Acoustics
Vibration
Structural Dynamics

WILTON PARK ROAD AND BERWICK PARK ROAD, WILTON

Planning Proposal Noise & Vibration Impact Assessment

17 May 2023

Altis Property Partners Holdings Pty Ltd

TM751-01F04 Wilton & Berwick Roads Wilton NVIA (r1).docx

40 YEARS 1982 - 2022 ACOUSTIC ENGINEERING EXCELLENCE

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1 Introduction

1.1 Overview and purpose of report

Renzo Tonin & Associates (RTA) has been engaged by Altis Property Partners Holdings Pty Ltd (Altis) on behalf of Altis ARET Sub Trust 26 to undertake a construction and operation noise and vibration impact assessment (NVIA) to support the Planning Proposal for rezoning the land directly to the south of Wilton Park Road and Berwick Park Road, Wilton, for a proposed warehouse/distribution centre masterplan (the Proposal).

This report reviews noise and vibration impacts during the construction and operational stages of the Proposal. It also provides mitigation and management recommendations to reduce impacts during the construction and operation phases of the Proposal.

The noise and vibration assessment has been carried out in accordance with the policies, guidelines and standards presented in Section 3 of this report addressing construction noise and vibration and operational noise, respectively.

1.2 Proposal overview

1.2.1 Location

The Proposal, shown in Figure 1, is situated within the Wilton Growth Area in Southwest Sydney, that falls within the Wollondilly Shire Council Local Government Area (LGA). The land is strategically located on the junction of the Hume Motorway and Picton Road leading to Port Kembla. The Proposal location is currently zoned *RU2 Rural Landscape* and is proposed to be zoned *E4 General Industrial*.

Figure 1: Proposal location

1.2.2 Proposal description

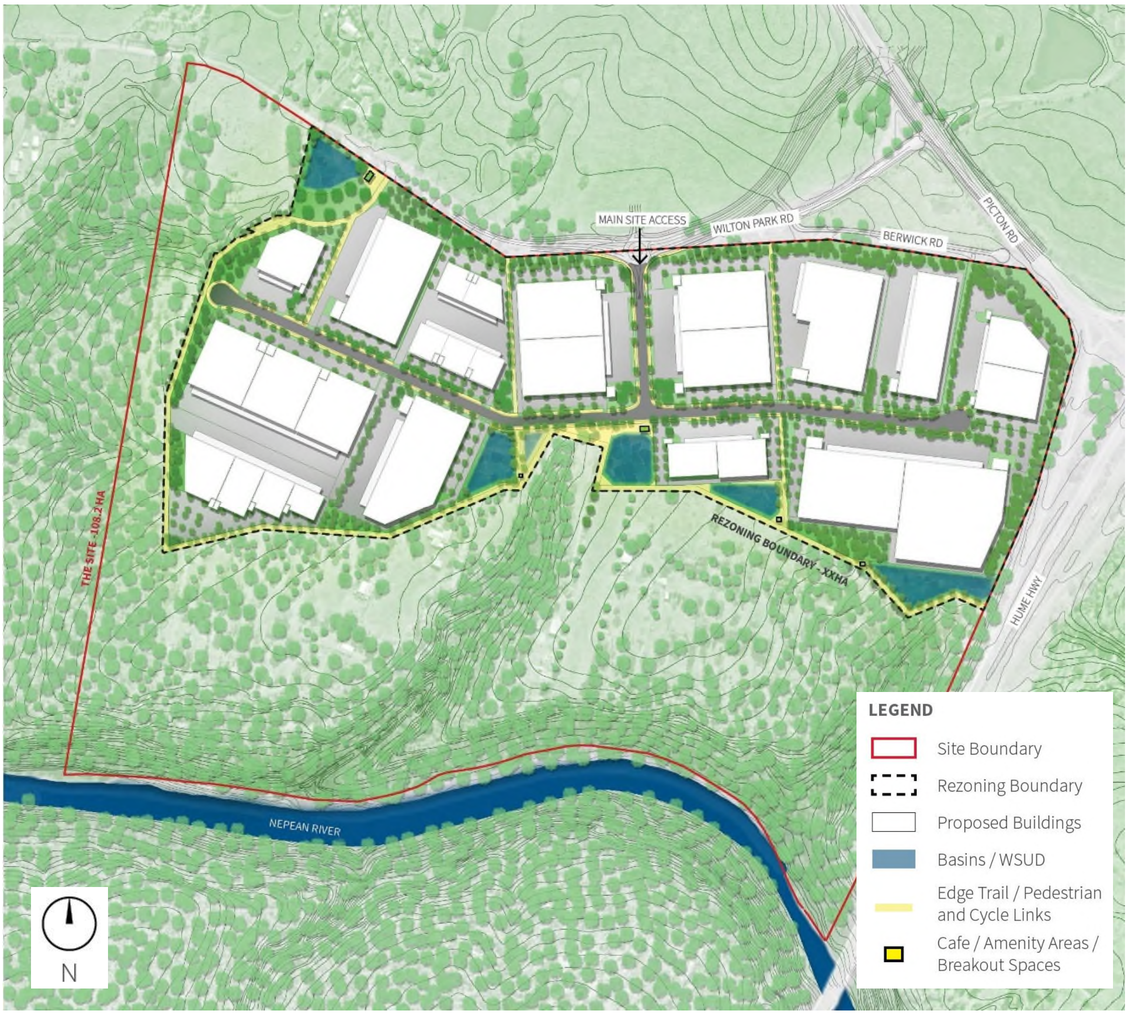
The subject site is currently zoned *RU2 - Rural Landscape* but have been earmarked in both local (Wollondilly Shire Council) and State [NSW Department of Planning and Environment (DPE)] documents for future employment land use. Altis is seeking to rezone the subject site to an employment land use (*E4 General Industrial* type zoning).

The subject site consists of the following properties:

- 10 Berwick Park Road, 20 Berwick Park Road, 30 Berwick Park Road, 25 Wilton Park Road, 45 Wilton Park Road, 55 Wilton Park Road, 75 Wilton Park Road, 85 Wilton Park Road and 95 Wilton Park Road

The subject site is approximately 110 ha in area and is bound by Hume Motorway to the east, Berwick Park Road, and Wilton Park Road in the north and Nepean River to the south. The Proposal is for the construction and operation of an industrial estate, consisting of various small to large warehouses. This will result in circa 45 ha of urban capable land and 220,000m^2 in potential gross area under roof. The layout of the Proposal is shown in Figure 2.

Figure 2: Proposal layout



1.2.2.1 Operations

At this stage, the final nature of the proposed warehouse operations are not known and the potential tenants have not been determined. As such, the requirement for different types of vehicles, the times of operation and nature of operations are subject to the type of final tenants.

Typically, however across the Proposal, the following types of tenants are expected:

- The larger warehouses are likely to be tenanted by logistics and distribution tenants.
- The smaller warehouses, tenanted by small manufacturers, trade offices/workshops (i.e. mechanics, plumbers, electricians, carpenters), or small retailer factories.

The Proposal hours of operation are to be 24 hours, 7 days per week.

Currently, the project is proposed to commence construction in 2025, becoming operational during 2026 to 2030.

1.2.2.2 Construction works

The following construction works will be required to construct, fit out and operate the Proposal:

- Land preparation – clearing, bulk earthworks, retaining walls, drainage
- Utility works – water, comms, power, sewer
- Roadworks – pavements, kerb/gutter, footpaths
- Industrial buildings – footings, foundation slab, structural steel, cladding, fit outs across the warehouses

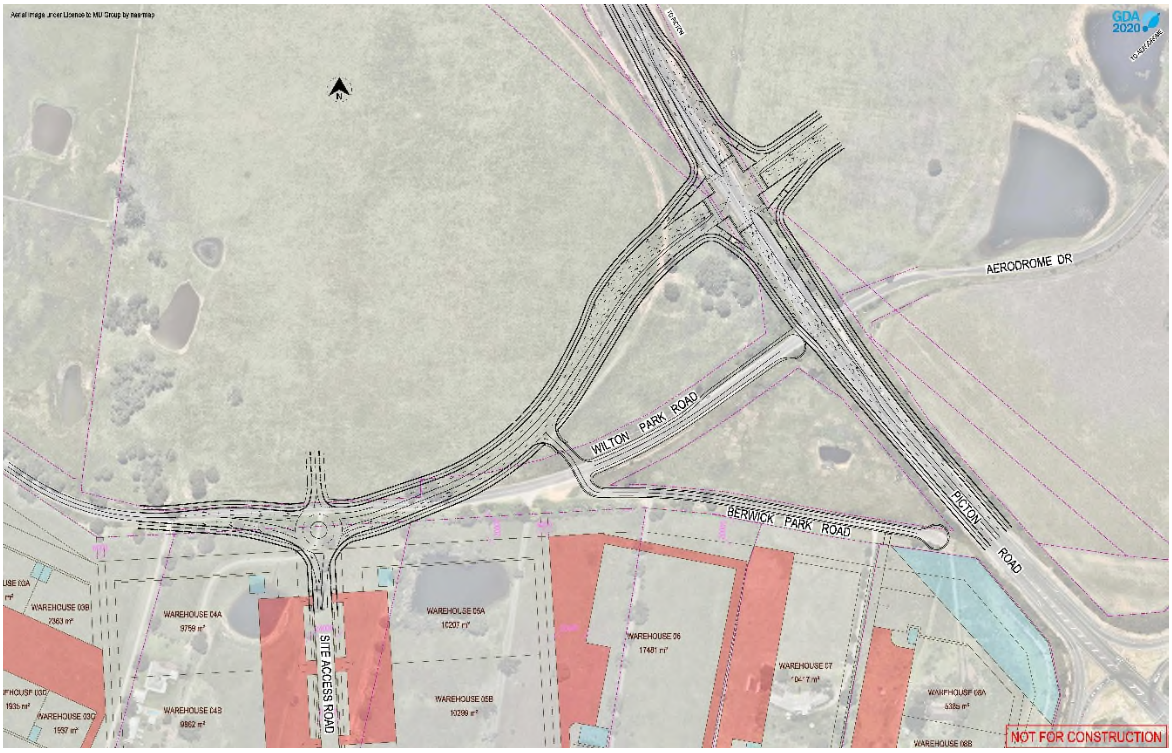
1.2.3 Access

Access to the Proposal site is to be via the arterial roads of the Hume Motorway and/or Picton Road and along Wilton Park Road. As part of the Picton Road upgrade and the development of the Wilton Town Centre (WTC), it is proposed to realign Wilton Park Road and the intersection with Picton Road (see Figure 5), with an interim configuration prior to that (see Figure 3). Wilton Park Road is currently a local road, but it is designated as a sub-arterial road according to the approved WTC structure plan and is also under consideration as a route option for the Picton Bypass route. For the interim stage, Proposal vehicles will travel along the existing Wilton Park Road alignment and will transfer to the new alignment once constructed.

Vehicles operating to and from the Proposal will then turn off Wilton Park Road via a proposed new roundabout onto the public roads within the Proposal industrial estate, prior to entering the industrial warehouse lots. Each warehouse lot has a driveway off the estate public roads, some of which are shared entry/exit points and other have dedicated entry and exit points. Typically, heavy vehicles access and carpark access are via separate locations. A map of the Proposal traffic routes is shown in Section 5.1.

Figure 3: Indicative interim Wilton Park Road (intersection design) configuration

Figure 4: Indicative ultimate Wilton Park Road configuration



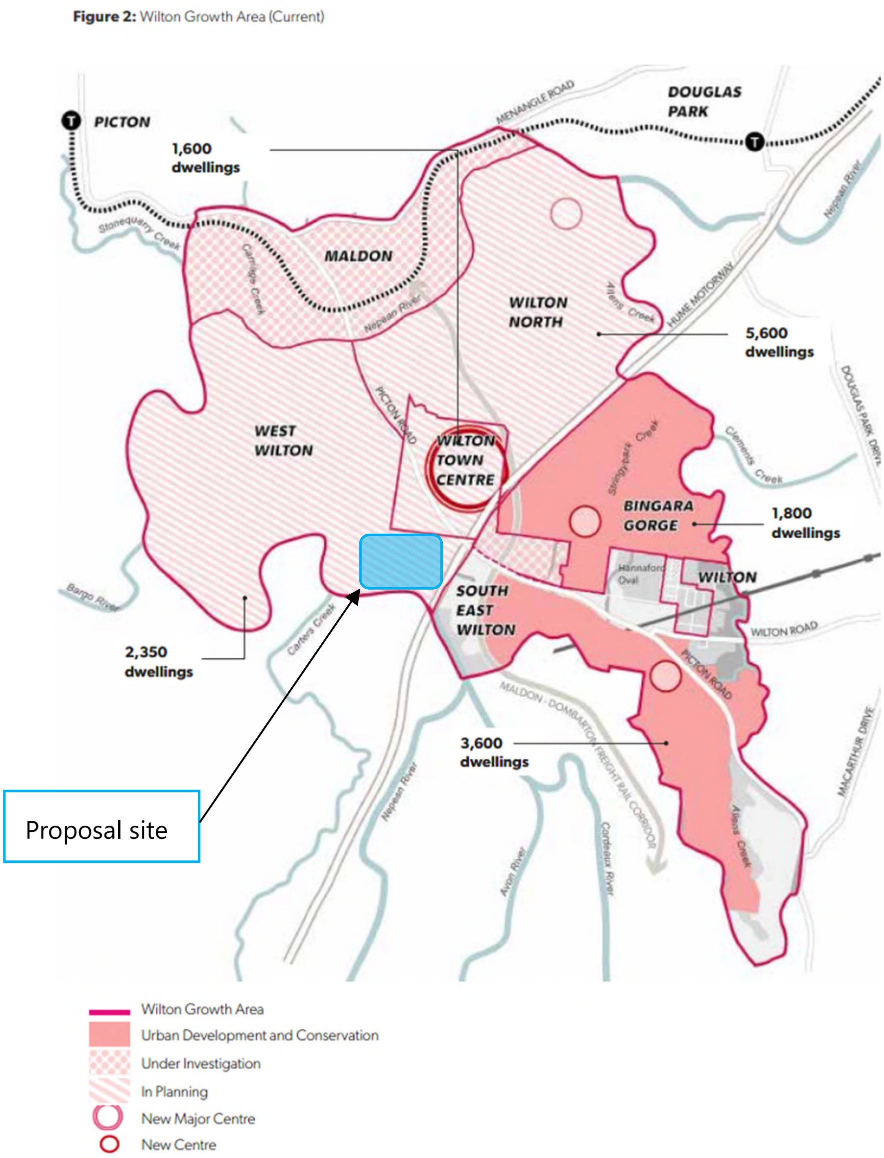
1.3 Context

1.3.1 Wilton 2040

The Greater Sydney Region Plan (the Plan) provides high level strategic guidance for the development of Greater Sydney to 2056. The Region Plan identifies Wilton as a Growth Area within the Western Parkland City. Wilton 2040, was a document setting out the strategic direction for Wilton Growth Area to achieve the Plan's vision, objectives and its implementation over the next 20 years as the area grows. Development will need to be consistent with this plan.

