplier or suitably qualified specialist before purchase.*

APPENDIX A - MATERIAL SUPPLIERS

Acoustic Glazing Suppliers:

'Southern Star Windows', telephone: 1300 733 599
https://www.windowsanddoors.build/contactus
'Trend Windows & Doors Pty Ltd', telephone: (02) 9840 2000.
www.trendwindows.com.au
'Wideline Pty Ltd', telephone: (02) 8304 6400.
www.wideline.com.au
'Vantage Windows', telephone: 1300 026 189
http://www.awsaustralia.com.au
'Christoffel Pty Ltd', telephone: (02) 9627 4811
www.christoffel.com.au/contact.htm
'Sound Barrier Systems Pty Ltd', telephone: (02) 9540 4333
www.soundbarrier.com.au
'Velux Australia', telephone: 1300 859 856
www.velux.com.au

Acoustic Door Seals Suppliers:

'*Kilargo*', telephone: 1300 858 010
www.kilargo.com.au
'Raven', telephone: 1800 888 123
www.raven.com.au

Internal Wall-Mounted Air Ventilators Suppliers:

Active:
'Acoustica', telephone: 1300 722 825
www.acoustica.com.au
'Sonair', telephone: 1300 858 674
www.edmonds.com.au

Passive:
'Silenceair®', telephone: (02) 9555 7215
www.silenceair.com

APPENDIX B – ACOUSTIC BARRIERS

Typically, acoustic barrier fences may be constructed of timber, *'Colorbond™',* aerated concrete, glass, polycarbonate sheets or a combination of one or more of the following materials as shown in Table A below.

TABLE A – RECOMMENDED MATERIALS FOR CONSTRUCTION OF ACOUSTIC BARRIERS

Material	Typical Thickness (mm)	Surface Density (kg/m^2)	Sound Transmission Loss - R_w (dB)
Polycarbonate or Acrylic	12	15	33
	20	24	35
Timber	15	7.3	24
	30	16	28
Aerated Concrete blocks	100	65	38
Toughened Glass	6	15	30

Note: Rw values are based on the material density. Actual performance is related to the quality of installation.

The range of thickness for polycarbonate/acrylic and timber reflects the level of noise reduction required. The required thickness is related to the level of noise to be ameliorated and the height of the acoustic barrier/fence.

Timber fences should be constructed of not less than 15 mm thick lapped and capped timber provided such thickness can be maintained to prevent warping. For all constructions, the fence must not contain any acoustically untreated holes or gaps. The overlap of timber panels must be sufficient to prevent line of sight particularly after a period of time when timber panels become weathered. The overlap should be a minimum of 15 mm. The fence must be professionally constructed using a safe and secure method to ensure total stability in all predictable wind and weather conditions.