The Wilton Growth Area will be a mix of residential, commercial and industrial uses, with a major town centre precinct. The Wilton Growth Area consists of five precincts. These areas with their status as presented in the Wilton 2040 (DPIE, 2018) are shown in Figure 5.

Figure 5: Wilton growth areas precincts (Wilton 2040, Figure 2)



The Wilton 2040 plan outlines that these changes are expected to take place in the short term, consistent with the changes taking place in a similar timeframe to the Proposal, as shown by the timeframe in Figure 6 from Wilton 2040.

Figure 6: Wilton growth area expected timeline (Wilton 2040, Table 1)

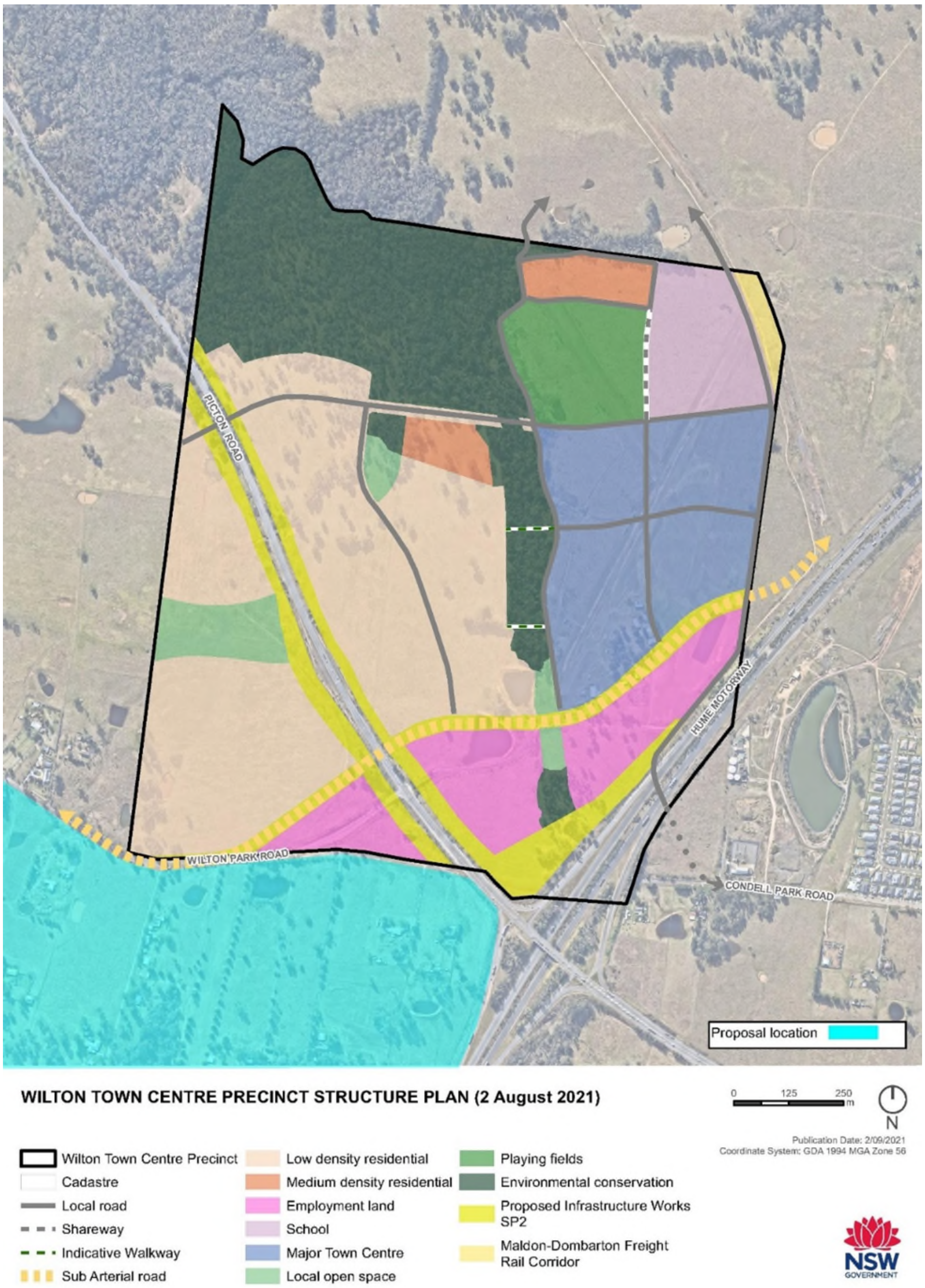
Table 1: Potential new homes by Precinct

Precinct	Potential new homes	Expected Staging
Bingara Gorge	1,800	Under construction
South East Wilton	3,600	First homes from mid-2020
Wilton Town Centre	1,600	First homes from mid-2020
North Wilton	5,600	First homes from mid-2020
West Wilton	2,350	First homes from 2025
Wilton Rural Residential	50	First homes from 2025

1.3.2 Wilton Town Centre Precinct

The Proposal is located directly south of the Wilton Town Centre (WTC) precinct. The WTC was rezoned, with the zoning commencing 30 September 2022. This is presented in Figure 7, with the location of the Proposal overlayed.

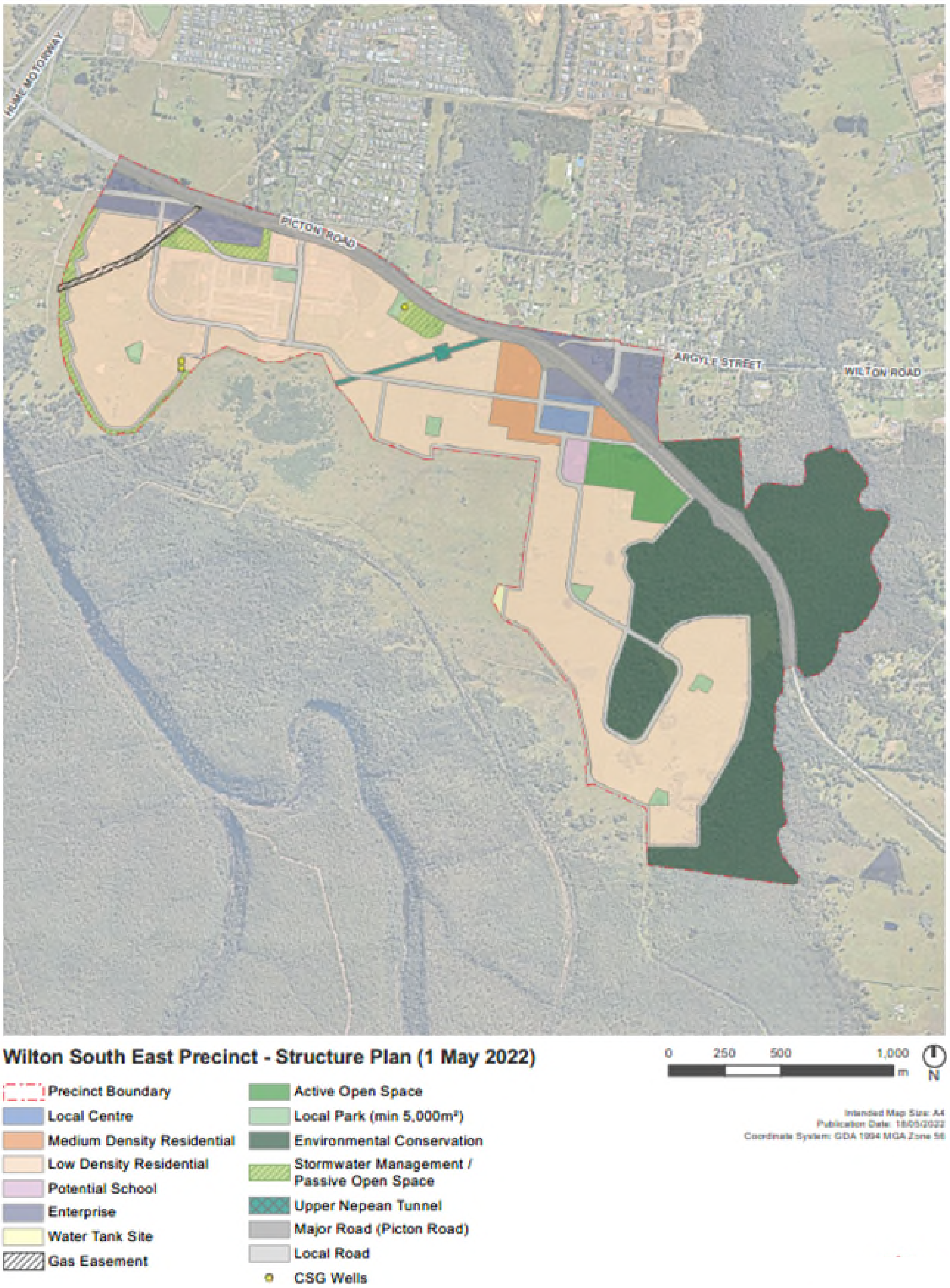
Figure 7: Wilton Town Centre (WTC) precinct structure plan (Final, August 2021) with proposal



1.3.3 Wilton South East Precinct (WSEP)

Across the Hume Motorway is the Wilton South East Precinct (WSEP) rezoned area. The WSEP rezoning package was finalised in 2017 under the State Environmental Planning Policy (Sydney Region Growth Centres) 2006 (Growth Centres SEPP), with the final Structure Plan updated in August 2022 as a result of the approval of the Cumberland Plain Conservation Plan. This is presented in Figure 8.

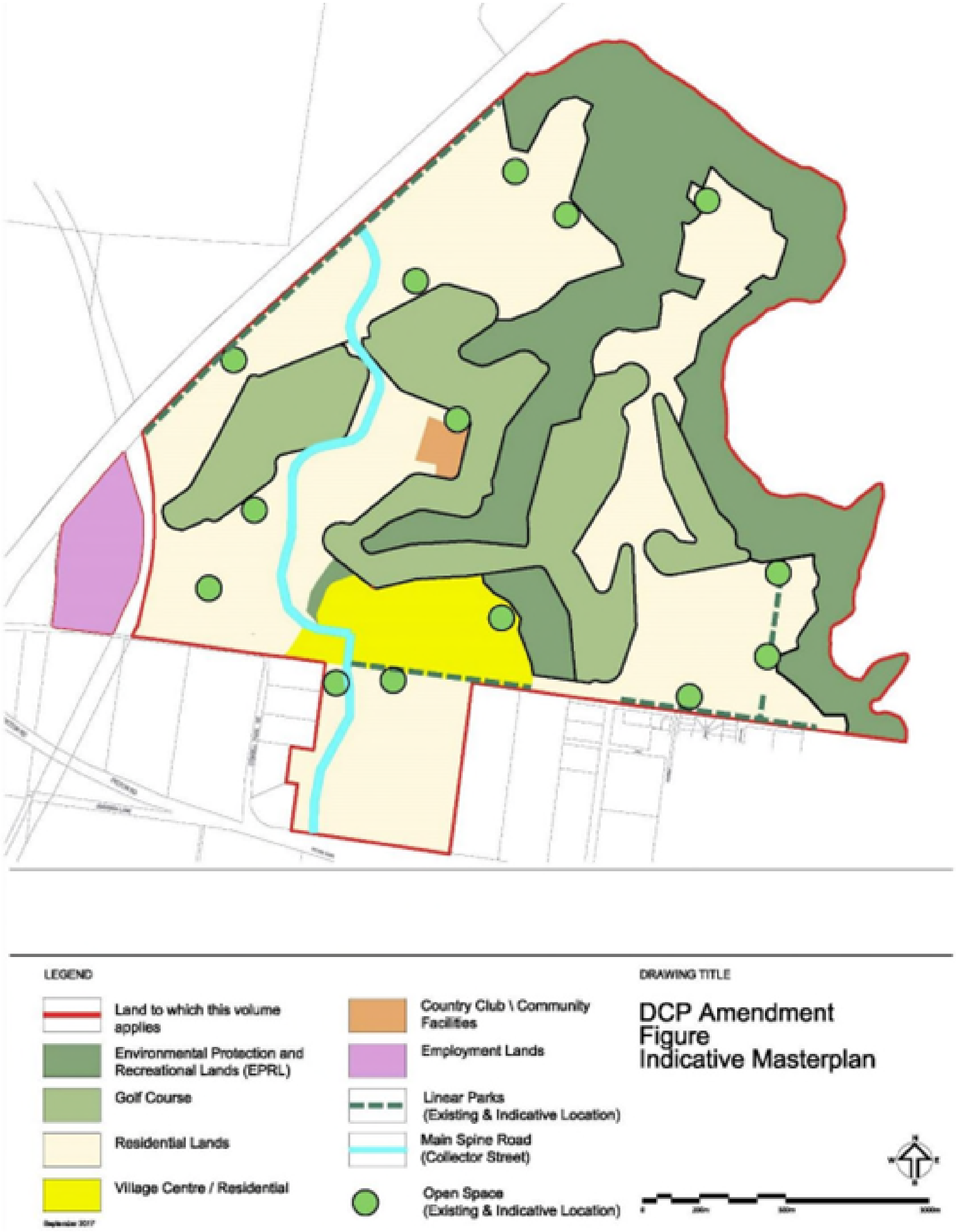
Figure 8: Wilton South East Precinct (WSEP) structure plan (Final, August 2022)



1.3.4 Wilton Park, Wilton (Bingara Gorge)

North-east from the Proposal across the Hume Motorway is the Wilton Park (Bingara Gorge) development area, which is currently under development. This is presented in Figure 9.

Figure 9: Wilton Park, Wilton (Bingara Gorge) Master Plan (Wollondilly DCP 2016, Volume 2 – Urban Release Areas)



1.3.5 Picton Road upgrade

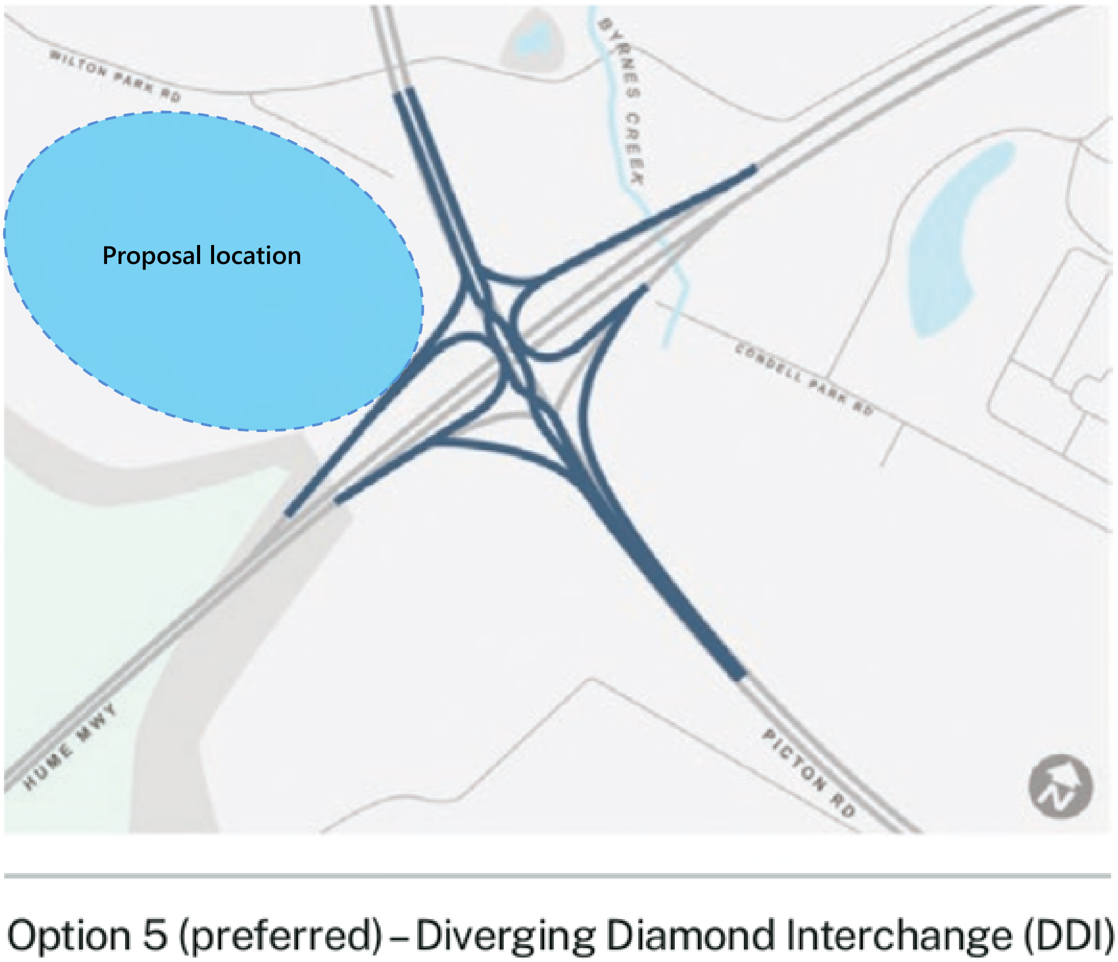
In November 2020, the NSW Government announced their plan to upgrade Picton Road between the Wilton Growth Area and the M1 Princes Motorway, including the interchange with the Hume Motorway. Picton Road is an important transport corridor linking the Illawarra Region with Sydney and the Greater Macarthur Growth area.

The latest project update (April 2022) indicates that the project is currently under strategic assessment phase, with detailed design anticipated to be released towards the end of 2023.

In October 2022, the Preferred Option Report (POR) for the *Picton Road and M31 Hume Motorway interchange* was released, which is part of the western section, and on close proximity to the Proposal site. The preferred option for the intersection upgrade was a Diverging Diamond Interchange (DDI).

The POR notes that a concept design will be created, and further environmental studies will be carried out. The Review of Environmental Factors (REF) for the project will be placed on display in 2023.

Figure 10: Picton Road and M31 Hume Motorway interchange - Preferred Option Report - Preferred option for the intersection upgrade (with proposal area indicated)



1.3.6 Picton Bypass

NSW Government has provided funding for TfNSW to investigate potential options for a future bypass of Picton town centre. A proposed bypass would provide an alternative route for heavy vehicles by linking Thirlmere and Tahmoor with the Hume Motorway via Picton Road.

As mentioned in the WGA Infrastructure Phasing Plan, upgrades for West Wilton four-lane sub-arterial road and west Wilton sub-arterial road river crossing are subject to the Picton Bypass Route. This will potentially impact the intersection of Picton Road / Wilton Park Road and modify Wilton Park Road.

Refer to the Proposal traffic assessment Planning Proposal Submission (Ason, 2022) for further information.

1.4 Assessment objectives

The assessment objectives are to determine the potential levels of noise and vibration at sensitive receivers located near the Proposal and determine the levels of mitigation that would be required to enable compliance with the current NSW and Wollondilly Shire Council requirements.

As part of preparing this assessment, the following policies, guidelines and standards have been considered:

- NSW *Noise Policy for Industry* (NPfI) (EPA 2017)
- NSW *Road Noise Policy* (RNP) (DECCW 2011)
- *Noise Criteria Guideline* (NCG) (RMS 2015)
- *Noise Mitigation Guideline* (NMG) (RMS 2015)
- NSW *Interim Construction Noise Guideline* (ICNG) (DECC 2009)
- NSW *Assessing Vibration – A Technical Guideline* (AVTG) (DEC 2006)
- NSW *Environmental Criteria for Road Traffic Noise* (ECRTN) (EPA 1999)
- NSW *Noise Guide for Local Government* (NGLG) (EPA 2023).

Reference has also been made to the relevant council documents, including the *Wilton Growth Area Development Control Plan 2021* (WGA DCP).

The Planning Proposal has also considered the Wollondilly Shire Council Development Control Plan 2016 (Wollondilly DCP). The Wollondilly DCP identifies a number of applicable requirements for noise for the site, including:

- Volume 1 – General, Part 2 – General considerations for all development, Section 2.2 "*Controls*"
- Volume 7 – Industry and Infrastructure, Section 2.11 "*Noise*"

It was determined that by assessing the potential noise impacts against the NSW EPA guidelines, as detailed in Section 3 as part of future applications, will generally also achieve the outcomes as required by the Wollondilly DCP for the proposed industrial development types.

Requirements relating to the *Wilton Growth Area Development Control Plan 2021* are detailed in Section 3.5.

1.5 Nearby noise and vibration sensitive receivers

1.5.1 Site and surrounding land use

The Proposal site is located within the Wilton Growth Area. The land surrounding the Proposal area currently comprises a predominantly rural typology, with a variety of rural dwellings, rural land, farm dams and scattered vegetation, with the Hume Motorway located along the eastern boundary of the Proposal.

North & North East: As per Section 1.3 the land directly north has been rezoned for the Wilton Town Centre, which includes low density residential directly north of the Proposal across Wilton Park Road.

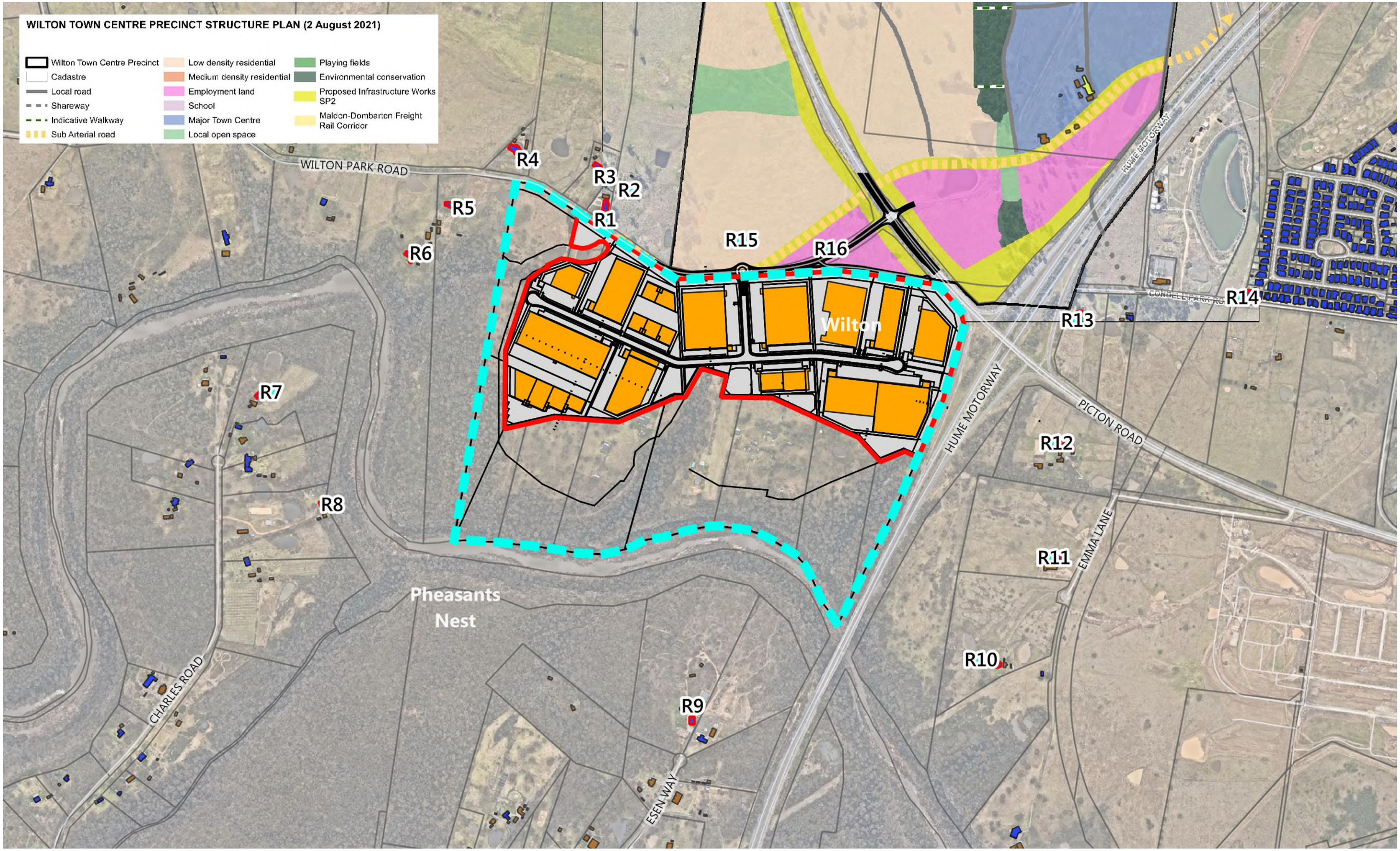
North West: North-west from the Proposal are existing residential receivers, which are located within West Wilton.

East: Located directly to the east across the Hume Motorway are a number of existing residential receivers. These receivers are located in *RU2 Rural Landscape* zoning. Located further east across the Hume Motorway are the residential land release areas of Bingara Gorge and South-East Wilton, which are currently under development.

South and west: Located south and west of the Proposal are existing residential receivers located within Pheasants Nest.

Figure 11 shows the location of the Proposal, the nearby noise sensitive receivers and the land uses (including Wilton Town Centre approved structure plan) near the Proposal.

Figure 11: Site location, nearby noise sensitive receivers and land uses (including Wilton Town Centre approved structure plan)



Legend

- Proposal boundary
- Proposal warehouse area
- Proposal warehouse buildings

Receiver type

- Residential
- Industrial
- Commercial
- Non-receiver building
- Representative recevier location

250 0 250 500 750 1000 m

NOTES:
1. Wilton Town Centre Precinct Structure Plan (2 August 2021) overlayed on areial imagery directly north of the proposal. Legend included for indiciated land use types.

Landuse classification based upon a desktop review only, subject to further review and detailed design.
Imagery source: Nearmap and Sixmaps (NSW Department Finance, Services and Innovation [16/11/2022])

1.5.2 Representative receivers

To review the potential range of noise emissions around the Proposal 16 representative and worst-affected receiver locations have been identified. These locations were selected to represent all the nearby potentially impacted receivers to them and assist in simplifying the assessment and reporting. These representative receiver locations are:

- R1 to R14 - existing residential receivers near to the Proposal.
- R15 - the future residential receivers within the WTC.
- R16 - the future employment lands directly adjacent to the north within the WTC structure plan.

Figure 11 shows the locations of the future WTC receivers, both residential and industrial, and the final Wilton Park Road design. For R15 (future WTC residences) and R16 (future WTC employment area receivers) areas, multiple locations closest to the Proposal have been assessed within the indicated areas, as the final receiver locations are not known. The locations of the representative receiver points for the operational noise assessment are presented in Table 1-1, and a map of these locations is presented in Figure 11.

Table 1-1: Representative receiver locations

Rec No.	Address / location	Receiver type	Approximate distance to the Proposal, metres
R1	90 Wilton Park Road	Residential	30
R2	80 Wilton Park Road	Residential	130
R3	100 Wilton Park Road	Residential	130
R4	120 Wilton Park Road	Residential	210
R5	125 Wilton Park Road	Residential	280
R6	135 Wilton Park Road	Residential	320
R7	220 Charles Road, Pheasants Nest	Residential	660
R8	200 Charles Road, Pheasants Nest	Residential	540
R9	55 Esen Place, Pheasants Nest	Industrial	830
R10	20 Emma Lane, Wilton	Residential	600
R11	10 Emma Lane, Wilton	Residential	480
R12	50 Janderra Lane, Wilton	Residential	350
R13	165 Condell Park Road, Wilton	Residential	320
R14	118 Condell Park Rd, Wilton	Residential	810
R15	Future WTC residences[1]	Residential	Adjacent north across Wilton Park Road
R16	Future WTC employment area receivers	Industrial	Adjacent north across Berwick Park Road & Wilton Park Road

Notes: 1. Future residential receivers assumed to be set back a minimum 20 metres from Wilton Park Road, consistent with the general setback guidance in the Wilton Growth Area Development Control Plan (2021).

1.6 Acoustic terms & quality

This report is technical in nature and uses acoustic terminology throughout. A summary and explanation of the common acoustic terms that have been used in this report is presented in APPENDIX A Section A.1. Some of the key acoustic concepts used in this report are outlined in APPENDIX A Section A.3.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

2 Existing noise environment

Criteria for the assessment of operational and construction noise are usually derived from the existing noise environment of an area, excluding noise from the subject development.

As the noise environment of an area almost always varies over time, background and ambient noise levels need to be determined for the operational times of the proposed development. Background noise varies over the course of any 24-hour period, typically from a minimum at 3:00am in the morning to a maximum during morning and afternoon traffic peak hours. Therefore, the NSW Environment Protection Authority (EPA) *Noise Policy for Industry* (NPfI) (EPA 2017) requires that the level of background and ambient noise be assessed separately for the daytime, evening and night-time periods. Fact Sheet B of the NPfI outlines the methods for determining the background noise level of an area.

The time periods established for the assessment in accordance with the NPfI are as follows:

- **Day** is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
- **Evening** is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
- **Night** is defined as 10:00pm to 7:00am, Monday to Sunday & Public Holidays.

2.1 Changing land use and noise environment

However, when evaluating the noise impacts for a proposed site it is important to consider the likely future situation and any changing character of the surrounding land use and noise environment. NPfI Section 2.4.3 "*Effects of changing land use*" is relevant in the context of the Proposal for deriving project trigger noise levels and noise management levels for the Proposal. NPfI Section 2.4.3 states:

> *When land uses in an area are undergoing significant change, for example, residential subdivisions with associated development of local and regional roads, the background noise levels would be expected to change, sometimes significantly. The impact of noise from an existing industry on a proposed new residential area should be made using the recommended amenity noise level for the residential land use, not the project intrusiveness noise level.*

The area surrounding the Proposal and areas in proximity to the potentially impacted receiver locations, are undergoing significant change. Further details of context for this are provided in Section 1.3.

Noting that the monitoring of existing noise levels for existing and future receivers, will not be representative of the future situation that the Proposal will be operating within, background noise monitoring has not been directly undertaken for the Proposal. The approaches described below were therefore adopted.

2.1.1 Operational noise emissions (Noise Policy for Industry)

In accordance with NPfI Section 2.4.3 "*Effects of changing land use*" existing background noise levels are not used to determine the project trigger noise levels. The NPfI's recommended amenity noise level for residential land use will be used for assessing the Proposal's operational noise emissions.

2.1.2 Construction noise impacts (Interim Construction Noise Guideline)

With consideration on the changing nature of the area impacting background levels at the time of construction, the monitoring undertaken for the Wilton Junction Masterplan by Atkins Acoustics (*Wilton Junction Master Plan Rezoning Study Noise and Vibration Management Assessment, reference 44.6827.R1:GA/DT/2014, Rev 08, dated May 2014*) (Atkins, 2014) in proximity of Picton Road and the Hume Motorway is considered herein for construction noise assessment. Furthermore, given that construction is proposed for standard construction hours, typical daytime background levels have been considered from the TfNSW Construction Noise and Vibration Standard (TfNSW 2019), for an area with low levels of traffic noise. Table 2-1 presents the most conservative of the available data that is adopted as the rating background noise level for the assessment of construction noise.

Table 2-1: Adopted rating background noise levels (RBL), dB(A)

Ref.	Location description	Rating background noise levels (RBL), $L_{A90,\ 15\ minute}$
		Day[1]
L1	Residential receivers in proximity to the project[2]	45

Notes:
1. Day: 7.00am to 6.00pm Monday to Saturday and 8.00am to 6.00pm Sundays & Public Holidays
2. Conservatively based upon the category of "Areas with low density transportation"

2.2 Shoulder periods

Fact Sheet A3 of the NPfI outlines the approach for considering and addressing shoulder periods. The NPfI states:

> *For example, where early morning (5 am to 7 am) operations are proposed, it may be unreasonable to expect such operations to be assessed against the night-time project noise trigger levels – especially if existing background noise levels are steadily rising in these early morning hours.*"

As detailed in Section 2.1, due to the changing character of the surrounding land use the existing noise environment is unlikely to reflect the actual environment at nearby residential receivers in future when the proposal is operating. This is because of the proposed future planning outcomes for the surrounding area envisaged by the state planning instruments. However, noting the nature of the proposed warehouse and logistics operations, early morning operations for some tenants are likely to occur. Also because of the proximity of the nearby sub-arterial and arterial roads [predominately Picton Road, Hume Motorway and Wilton Park Road (future)] the ambient noise environment at nearby residential receivers may steadily rise in the early morning hours leading up to the day period.

As such, it may be appropriate to consider if a shoulder period is appropriate and justified at that time. Also, as part of the approval process for proposed warehouse tenancies, where there are remaining residual impacts of the project trigger levels identified in Section 3.3, it may be appropriate to review background noise levels by undertaking noise monitoring at the time of the warehouse tenant proposal. This would likely provide a way to determine if a shoulder period is appropriate and justified as per Fact Sheet A3 if the NPfI. If appropriate and justified, shoulder period noise levels would then be used to update and adjust the applicable project trigger levels across the Proposal, consistent with the NPfI.

3 Noise and vibration objectives

3.1 Construction noise objectives

3.1.1 Noise management levels (NMLs)

The NSW *Interim Construction Noise Guideline* (ICNG, 2009) provides guidelines for assessing noise generated during the construction phase of developments.

The key components of the guideline that are incorporated into this assessment include:

- Use of L_{Aeq} as the descriptor for measuring and assessing construction noise.
- Application of reasonable and feasible noise mitigation measures.
- As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice and is practical to build given the project constraints.
- Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects.

The ICNG provides two methods described for the assessment of construction noise, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration and involves the measurement and prediction of noise levels and assessment against set criteria. A qualitative assessment is recommended for small projects with duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification. Given the scale and duration of the construction works proposed, a quantitative assessment is carried out herein, consistent with the ICNG requirements.

Table 3-1 reproduced from the ICNG, sets out the airborne noise management levels and how they are to be applied for residential receivers.

Table 3-1: Noise management levels at residential receivers

Time of day	Management level $L_{Aeq\ (15\ min)}$ *	How to apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.

Time of day	Management level $L_{Aeq\ (15\ min)}$ *	How to apply
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before/ after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see *ICNG* section 7.2.2.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 metres above ground level. If the property boundary is more than 30 metres from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 metres of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Table 3-2 sets out the ICNG noise management levels for other noise sensitive receiver locations.

Table 3-2: Noise management levels at other noise sensitive land uses

Land use	Time of day	Where objective applies	Management level $L_{Aeq\ (15\ min)}$
Classrooms at schools and other educational institutions	When in use	Indoor noise level Outdoor noise level[1]	45 dB(A) 55 dB(A)
Hospital wards and operating theatres	When in use	Indoor noise level Outdoor noise level[1]	45 dB(A) 55 dB(A)
Places of worship	When in use	Indoor noise level Outdoor noise level[1]	45 dB(A) 55 dB(A)
Active recreation areas	When in use	Outdoor noise level	65 dB(A)
Passive recreation areas	When in use	Outdoor noise level	60 dB(A)
Commercial premises	When in use	Outdoor noise level	70 dB(A)
Industrial premises	When in use	Outdoor noise level	75 dB(A)

Notes: 1. Outdoor noise level based on internal noise level in ICNG and assumes 10 dB loss through an open window

3.1.2 Summary of construction noise management levels

Table 3-3 presents the construction noise management levels established for the nearest noise sensitive residential receivers based upon the noise monitoring outlined in Section 2. The assessment locations and nearby sensitive receivers for the construction assessment are identified in Figure 11.

Table 3-3: Construction noise management levels

NCA / Rec. Id	Location description	Noise management level $L_{Aeq(15min)}$[1] Monday to Fridays (7:00am to 6:00pm) Saturdays (8:00am to 1:00pm)
R1 to R15	Residential premises (when present at the time of construction)	50
R16	Industrial premises	75[2]

Notes: 1. Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5m above ground level. If the property boundary is more than 30m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

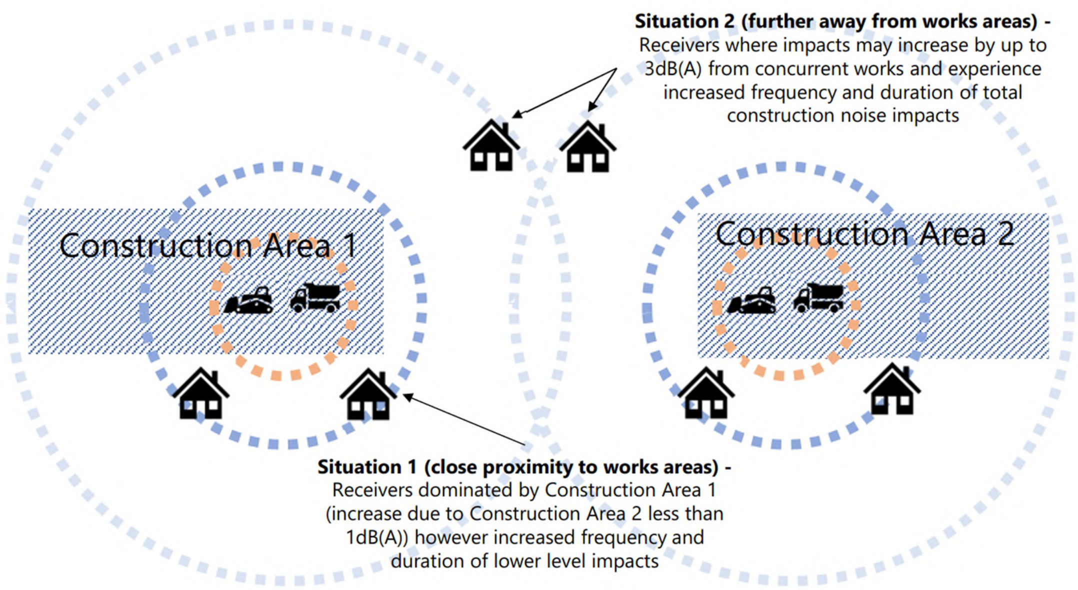
2. Noise management levels apply when receiver areas are in use only.

3.1.3 Cumulative construction project noise

The Proposal is located in proximity to the WTC. As such, construction works for this area may be underway concurrently with the Proposal. As such, there will be multiple construction projects undergoing noise generating construction works concurrently.

Typically, while impacts from one project or one construction site may be relatively short-term or noise intensive periods intermittent, when multiple construction projects are occurring at the same time near to a particular receiver cumulative construction noise impacts can occur. This can mean that construction noise impacting a sensitive receiver may be louder than from an individual set up works (ie. by up to 3 dB(A) with similar contributions from one other project), the overall duration of construction impacts may be overall longer or impacts more frequent. Typically, concurrent projects can impact nearby receiver locations in one of two ways, as also shown in Figure 12.

Figure 12: Cumulative construction noise impacts



As such, because there is potential for cumulative noise impacts as a result of the Proposal combined with other future concurrent construction projects, it is recommended that where this is the case that mitigation and management measures are implemented in order to minimise cumulative impacts, as detailed in Section 4.7.1.3.

3.2 Construction vibration objectives

Construction vibration is associated with three main types of impact:

- disturbance to building occupants
- potential damage to buildings, and
- potential damage to sensitive equipment in a building.

Generally, if disturbance to building occupants is controlled, there is limited potential for structural damage to buildings.

Vibration amplitude may be measured as displacement, velocity, or acceleration.

- Displacement (x) measurement is the distance or amplitude displaced from a resting position. The International System of Units (SI unit) for distance is the metre (m), although common industrial standards include mm.
- Velocity ($v=\Delta x/\Delta t$) is the rate of change of displacement with respect to change in time. The SI unit for velocity is metres per second (m/s), although common industrial standards include mm/s. The Peak Particle Velocity (PPV) is the greatest instantaneous particle velocity during a given time interval. If measurements are made in 3-axis (x, y, and z) then the resultant PPV is the vector sum (i.e. the square root of the summed squares of the maximum velocities) regardless of when in the time history those occur.
- Acceleration ($a=\Delta v/\Delta t$) is the rate of change of velocity with respect to change in time. The SI unit for acceleration is metres per second squared (m/s^2). Construction vibration goals are summarised below.

Construction vibration goals are summarised below.

3.2.1 Disturbance to buildings occupants

The acceptable vibration values to assess the potential for human annoyance from vibration are set out in the NSW '*Environmental Noise Management Assessing Vibration: A Technical Guideline*' (AVTG).

To assess the potential for vibration impact on human comfort, an initial screening test will be done based on peak velocity units, as this metric is also used for the cosmetic damage vibration assessment. The screening test is based on the continuous vibration velocity (i.e. vibration that continues uninterrupted for a defined period). If the predicted vibration exceeds the initial screening test, the total estimated Vibration Dose Value (i.e. eVDV) will be determined based on the level and duration of the vibration event causing exceedance.

The initial screening test values and VDVs recommended in BS 6472-1992 for which various levels of adverse comment from occupants may be expected, are presented in Table 3-4. The 'Low probability of adverse comment eVDV' represent the preferred and maximum value presented in the AVTG.

Table 3-4: Vibration management levels for disturbance to building occupants

Place and Time	Initial screening test Velocity, PEAK, mm/s (>8Hz)	Low probability of adverse comment eVDV $m/s^{1.75}$	Adverse comment possible eVDV $m/s^{1.75}$	Adverse comment probable eVDV $m/s^{1.75}$
Critical areas (day or night)[1]	0.28	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Residential buildings 16 hr day[2]	0.56	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hr night[2]	0.40	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Offices, schools, educational institutions and places of worship (day or night)	1.10	0.4 to 0.8	0.8 to 1.6	1.6 to 2.4
Workshops (day or night)	2.20	0.8 to 1.6	1.6 to 3.2	3.2 to 6.4

1. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above
2. Daytime is 7am to 10pm and night-time is 10pm to 7am

3.2.2 Building damage

Potential structural damage of buildings as a result of vibration is typically managed by ensuring vibration induced into the structure does not exceed certain limits and standards, such as British Standard 7385 Part 2 and German Standard DIN4150-3. Currently there is no existing Australian Standard for assessment of structural building damage caused by vibration energy.

It is noted that vibration levels required to cause minor cosmetic damage are typically 10 times higher than levels that will cause disturbance to building occupants. Many building occupants assume that building damage is occurring when they feel vibration or observe rattling of loose objects, however the level of vibration at which people perceive vibration or at which loose objects may rattle is far lower than vibration levels that can cause damage to structures.

The cosmetic damage levels set by BS7385 are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular building types. Table 3-5 sets out the recommended vibration limits from BS7385 for transient vibration to ensure minimal risk of cosmetic damage to residential, commercial and industrial buildings and is frequency dependent and specific to particular categories of structure.

Table 3-5: BS 7385 Transient vibration values for minimal risk of damage

Group	Type of building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures. Industrial and heavy commercial buildings.	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures. Residential or light commercial type buildings.	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

3.2.3 Vibration screening criteria

The limits presented in Table 3-5 above relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, then the guide values in Table 3-5 may need to be reduced by up to 50 percent. This is especially applicable at the lower frequencies where lower guide values apply.

On this basis, consistent a conservative vibration screening criteria per receiver type is given below:

- Reinforced or framed structures (Line 1): 25.0 mm/s
- Unreinforced or light framed structures (Line 2): 7.5 mm/s

At locations where the predicted and/or measured vibration levels are greater than shown above (peak component particle velocity), a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure would be required to determine the applicable safe vibration level. The analysis would take into consideration the transient vibration guide values for minimal risk of cosmetic damage set out in Table 3-5.

3.2.4 Heritage items

The German Standard DIN 4150 provides a conservative criterion for vibration limits for different buildings and has been used to identify the vibration criteria for the Project where the British Standard does not apply. The German standard values for peak particle velocity (PPV) (mm/s) measured at the foundation of the building are summarised in Table 3-6.

Table 3-6: DIN 4150-3 guideline values for short-term vibration on structures

Group	Type of structure	Guideline values vibration velocity (mm/s)				
		Foundations, all directions at a frequency of:			Topmost floor, horizontal	Floor slabs, vertical
		1 to 10Hz	10 to 50Hz	50 to 100Hz	All frequencies	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 30	40 to 50	40	20
2	Residential buildings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15	20
3	Structures that because of their particular sensitivity to vibration, cannot be classified into Group 1 or 2 and are of great intrinsic value e.g. heritage listed buildings	3	3 to 8	3 to 8	8	20

As noted in BS 7385, heritage buildings and structures should not be assumed to be more sensitive to vibration, unless structurally unsound. A conservative vibration damage screening level for heritage buildings/structures can be set to 3 mm/s (peak component particle velocity), the more stringent criterion in the German Standard DIN 4150. This screening level will allow potentially impacted heritage structures to be identified. If a heritage structure is predicted to be exposed to vibration levels above the conservative vibration screening level of 3mm/s, further investigation would be undertaken to determine whether the structure is structurally unsound. Where a heritage building is deemed to be sensitive to vibration impacts, the more stringent DIN 4150 Group 3 guideline values can be applied. Otherwise, structural damage vibration limits based on BS 7385 (Section 3.2.2 and 3.2.3) can be applied.

3.2.5 Damage to vibration sensitive equipment

Some high technology manufacturing facilities, hospitals and laboratories utilise equipment that is highly sensitive and susceptible to vibration, for example scanning electron microscopes and micro-electronic manufacturing facilities. In addition, buildings housing sensitive computer or telecommunications equipment may require assessment against stricter criteria than those nominated for building damage.

There is no explicit guidance on acceptable vibration levels for such equipment, so recommended vibration levels should be obtained from instrument manufacturers. In the absence of equipment specific data provided by manufacturers, there are generic vibration criteria that can be used to assess the impact of vibration generating activities on buildings housing vibration sensitive equipment. For example, the Vibration Criteria (VC) curves are often referred to as they are generic and apply to all tools/ equipment types within each category. The VC curves are defined over the frequency range 8 to 100 Hz.

Table 3-7 below summarises a range of suitable and conservatively stringent vibration limits that are applicable to buildings housing vibration sensitive equipment which may potentially be affected by construction vibration.

Table 3-7: Acceptable vibration limits for vibration measured on building structure housing sensitive equipment

Equipment Requirements	Vibration Limit[1] mm/s,		Description of Use[3]
	RMS[4]	Peak [5]	
Computer Areas[2]	0.7	1.0	Barely perceptible vibration. Adequate for computer equipment accommodation environments.
Medical[2, 3]	0.1	0.14	Vibration not perceptible. Suitable in most instances for microscopes to 100X and for other equipment of low sensitivity.
VC-A[3]	0.05	0.07	Vibration not perceptible. Adequate in most instances for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc

Notes: 1. As measured in one-third octave bands of frequency over the frequency range 8 to 100 Hz. Vibration measured on the building structure near vibrating equipment or in areas containing sensitive equipment.

2. Based on AS 2834 Computer Accommodation

3. Gordon CG Generic Vibration Criteria for Vibration Sensitive Equipment

4. Root Mean Square value representing the average value of a signal

5. In the absence of Peak limits, RMS limits are converted to Peak by conservatively assuming the vibration signal is sinusoidal and random with a nominal crest factor of 1.414

3.2.6 Damage to buried services

Section 5.3 of DIN 4150-3:2016 also sets out guideline values for vibration velocity to be used when evaluating the effects of vibration on buried pipework. These values, which apply at the wall of the pipe, are reproduced and presented in Table 3-8 below.

Table 3-8: DIN 4150-3:1999 Guideline values for vibration velocity to be used when evaluating the effects of short-term vibration on buried pipework

Line	Pipe Material	Guideline values for vibration velocity measured on the pipe, mm/s
1	Steel (including welded pipes)	100
2	Vitrified clay, concrete, reinforced concrete, prestressed concrete, metal (with or without flange)	80
3	Masonry, plastics	50

For long-term vibration the guideline levels presented in Table 3-8 should be halved.

Recommended vibration goals for electrical cables and telecommunication services such as fibre optic cables range from between 50 mm/s and 100 mm/s. It is noted however that although the cables may sustain these vibration levels, the services they are connected to, such as transformers and switch blocks, may not. It is recommended that should such equipment be encountered during the construction process an individual vibration assessment should be carried out. This may include a specific vibration impact statement addressing impact on the utility and consultation with the utility provider to confirm specific vibration requirements.

3.3 Operational noise

This assessment aims to establish the requirements for operational noise emissions from the Proposal in accordance with the NSW *Noise Policy for Industry* (NPfI), 2017. The assessment procedure has two components:

- Controlling intrusive noise impacts in the short-term for residences; and
- Maintaining noise level amenity for residences and other land uses.

In accordance with the NPfI, noise impact should be assessed against the project noise trigger level which is the lower value of the project intrusiveness noise levels and project amenity noise levels.

3.3.1 Intrusive noise levels

According to the NPfI, the intrusiveness of a noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the $L_{Aeq,15min}$ descriptor) does not exceed the background noise level measured in the absence of the source by more than 5 dB(A). The aim is so that there is not a noticeable difference as a result of a new development. However, due to the changing nature of the Wilton area, this is not necessarily, considering the intended planning outcomes from the Wilton Growth Area.

The project intrusiveness noise level, which is only applicable to residential receivers, is determined as follows:

$L_{Aeq,15minute}$ **Intrusiveness noise level = Rating Background Level ('RBL') plus 5 dB(A)**

However, when evaluating the noise impacts for a proposed site it is important to consider the likely future state and any changing character of the surrounding land use and noise environment. NPfI Section 2.4.3 "*Effects of changing land use*" is relevant in the context of the Proposal for deriving project trigger noise levels for the Proposal. NPfI Section 2.4.3 states:

When land uses in an area are undergoing significant change, for example, residential subdivisions with associated development of local and regional roads, the background noise levels would be expected to change, sometimes significantly. The impact of noise from an existing industry on a proposed new residential area should be made using the recommended amenity noise level for the residential land use, not the project intrusiveness noise level.

Consistent with the Growth Area vision for the Wilton detailed Section 1.3 and considering the following **proposed future planning outcomes** for the surrounding area envisaged by the state planning instruments, it is likely that existing night-time background noise levels will increase from existing levels:

- Wilton Town Centre
- Picton Road Upgrade
- Wilton South East Precinct

- Wilton Park, Wilton (Bingara Gorge)
- West Wilton (however, no structure plan has been finalised for the area)

As such, consistent with NPfI Section 2.4.3, it is not recommended that project intrusive noise levels are used to determine the applicable project noise trigger levels, because the area is undergoing significant change and the existing noise environment will also likely change significantly.

3.3.2 Amenity noise levels

The project amenity noise levels for different time periods of day are determined in accordance with Section 2.4 of the NPfI. The NPfI recommends amenity noise levels ($L_{Aeq,period}$) for various receivers including residential, commercial, industrial receivers and sensitive receivers such as schools, hotels, hospitals, churches and parks. These "recommended amenity noise levels" represent the objective for total industrial noise experienced at a receiver location. However, when assessing a single industrial development and its impact on an area, then "project amenity noise levels" apply.

The recommended amenity noise levels applicable for the subject receiver areas are reproduced from the NPfI Table 2.2 in Table 3-9 below.

Table 3-9: NPfI Recommended amenity noise levels

Type of receiver	Noise amenity area	Time of day	Recommended amenity noise level, $L_{Aeq,}$ dB(A)
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks	See column 4	See column 4	5 dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day
School classroom (internal)	All	Noisiest 1-hour period when in use	35[5]
Hospital ward	All		
- Internal		Noisiest 1-hour	35
- External		Noisiest 1-hour	50
Place of worship (internal)	All	When in use	40
Passive recreation (e.g. national park)	All	When in use	50
Active recreation (e.g. school	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	70

Type of receiver	Noise amenity area	Time of day	Recommended amenity noise level, L_{Aeq}, dB(A)
Industrial interface (applicable only to residential noise amenity areas)	All	When in use	Add 5 dB(A) to recommended noise amenity area

Notes:
1. Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am.
2. On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.
3. The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.
4. The recommended amenity noise levels refer only to noise from industrial sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated
5. In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable L_{Aeq} noise level may be increased to 40 dB $L_{Aeq(1hr)}$

3.3.2.1 Residential amenity category

Table 2.3 "*Determining which of the residential receiver categories applies*" of the NPfI provides guidance on assigning residential receiver noise categories. It presents three methods for determining which of the residential receiver noise categories apply. The three methods presented are:

- typical planning zoning (column 2 of NPfI Table 2.3);
- typical existing background noise levels (column 3 of NPfI Table 2.3); and
- description of the acoustical environment (column 4 of NPfI Table 2.3).

Recently the NSW EPA provided updated guidance on the methodology for determining the amenity category for residential receivers in *Acoustics Australia (Volume 50, No.3 September 2022)*. The first step in the procedure is determining the planning land use zoning for the potentially affected residential receiver. The amenity category from zoning can be adjusted where there is strong justification and having regard to the '*typical existing background noise levels*'. However, noting the changing nature of the area around the Proposal, the amenity category has been conservatively selected based upon the current land use zoning for all nearby residential receivers.

3.3.2.1.1 Existing Wilton residences

The nearest residential receivers that are located outside of the future Wilton Town Centre, are located on Wilton Park Road, Wilton to the north-west; at Pheasants Nest to the east and south; and Wilton across the Hume Motorway to the east.

These residences are in areas zoned RU2 Rural Landscape and so fall under the Rural residential category in column 2 of NPfI Table 2.3, as shown in Table 3-10.

Table 3-10: Zoning of residential receivers

Location / Suburb	Zoning of residence	Column 2 of NPfI Table 2.3 classification
West Wilton	RU2 Rural Landscape	Rural residential
Pheasants Nest	RU2 Rural Landscape	Rural residential
Wilton South East	RU2 Rural Landscape	Rural residential

As such and in-line with undertaking a conservative assessment these receivers have been categorised as 'rural'.

3.3.2.1.2 Future Wilton Town Centre residential area

The nearest residential receivers are located in the proposed residential area of the future WTC. This area is zoned as Low Density residential (R2), and as such falls under the Suburban residential category in column 2 of NPfI Table 2.3, as shown in Table 3-10.

3.3.2.2 Project amenity noise levels

To ensure that the total industrial noise level (existing plus new) remains within the recommended amenity noise levels for an area, the project amenity noise level should apply for each new industrial noise source coming into the area.

The NPfI requires adjustments to take into consideration potential other industrial noise generating operations when deriving the amenity project noise trigger level. As such, even though there is minimal existing industry in proximity to the nearest sensitive receivers, there is future employment lands proposed as part of the WTC structure plan (see Section 1.3.2) and so consistent with the NPfI Section 2.4, the project amenity noise level has been determined as follows:

$$L_{Aeq,period} \textbf{ Project amenity noise level} = L_{Aeq,period} \textbf{ Recommended amenity noise level} - 5 \text{ dB(A)}$$

Furthermore, given that the intrusiveness noise level is based on a 15 minute assessment period and the project amenity noise level is based on day, evening and night assessment periods, the NPfI provides the following guidance on adjusting the $L_{Aeq,period}$ level to a representative $L_{Aeq,15minute}$ level in order to standardise the time periods.

$$L_{Aeq,15minute} = L_{Aeq,period} + 3\text{dB(A)}$$

The project amenity noise levels ($L_{Aeq,\ 15min}$) applied for the Proposal are reproduced in Table 3-11.

Table 3-11: Project amenity noise levels

Type of receiver	Noise amenity area	Time of day[1]	Recommended noise level, dB(A)	
			$L_{Aeq, Period}$	$L_{Aeq, 15min}$
Residence (existing)	Rural	Day	50 – 5[5] = 45	45 + 3 = **48**
		Evening	45 – 5[5] = 40	40 + 3 = **43**
		Night	40 – 5[5] = 35	35 + 3 = **38**
Residences (WTC)	Suburban	Day	55 – 5[5] = 45	50 + 3 = **53**
		Evening	45 – 5[5] = 40	40 + 3 = **43**
		Night	40 – 5[5] = 35	35 + 3 = **38**
School classroom (internal)[3]	All	Noisiest 1-hour period when in use	40 – 5[5] = 35	35 + 3 = **38**
Place of worship (internal)	All	When in use	40 – 5[5] = 35	35 + 3 = **38**
Hospital ward	All	Noisiest 1-hour	50 – 5[5] = 45	45 + 3 = **48**
Active recreation area (school playground)	All	When in use	55 – 5[5] = 50	50 + 3 = **53**
Passive recreation area	All	When in use	50 – 5[5] = 45	45 + 3 = **48**
Commercial Premises	All	When in use	65 – 5[5] = 60	60 + 3 = **63**
Industrial premises	All	When in use	70 – 5[5] = 65	65 + 3 = **68**

Notes:
1. Daytime 7:00am to 6:00pm; Evening 6:00pm to 10:00pm; Night-time 10:00pm to 7:00am. On Sundays and Public Holidays, Daytime 8:00am - 6:00pm; Evening 6:00pm - 10:00 pm; Night-time 10:00pm - 7:00am.
2. The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.
3. In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable LAeq noise level may be increased to 40 dB LAeq(1hr)

3.3.3 Project noise trigger levels

The project noise trigger levels have been converted to $L_{Aeq\ 15min}$ values in accordance with Section 3.3.2.2 and these are presented in Table 3-12. The project intrusive noise levels have been presented for reference purposes only as per Section 3.3.1, and have not been used to determine the final project noise trigger levels. In accordance with the NPfI the project noise trigger levels (PNTL), are presented in Table 3-12 below.

Table 3-12: Project noise trigger levels

Receiver location	$L_{Aeq, 15min}$ Project noise trigger levels, dB(A)		
	Day	Evening	Night
Residential receivers[3]			
Residence (existing)	48	43	38
Residence (WTC)	53	43	38
Other sensitive receivers[4]			
Commercial	63	63	63[2]
Industrial	68	68	68[2]

Notes:
1. Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 5.00 am. On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 7.00 am.
2. Project noise trigger level is only applicable when the receiver type is in use.
3. For a residence, the project noise trigger level and maximum noise levels are to be assessed at the reasonably most-affected point on or within the residential property boundary in accordance with the NPfI.
4. For commercial or industrial premises the noise level is to be assessed at the reasonably most-affected point on or within the property boundary.

3.3.4 Cumulative industrial noise

The management of cumulative operational noise is required by the NPfI. By addressing cumulative noise impacts consistent with the NPfI, this will also sufficiently address cumulative impacts in accordance with the DPE guideline "*Cumulative Impact Assessment Guidelines for State Significant Projects*" (DPE, 2022) as detailed in Section 3.5 of that document.

As stated in Section 2.1 of the NPfI "*The project intrusiveness noise level aims to protect against significant changes in noise levels, whilst the project amenity noise level seeks to protect against cumulative noise impacts from industry and maintain amenity for particular land uses.*".

The NPfI amenity noise criteria derived herein aims to control the total industrial noise level (existing plus new) with the aim for it to remain within the recommended amenity noise levels for the area. As such, the potential cumulative noise impacts as a result of the future development have been considered in the assessment through the derivation of criteria in accordance with the NPfI, and assessment against these levels.

As the Proposal contains multiple warehouse tenancies that would be undertaking operations separately from each other, there is potential cumulative noise from all operating tenancies which should be considered. Considering this, potential management approaches to achieve the project noise trigger levels should be incorporated into future management of the site and consideration of future tenants, with consideration of the elements detailed in NPfI Section 2.8 Noise management precinct. As there are many ways to manage these potential cumulative noise emissions, this should be considered as part of the Operational Noise Management Plan developed for any future development application, which is further described in Section 5.2.4.

3.3.5 Sleep disturbance noise levels

The potential for sleep disturbance due to maximum noise level events from the Proposal site during the night-time period needs to be considered. In accordance with NPfI, a detailed maximum noise level event assessment should be undertaken where the subject development night-time noise levels at a residential location exceed the following noise trigger levels:

- $L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater.

Considering that the existing area is rural, and future background noise levels are not known, a screening level for sleep disturbance as presented in Table 3-13 has been established for this Proposal.

Table 3-13: EPA NPfI Sleep disturbance assessment trigger levels - Night (10:00pm to 7:00am)

Receiver type	Assessment level $L_{Aeq,15min}$	Assessment level L_{AFmax}
All residences	40[1]	52[2]

Notes:
1. As per NPfI Section 2.5, minimum screening level is the greater of L_{Aeq} 40 dB(A) or RBL + 5dB.
2. As per NPfI Section 2.5, minimum screening level is the greater of L_{AFmax} 52 dB(A) or RBL + 15dB.

The detailed assessment should consider all feasible and reasonable noise mitigation and management measures with a goal of achieving the sleep disturbance noise trigger levels. The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the NSW Road Noise Policy (see Section 3.3.5.1.1).

Other factors that may be important in assessing the extent of impacts on sleep include:

- how often high noise events will occur
- the distribution of likely events across the night-time period and the existing ambient maximum events in the absence of the subject development
- whether there are times of day when there is a clear change in the noise environment (such as during early-morning shoulder periods)
- current scientific literature available at the time of the assessment regarding the impact of maximum noise level events at night (see Section 3.3.5.1.2).

Maximum noise level event assessments should be based on the L_{AFmax} descriptor on an event basis under 'fast' time response.

3.3.5.1 Current reference literature

3.3.5.1.1 NSW RNP

In relation to maximum noise level events, the NSW RNP identifies in its summary on sleep disturbance research to date that:

1. *Maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep*
2. *One or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.*

The above references identify that internal noise levels of 50 to 55 dB(A), are unlikely to cause awakenings. On the assumption that there is a 10 dB(A) outside-to-inside noise loss through an open window (see Section 2.6 of the NPfI, p15), this indicates that external noise levels of L_{Amax} 60 to 65 dB(A) are unlikely to cause awakening reactions. Given the equivalent external noise levels and considering the second point above, an L_{Amax} 65 dB(A) has then been used as the assessment noise level to determine the potential for awakening reactions.

3.3.5.1.2 World Health Organisation reports

As stated in the NPfI, other factors that may be important in assessing the extent of impacts on sleep, includes current scientific literature regarding the impact of maximum noise level events at night. The organisation that reports on the current scientific literature pertaining to night-time impacts on sleep is the World Health Organisation (WHO).

The latest guidelines produced by the WHO relating to night-time impacts on sleep, were produced in 2009 and 2018. These reports mainly focus on sleep disturbance from transportation noise sources, such as aircraft, road and rail, with the 2018 guideline also providing recommendations for wind turbine and leisure noise sources. As stated in the later report, it does not provide specific recommendations for industrial activity noise due to lack of information and data.

However, given that some of the proposed operations of the Proposal, may have a similar nature and character of noise to road traffic noise, guidance and limits relating to road traffic noise are referred to in this NVIA to assess potential sleep disturbance from site operations and activities.

Following the publication of community noise guidelines in 1999, the WHO released the *Night Noise Guidelines for Europe (WHO 2009)* in 2009, which uses $L_{night\ (outside)}$ as a primary measure of night-time noise. The $L_{night\ (outside)}$ is an A-weighted noise level at the most exposed facade outdoors over all night periods determined as a long-term average over a year, and is roughly equivalent to the external $L_{Aeq,9hour}$ night-time descriptor.

The report recommends a long-term $L_{night\ (outside)}$ noise guideline level of 40 dB(A), with an interim $L_{night\ (outside)}$ target level of 55 dB(A). The interim target is only intended as an intermediate step in localised situations as health impacts, particularly on vulnerable groups, are apparent at this noise level. The report notes:

1. For $L_{Aeq(9hour)}$ (external) levels above 55 dB(A), adverse health effects occur frequently, and a sizeable proportion of the population is highly annoyed and sleep disturbed.

2. For $L_{Aeq(9hour)}$ (external) levels between 40 dB(A) and 55 dB(A), adverse health effects are observed and vulnerable groups are more severely affected.

The WHO released the latest research into sleep in 2018 as the *Environmental Noise Guidelines for the European Region: A systematic Review on Environmental Noise and Effects on Sleep* (WHO 2018). The WHO 2018 guideline recommends reducing noise levels produced by road traffic during night-time to below 45 dB(A) $L_{night\ (outside)}$, as night-time road traffic noise above this level is associated with adverse effects on sleep.

The WHO 2018 guideline does not recommend criteria in terms of single-event noise indicators or maximum sound pressure levels (eg L_{Amax}), because the assessment of the relationship between different types of single-event noise indicators and long-term health outcomes at the population level remains tentative. The WHO guideline therefore makes no recommendations for single-event noise indicators. Thus, the WHO guideline is restricted to long-term health effects during night time and therefore only includes recommendations about average noise indicators, e.g. $L_{night\ (outside)}$.

3.3.5.2 Sleep disturbance assessment noise levels

In accordance with the NPfI and current scientific literature, the sleep disturbance project assessment noise levels, are presented in Table 3-14 below.

Table 3-14: Sleep disturbance project assessment noise levels[5]

Receiver location	EPA NPfI sleep disturbance assessment levels		WHO 2018 $L_{Aeq,15min}$[3]	Awakening reaction[4], L_{Amax}
	Assessment level $L_{Aeq,15min}$	Assessment level L_{AFmax}		
All residences	40[1]	52[2]	48[3]	65

Notes:
1. As per NPfI Section 2.5, minimum screening level is the greater of LAeq 40 dB(A) or RBL + 5dB.
2. As per NPfI Section 2.5, minimum screening level is the greater of LAFmax 52 dB(A) or RBL + 15dB.
3. As per Section 2.2 of the NPfI, the WHO 45 dB(A) Lnight (outside) has been converted to a LAeq,15minute level by adding 3 dB(A).
4. As per the NSW RNP, as detailed in Section 3.3.5.1.1.
5. Sleep disturbance assessment is applicable for the night period (10:00pm to 7:00am), as per Section 2.5of the NPfI.

3.4 Road traffic noise

Noise impacts from the potential increases in traffic on the surrounding road network due to construction and operational activities from the Proposal is assessed in accordance with the NSW *Road Noise Policy* (DECCW, 2011) (RNP). The RNP sets out criteria to be applied to particular types of road and land uses. These noise criteria are to be applied when assessing noise impacts and determining mitigation measures for sensitive receivers that are potentially affected by road traffic noise associated with the construction and operation of the subject site, with the aim of preserving the amenity appropriate to the land use.

3.4.1 Proposal route road types

Wilton Park Road is currently a local road, but it is designated a sub-arterial road in the approved Wilton Town Centre (WTC) structure plan and is also under consideration as a route option for the Picton Bypass route. As such, this road will be a sub-arterial road when the Proposal is operating, and so it has been assessed as a sub-arterial road.

Accordingly, the Proposal will be operating along sub-arterial / arterial roads and not local roads. The only exception is for the internal industrial estate roads. However, there are no residences within the industrial estate, and the nearby residential receivers will be potentially more impacted by traffic noise from the Proposal when operating on the sub-arterial / arterial roads.

3.4.2 Assessment criteria

For existing residences affected by additional traffic generated by land use developments on existing sub-arterial / arterial roads, the following RNP road traffic noise criteria would apply.

Table 3-15: RNP Road Traffic Noise Criteria, dB(A)

Road Category	Type of Project/Land Use	Assessment Criteria, dB(A)	
		Day 7am – 10pm	Night 10pm – 7am
Freeway/arterial/sub-arterial roads	3. Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq,(15\ hour)}$ 60 (external)	$L_{Aeq,(9\ hour)}$ 55 (external)

Further to the above, the RNP states the following for land use developments generating additional traffic:

> *"For existing residences and other sensitive land uses affected by* **additional traffic on existing roads generated by land use development***, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option'."*

The RNP states that in assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

3.5 Wilton Growth Area Development Control Plan 2021

In August 2021, the *Wilton Growth Area Development Control Plan 2021* (WGA DCP) was finalised.

However, WGA DCP Section 1.1.4 "*Where does the Plan Apply*" notes that:

> *This DCP applies to land in the South East Wilton and North Wilton Precincts within the Wilton Growth Area as mapped in the Growth Centres SEPP, and as shown in Schedule 1 (South East Wilton Precinct) and Schedule 2 (North Wilton Precinct).*
>
> *It is anticipated that as other precincts within the Wilton Growth Area are rezoned, schedules for those precincts will be added to this DCP by amending the DCP.*

As such, even though the schedules, and requirements of this DCP are not directly applicable to the subject precinct yet, it is expected that they are likely to be similar and consistent for other Wilton Growth Area precincts, such as the Wilton Town Centre (WTC) and West Wilton. As the new precincts are added to this DCP, the DCP will be amended accordingly.

The DCP controls applicable to noise are detailed in Table 3-16.

Table 3-16: *Wilton Growth Area Development Control Plan 2021* (WGA DCP) noise related controls

Wilton Growth Area Development Control Plan (DCP) 2021	
Section 3.12 Odour, noise and air quality	
Section 3.12.1 Objectives	
1.	Preserve air quality, minimise pollution, and improve environmental amenity
2.	Ensure appropriate levels of air quality for the health and amenity of residents.
	Section 3.12.2 Controls
1	…
2	Development will comply with the Protection of the Environment Operations Act 1997 and supporting Regulations. Development that is likely to be impacted upon by atmospheric pollutants and/or odours from existing land uses, may require the undertaking of an Odour Impact Assessment or similar assessment dependent on the type of pollutant being assessed. Assessment will be undertaken in accordance with the NSW EPA Technical Framework "Assessment and Management of Odour from Stationary Sources in NSW".
3	Where necessary, a barrier such as continuous dense landscaping (bunds and vegetation) or appropriate green infrastructure is to be provided to assist in air pollutants, noise and odour dispersion from nearby sources of air pollution noise, and/or odour.
4	DA's for noise impacted dwellings should detail siting considerations, design and architectural treatments with consideration to the design principles in Section 3.8 of the Development near Rail Corridors and Busy Roads – Interim Guideline (Department of Planning 2008) and include ventilation that meets the requirements of the Building Code of Australia where windows are required to remain closed to meet internal noise levels.
5	Development on land adjoining busy roads will demonstrate compliance with: i. Minimum separation distances from the kerb as outlined in Table 3; or ii. Where minimum separation distances are not achievable, ducted mechanical ventilation for the supply of outdoor air in compliance with AS1668.2: The use of ventilation and air conditioning in buildings – Part 2: Mechanical ventilation in buildings. Mechanical ventilation outdoor air intakes will be located at least the minimum distance from the kerb specified in Table 3, measured in the horizontal and vertical planes from the kerb. Filtration of outdoor air will be to a minimum Australian Standard performance rating of F6 or minimum efficiency reporting value (MERV) 9.
6	Alternative setbacks may be considered by Council, where the applicant can demonstrate that a development will comply with required noise, odour and air quality outcomes, and the application is adequately supported by specialist studies, prepared by a suitably qualitied professional.

Wilton Growth Area Development Control Plan (DCP) 2021

Table 3: Minimum setback required for air quality controls

Road classification	Residential type buildings	Childcare facilities, hospitals, aged care facilities, schools
Motorway	30m	80m
High Volume: More than 60,000 AADT; and 40,000-60,000 and 5% or more Heavy Vehicles	20m	80m
Moderate 20,000-40,000	n/a	40m
Intermediate Roads: 40,000-60,000 AADT; and 30,000-40,000 and 10% or more Heavy Vehicles	40m	40m
Intermediate Roads	30m	60m

4 Construction noise and vibration assessment

4.1 Background

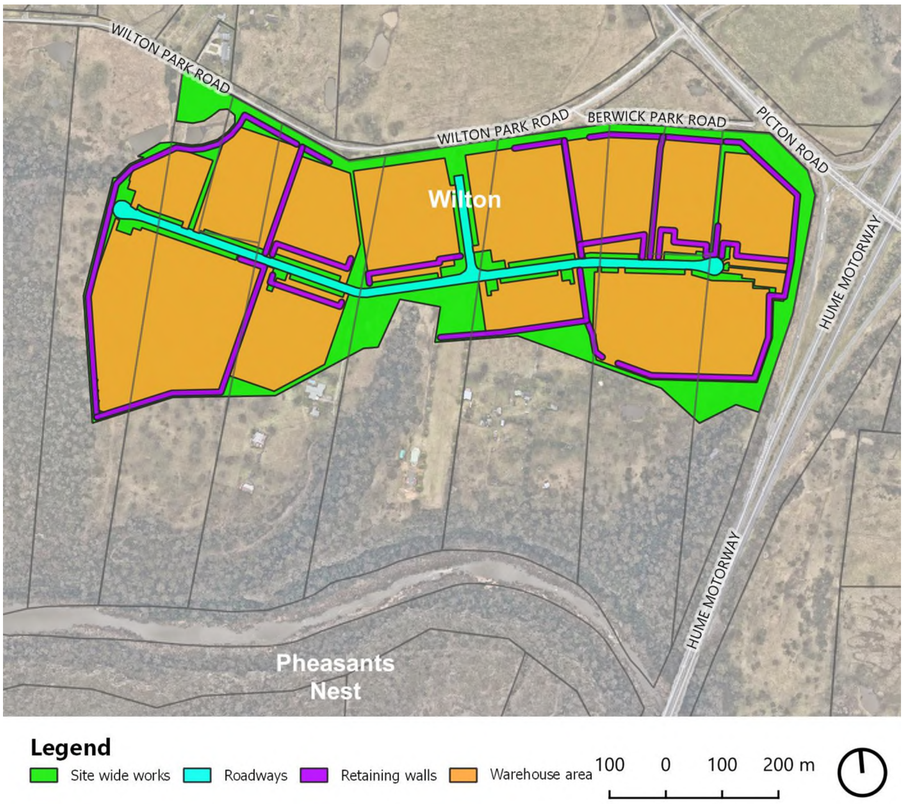
Construction activities associated with the proposed development will result in increased noise levels during construction hours. The works undertaken in the various stages consist of a mixture of both high and low noise activities. This assessment identifies potentially noisy activities, their impacts on surrounding receivers and outlines management strategies to control the impacts of noise and vibration during the construction stages of the project.

4.2 Proposal construction works

The following construction works will be required to construct and fit out Proposal, as detailed in Section 1.2.2.

- Land preparation – clearing, bulk earthworks, drainage across the site and retaining walls
- Utility works – water, comms, power across the site
- Roadworks – pavements, kerb/gutter, footpaths
- Industrial warehouse buildings – pier, foundation slab, structural steel, cladding, fit outs

Figure 13: Key construction areas



4.3 Construction hours

Construction works for the Proposal are proposed to take place during the ICNG standard construction hours, which are:

- 7:00am to 6:00pm Monday to Friday
- 8:00am to 1:00pm on Saturday
- No work performed on Sunday and Public Holidays.

4.4 Out of hours construction works

Construction works are not proposed outside of ICNG standard construction hours.

Where Out-of-Hours Works (OOHWs) are required due to further design development identifying the need, then these would require separate approval.

It is recommended that where OOH is then proposed that background noise monitoring is undertaken at the time of the proposed works, to monitoring the existing noise levels at the nearest receivers to the works that will be there during the time of construction. Noise management levels should then be established consistent with the ICNG.

4.5 Construction noise and vibration activities and assumptions

4.5.1 Construction works and activities

An assessment of the potential level of construction noise and vibration impact has been carried out to determine whether mitigation would be required, and to determine appropriate management controls. Specific construction equipment requirements are not yet known. The type and number of plant and equipment associated with the proposed works was assumed based upon experience with similar noise assessments.

Prior to the commencement of construction, the final construction details should be reviewed against the assumptions in this report to ensure that the mitigation and management measures that will be implemented remain consistent with these assumptions, and appropriate for the project.

The approximate phases of the construction works are presented in Table 4-1. The key areas of construction are shown in Figure 13.

Table 4-1: Approximate construction phases

Stage / Description		Works area (Figure 13)
Land preparation	Site mobilisation	Site wide
	Site clearing	Site wide
	Bulk earthworks	Site wide
	Retaining walls	Retaining walls
Utility works	Utility, communications and stormwater works	Site wide
Roadworks	Road works (pavements, kerbs/gutters/footpaths)	Roadways
Warehouse and industrial building construction works	Foundations and building construction	Warehouse areas
	Building fit-out	Warehouse areas

4.5.2 Construction traffic

The worksite will generate additional traffic movements in the form of:

- Light vehicle movements generated by construction personnel travelling to and from work
- Heavy vehicle movements generated by:
  - Trucks removing construction waste from the site
  - Delivery vehicles bringing raw materials, plant, and equipment to the site

Construction traffic on the site is included as part of the construction noise assessment of the work activities identified in Section 4.5.1. When construction-related traffic moves on the public road network, a different noise assessment methodology is appropriate as vehicle movements would be regarded as additional road traffic on public roads rather than as part of the construction site's activities.

The estimated daily number of heavy vehicles accessing the site will be up to 50 trucks per day during peak periods or an average of 5 per hour, over a standard 10 hour work day.

The primary potential route to and from the Proposal for construction vehicles would be via Wilton Park Road, to Picton Road and Hume Motorway. Construction of the Proposal would generate additional truck movements along these routes.

Considering the existing traffic volumes on the primary potential routes to/from the site presented in Section 5.1.1 and that these routes currently carry high volumes of heavy vehicles, and there are no existing noise sensitive receivers along this section of Wilton Park Road, this volume of construction traffic as a result of this Proposal is not expected to significantly alter existing traffic noise at noise sensitive receivers along these routes.

Construction traffic from the site on public roads is predicted not to be a significant noise impact and is not further addressed in this report.

4.5.3 Construction noise sources

The schedule of items of plant and equipment likely to be used during the construction phases of the Proposal is presented in Table 4-2 below.

Table 4-2: Typical construction equipment & sound power levels, dB(A) re 1pW

Scenario	Plant / Equipment	Details or weight	Sound Power Level (Lw re: 1pW), dB(A), L_{Aeq}
S1 Site mobilisation	Semi-trailer truck		108
	Mobile crane		110
	Excavator with bucket	35 tonne	102
	Assumed combined activity noise level[1]		**113**
S2 Site clearing	Excavator with medium rockhammer (35t)	35 tonne	120
	Bulldozer	D9	114
	Dump truck		108
	Assumed combined activity noise level[1]		**121**
S3 Bulk earthworks	Excavator with large rockhammer (50t)	50 tonne	123
	Bulldozer	D9	114
	Scraper		110
	Dump truck		108
	Compactor	35 tonne	108
	Grader		113
	Assumed combined activity noise level[1]		**124**
S4 Retaining walls	Excavator with bucket	35 tonne	102
	Dump truck		108
	Semi-trailer truck		108
	Franna crane	20 tonne	98
	Concrete Agitator		108
	Truck & Dog		108
	Tipper Truck		104
	Assumed combined activity noise level[1]		**113**
S5 Utility and stormwater works	Excavator with bucket	35 tonne	102
	Dump truck		108
	Semi-trailer truck		108
	Franna crane	20 tonne	98
	Concrete Agitator		108
	Truck & Dog		108
	Tipper Truck		104
	Assumed combined activity noise level[1]		**113**

Scenario	Plant / Equipment	Details or weight	Sound Power Level (Lw re: 1pW), dB(A), L_{Aeq}
S6 Road pavement construction	Excavator with large rockhammer (50t)	50 tonne	123
	Grader		113
	Compactor (Roller)		107
	Concrete Agitator		108
	Truck & Dog		108
	Tipper Truck		104
	Asphalt truck & sprayer		103
	Assumed combined activity noise level[1]		**124**
S7 Building construction	Concrete Agitator		108
	Semi-trailer truck		108
	Hand tools		104
	Mobile crane		110
	Concrete pump		103
	Bobcat		107
	Concrete vibrators		106
	Assumed combined activity noise level[1]		**114**
S8 Building fitout	Semi-trailer truck		108
	Hand tools		104
	Bobcat		107
	Scissor lift		97
	Assumed combined activity noise level[1]		**111**

Notes 1. Based upon the 3 (noisiest) plant operating concurrently

The sound power levels for the majority of construction plant and equipment presented in the above table are based on maximum noise levels given in Table A1 of Australian Standard 2436 - 2010 ‘Guide to Noise Control on Construction, Demolition and Maintenance Sites’, the Interim Construction Noise Guideline (ICNG), information from past projects and/or information held in our library files.

4.6 Construction noise and vibration assessment

4.6.1 Predicted construction noise levels

Noise levels at any receiver location resulting from construction works would depend on the location of the receiver with respect to the area of construction, shielding from intervening topography and structures, and the type and duration of construction being undertaken. Furthermore, noise levels at receivers would vary significantly over the total construction program due to the transient nature and large range of plant and equipment that could be used.

Noise emissions were determined by modelling the noise sources, receiver locations, and operating activities, based on the information presented in Section 4.5.1.

Table 4-3 presents noise levels likely to be experienced at the nearby affected receivers based on the construction activities and plant and equipment associated with the proposed site. The predicted noise levels have conservatively been based upon the noise level when the plant or equipment are at the location closest to the receiver. Noise levels were calculated taking into consideration attenuation due to distance between the construction works and the receiver locations.

The predicted noise levels presented in Table 4-3 indicate that the noise levels during all construction stages when they are occurring nearby the closest receivers along Wilton Park Road, then the construction noise levels may be above the NML. However, when construction works are taking place at other locations within the Proposal site, the construction noise levels are less are often below the NML. During building construction and building fit-out works, it is only when construction equipment is occurring concurrently, and works are in close proximity to residences that construction noise levels may exceed the NML.

During the site clearing and bulk earthworks some residential receivers are identified as potentially being highly noise affected [i.e., exposed to noise levels greater than 75 dB(A)].

In light of the predicted noise levels above, it is recommended that a feasible and reasonable approach towards noise mitigation measures be applied to reduce noise levels as much as possible to mitigate the impact from construction noise. Further details on construction noise mitigation and management measures are provided in Section 4.6.2 below.

Table 4-3: Predicted $L_{Aeq(15min)}$ noise levels for typical construction plant, dB(A)

Receiver ID	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15[5]	R16[5]
Receiver type[1]	RES	RES	RES	RES	RES	RES	RES	RES	RES	RES	RES	RES	RES	RES	RES	COM
Noise management level	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	70
S1 - Site mobilisation																
Semi-trailer truck	35 - 64	35 - 52	33 - 49	32 - 46	30 - 45	26 - 45	21 - 37	<20 - 37	<20 - 36	<20 - 31	<20 - 32	<20 - 34	<20 - 27	<20 - 24	30 - 60	<20 - 43
Mobile crane	37 - 66	37 - 54	35 - 51	34 - 48	32 - 47	28 - 47	23 - 39	<20 - 39	<20 - 38	<20 - 33	<20 - 34	<20 - 36	<20 - 29	<20 - 26	32 - 62	21 - 45
Excavator with bucket	29 - 58	29 - 46	27 - 43	26 - 39	23 - 39	20 - 38	<20 - 31	<20 - 31	<20 - 30	<20 - 25	<20 - 26	<20 - 28	<20 - 21	<20	24 - 54	<20 - 37
Up to 3 (noisiest) plant operating concurrently	40 - 69	39 - 57	38 - 53	37 - 50	34 - 50	31 - 49	25 - 42	21 - 42	<20 - 40	<20 - 36	<20 - 36	<20 - 38	<20 - 32	<20 - 28	34 - 65	23 - 47
S2 – Site clearing																
Excavator with medium rockhammer (35t)	47 - 76	47 - 64	45 - 61	44 - 57	41 - 57	38 - 56	32 - 49	28 - 49	23 - 48	21 - 43	21 - 44	23 - 46	21 - 39	21 - 36	42 - 72	31 - 55
Bulldozer	41 - 71	41 - 59	40 - 55	38 - 52	36 - 52	33 - 51	27 - 44	22 - 43	<20 - 42	<20 - 38	<20 - 38	<20 - 40	<20 - 33	<20 - 30	36 - 67	25 - 49
Dump truck	35 - 64	35 - 52	33 - 49	32 - 46	30 - 45	26 - 45	21 - 37	<20 - 37	<20 - 36	<20 - 31	<20 - 32	<20 - 34	<20 - 27	<20 - 24	30 - 60	<20 - 43
Up to 3 (noisiest) plant operating concurrently	48 - 78	48 - 66	47 - 62	45 - 59	43 - 59	40 - 58	34 - 51	29 - 50	24 - 49	22 - 45	22 - 45	24 - 47	22 - 40	22 - 37	43 - 74	32 - 56
S3 – Bulk earthworks																
Excavator with large rockhammer (50t)	50 - 79	50 - 67	48 - 64	47 - 60	44 - 60	41 - 59	35 - 52	31 - 52	26 - 51	24 - 46	24 - 47	26 - 49	24 - 42	24 - 39	45 - 75	34 - 58
Bulldozer	41 - 71	41 - 59	40 - 55	38 - 52	36 - 52	33 - 51	27 - 44	22 - 43	<20 - 42	<20 - 38	<20 - 38	<20 - 40	<20 - 33	<20 - 30	36 - 67	25 - 49
Scraper	37 - 66	37 - 54	35 - 51	34 - 48	32 - 47	28 - 47	23 - 39	<20 - 39	<20 - 38	<20 - 33	<20 - 34	<20 - 36	<20 - 29	<20 - 26	32 - 62	21 - 45
Dump truck	35 - 64	35 - 52	33 - 49	32 - 46	30 - 45	26 - 45	21 - 37	<20 - 37	<20 - 36	<20 - 31	<20 - 32	<20 - 34	<20 - 27	<20 - 24	30 - 60	<20 - 43
Compactor	35 - 64	35 - 52	33 - 49	32 - 46	30 - 45	26 - 45	21 - 37	<20 - 37	<20 - 36	<20 - 31	<20 - 32	<20 - 34	<20 - 27	<20 - 24	30 - 60	<20 - 43
Grader	40 - 69	40 - 57	38 - 54	37 - 51	35 - 50	31 - 50	26 - 42	21 - 42	<20 - 41	<20 - 36	<20 - 37	<20 - 39	<20 - 32	<20 - 29	35 - 65	24 - 48
Up to 3 (noisiest) plant operating concurrently	51 - 80	51 - 68	49 - 65	48 - 61	45 - 61	42 - 60	36 - 53	32 - 53	27 - 52	25 - 47	25 - 48	27 - 50	25 - 43	25 - 40	46 - 76	35 - 59
S4 – Retaining walls																
Excavator with bucket	<20 - 51	<20 - 45	<20 - 41	<20 - 39	<20 - 39	<20 - 38	<20 - 32	<20 - 33	<20 - 29	<20 - 27	<20 - 34	<20 - 38	<20 - 33	<20 - 28	<20 - 53	<20 - 49
Dump truck	<20 - 57	<20 - 52	<20 - 47	<20 - 45	<20 - 46	<20 - 44	<20 - 38	<20 - 39	<20 - 35	<20 - 33	<20 - 40	<20 - 44	<20 - 39	<20 - 34	<20 - 59	<20 - 55
Semi-trailer truck	<20 - 57	<20 - 52	<20 - 47	<20 - 45	<20 - 46	<20 - 44	<20 - 38	<20 - 39	<20 - 35	<20 - 33	<20 - 40	<20 - 44	<20 - 39	<20 - 34	<20 - 59	<20 - 55
Franna crane	<20 - 47	<20 - 42	<20 - 37	<20 - 35	<20 - 36	<20 - 34	<20 - 28	<20 - 29	<20 - 25	<20 - 23	<20 - 30	<20 - 34	<20 - 29	<20 - 24	<20 - 49	<20 - 45
Concrete Agitator	<20 - 57	<20 - 52	<20 - 47	<20 - 45	<20 - 46	<20 - 44	<20 - 38	<20 - 39	<20 - 35	<20 - 33	<20 - 40	<20 - 44	<20 - 39	<20 - 34	<20 - 59	<20 - 55
Truck & Dog	<20 - 57	<20 - 52	<20 - 47	<20 - 45	<20 - 46	<20 - 44	<20 - 38	<20 - 39	<20 - 35	<20 - 33	<20 - 40	<20 - 44	<20 - 39	<20 - 34	<20 - 59	<20 - 55
Tipper Truck	<20 - 53	<20 - 48	<20 - 43	<20 - 41	<20 - 42	<20 - 40	<20 - 34	<20 - 35	<20 - 31	<20 - 29	<20 - 36	<20 - 40	<20 - 35	<20 - 30	<20 - 55	<20 - 51
Up to 3 (noisiest) plant operating concurrently	<20 - 62	<20 - 56	<20 - 51	<20 - 50	<20 - 50	<20 - 49	<20 - 43	<20 - 44	<20 - 40	<20 - 38	<20 - 45	<20 - 48	<20 - 44	<20 - 39	<20 - 64	<20 - 60

Receiver ID	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15[5]	R16[5]
Receiver type[1]	RES	RES	RES	RES	RES	RES	RES	RES	RES	RES	RES	RES	RES	RES	RES	COM
Noise management level	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	70
S5 – Utility and stormwater works																
Excavator with bucket	29 - 58	29 - 46	27 - 43	26 - 39	23 - 39	20 - 38	<20 - 31	<20 - 31	<20 - 30	<20 - 25	<20 - 26	<20 - 28	<20 - 21	<20	24 - 54	<20 - 37
Dump truck	35 - 64	35 - 52	33 - 49	32 - 46	30 - 45	26 - 45	21 - 37	<20 - 37	<20 - 36	<20 - 31	<20 - 32	<20 - 34	<20 - 27	<20 - 24	30 - 60	<20 - 43
Semi-trailer truck	35 - 64	35 - 52	33 - 49	32 - 46	30 - 45	26 - 45	21 - 37	<20 - 37	<20 - 36	<20 - 31	<20 - 32	<20 - 34	<20 - 27	<20 - 24	30 - 60	<20 - 43
Franna crane	25 - 54	25 - 42	23 - 39	22 - 36	<20 - 35	<20 - 35	<20 - 27	<20 - 27	<20 - 26	<20 - 21	<20 - 22	<20 - 24	<20	<20	<20 - 50	<20 - 33
Concrete Agitator	35 - 64	35 - 52	33 - 49	32 - 46	30 - 45	26 - 45	21 - 37	<20 - 37	<20 - 36	<20 - 31	<20 - 32	<20 - 34	<20 - 27	<20 - 24	30 - 60	<20 - 43
Truck & Dog	35 - 64	35 - 52	33 - 49	32 - 46	30 - 45	26 - 45	21 - 37	<20 - 37	<20 - 36	<20 - 31	<20 - 32	<20 - 34	<20 - 27	<20 - 24	30 - 60	<20 - 43
Tipper Truck	31 - 60	31 - 48	29 - 45	28 - 42	26 - 41	22 - 41	<20 - 33	<20 - 33	<20 - 32	<20 - 27	<20 - 28	<20 - 30	<20 - 23	<20	26 - 56	<20 - 39
Up to 3 (noisiest) plant operating concurrently	40 - 69	40 - 57	38 - 53	37 - 50	34 - 50	31 - 49	25 - 42	21 - 42	<20 - 40	<20 - 36	<20 - 37	<20 - 38	<20 - 32	<20 - 28	34 - 65	23 - 47
S6 – Road pavement construction																
Excavator with large rockhammer (50t)	43 - 64	45 - 60	40 - 60	39 - 59	41 - 60	41 - 59	38 - 51	39 - 46	39 - 48	34 - 46	39 - 54	39 - 57	36 - 47	36 - 44	48 - 59	46 - 63
Grader	33 - 54	35 - 50	30 - 50	30 - 49	31 - 50	31 - 50	28 - 41	29 - 36	30 - 38	24 - 36	29 - 44	29 - 47	26 - 37	26 - 34	38 - 50	36 - 53
Compactor (Roller)	27 - 48	29 - 44	24 - 44	24 - 43	25 - 44	25 - 44	22 - 35	23 - 30	24 - 32	<20 - 30	23 - 38	23 - 41	20 - 31	<20 - 28	32 - 44	30 - 47
Concrete Agitator	28 - 49	30 - 45	25 - 45	25 - 44	26 - 45	26 - 45	23 - 36	24 - 31	25 - 33	<20 - 31	24 - 39	24 - 42	21 - 32	21 - 29	33 - 45	31 - 48
Truck & Dog	28 - 49	30 - 45	25 - 45	25 - 44	26 - 45	26 - 45	23 - 36	24 - 31	25 - 33	<20 - 31	24 - 39	24 - 42	21 - 32	21 - 29	33 - 45	31 - 48
Tipper Truck	24 - 45	26 - 41	21 - 41	21 - 40	22 - 41	22 - 41	<20 - 32	<20 - 27	21 - 29	<20 - 27	<20 - 35	20 - 38	<20 - 28	<20 - 25	29 - 41	27 - 44
Asphalt truck & sprayer	23 - 44	25 - 40	<20 - 40	<20 - 39	21 - 40	21 - 40	<20 - 31	<20 - 26	<20 - 28	<20 - 26	<20 - 34	<20 - 37	<20 - 27	<20 - 24	28 - 40	26 - 43
Up to 3 (noisiest) plant operating concurrently	43 - 64	45 - 61	40 - 60	40 - 60	42 - 61	41 - 60	38 - 52	39 - 47	40 - 49	34 - 47	39 - 54	40 - 58	37 - 48	36 - 45	49 - 60	47 - 64
S6 – Building construction																
Concrete Agitator	21 - 53	23 - 49	22 - 47	20 - 45	21 - 45	25 - 44	24 - 38	23 - 38	22 - 35	<20 - 33	<20 - 39	<20 - 41	<20 - 34	<20 - 32	25 - 57	25 - 55
Semi-trailer truck	21 - 53	23 - 49	22 - 47	20 - 45	21 - 45	25 - 44	24 - 38	23 - 38	22 - 35	<20 - 33	<20 - 39	<20 - 41	<20 - 34	<20 - 32	25 - 57	25 - 55
Hand tools	<20 - 49	<20 - 45	<20 - 43	<20 - 41	<20 - 41	21 - 40	<20 - 34	<20 - 34	<20 - 31	<20 - 29	<20 - 35	<20 - 37	<20 - 30	<20 - 28	21 - 53	21 - 51
Mobile crane	23 - 55	25 - 51	24 - 49	22 - 47	23 - 47	27 - 46	26 - 40	25 - 40	24 - 37	<20 - 35	<20 - 41	<20 - 43	<20 - 36	<20 - 34	27 - 59	27 - 57
Concrete pump	<20 - 48	<20 - 44	<20 - 42	<20 - 40	<20 - 40	<20 - 39	<20 - 33	<20 - 33	<20 - 30	<20 - 28	<20 - 34	<20 - 36	<20 - 29	<20 - 27	<20 - 52	<20 - 50
Bobcat	20 - 52	22 - 48	21 - 46	<20 - 44	20 - 44	24 - 43	23 - 37	22 - 37	21 - 34	<20 - 32	<20 - 38	<20 - 40	<20 - 33	<20 - 31	24 - 56	24 - 54
Concrete vibrators	<20 - 51	21 - 47	20 - 45	<20 - 43	<20 - 43	23 - 42	22 - 36	21 - 36	<20 - 33	<20 - 31	<20 - 37	<20 - 39	<20 - 32	<20 - 30	23 - 55	23 - 53
Up to 3 (noisiest) plant operating concurrently	27 - 58	28 - 54	28 - 52	26 - 51	27 - 51	30 - 50	29 - 43	29 - 44	27 - 41	23 - 38	22 - 45	22 - 46	<20 - 39	21 - 37	30 - 63	30 - 61

Receiver ID	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15[5]	R16[5]
Receiver type[1]	**RES**	**RES**	**RES**	**RES**	**RES**	**RES**	**RES**	**RES**	**RES**	**RES**	**RES**	**RES**	**RES**	**RES**	**RES**	**COM**
Noise management level	**55**	**55**	**55**	**55**	**55**	**55**	**55**	**55**	**55**	**55**	**55**	**55**	**55**	**55**	**55**	**70**
S8 – Building fitout																
Semi-trailer truck	21 - 53	23 - 49	22 - 47	20 - 45	21 - 45	25 - 44	24 - 38	23 - 38	22 - 35	<20 - 33	<20 - 39	<20 - 41	<20 - 34	<20 - 32	25 - 57	25 - 55
Hand tools	<20 - 49	<20 - 45	<20 - 43	<20 - 41	<20 - 41	21 - 40	<20 - 34	<20 - 34	<20 - 31	<20 - 29	<20 - 35	<20 - 37	<20 - 30	<20 - 28	21 - 53	21 - 51
Bobcat	20 - 52	22 - 48	21 - 46	<20 - 44	20 - 44	24 - 43	23 - 37	22 - 37	21 - 34	<20 - 32	<20 - 38	<20 - 40	<20 - 33	<20 - 31	24 - 56	24 - 54
Scissor lift	<20 - 42	<20 - 38	<20 - 36	<20 - 34	<20 - 34	<20 - 33	<20 - 27	<20 - 28	<20 - 25	<20 - 22	<20 - 28	<20 - 30	<20 - 23	<20 - 21	<20 - 46	<20 - 45
Up to 3 (noisiest) plant operating concurrently	24 - 56	26 - 52	26 - 50	24 - 48	25 - 49	28 - 48	27 - 41	27 - 42	25 - 39	21 - 36	<20 - 42	20 - 44	<20 - 37	<20 - 35	28 - 61	28 - 59

Notes:

1. Predicted level not presented if less than 20 dB(A)
2. RES = Residential, COM = Commercial
3. In accordance with the ICNG, a 5 dB(A) ‘penalty’ is applied for activities identified as particularly annoying, such as rock hammers.
4. Construction noise levels with dark grey background identify residential receivers are predicted to be highly noise affected (HNA) [>75 dB(A)].
5. One representative receiver is shown for lots with multiple buildings.

4.6.2 Vibration assessment

4.6.2.1 Vibration sources

The pattern of vibration radiation is very different to the pattern of airborne noise radiation. Unlike noise, vibration cannot be readily predicted. There are many variables from site to site, such as the intervening geology between the activity and the receiver, building types and foundations. Vibration is also dependent on the actual plant used, its operation and the dominant frequencies of vibration generated, and the plant location on site relative to receivers.

The recommended minimum working distances for vibration intensive plant are presented in Table 4-4 and Table 4-5. The data relied upon for this assessment is taken from a database of vibration levels measured at various sites or obtained from other sources (such as BS5228-2:2009). They are not specific to this Project.

Site specific minimum working distances for vibration intensive plant items must be measured on site where plant and equipment are likely to operate close to or within the minimum working distances for cosmetic damage, as detailed in Table 4-4.

Table 4-4: Minimum working distances (m) for cosmetic damage (continuous vibration)

Plant item	Minimum working distance (m)[5]		
	Reinforced or framed structures (e.g. commercial buildings)[1,3]	Unreinforced or light framed structures (e.g. residential buildings)[1,3]	Sensitive structures (e.g. heritage structures)[2,4,5]
Large excavator with hydraulic hammer attachment (up to 90t)	5	15	30
Medium excavator with hydraulic hammer attachment (up to 15t)	5	5[7]	10
Small excavator with hydraulic hammer attachment (up to 5t)	5	5	10
Vibratory roller (up to 11t)	5	15	20
Pile boring	5	5	5

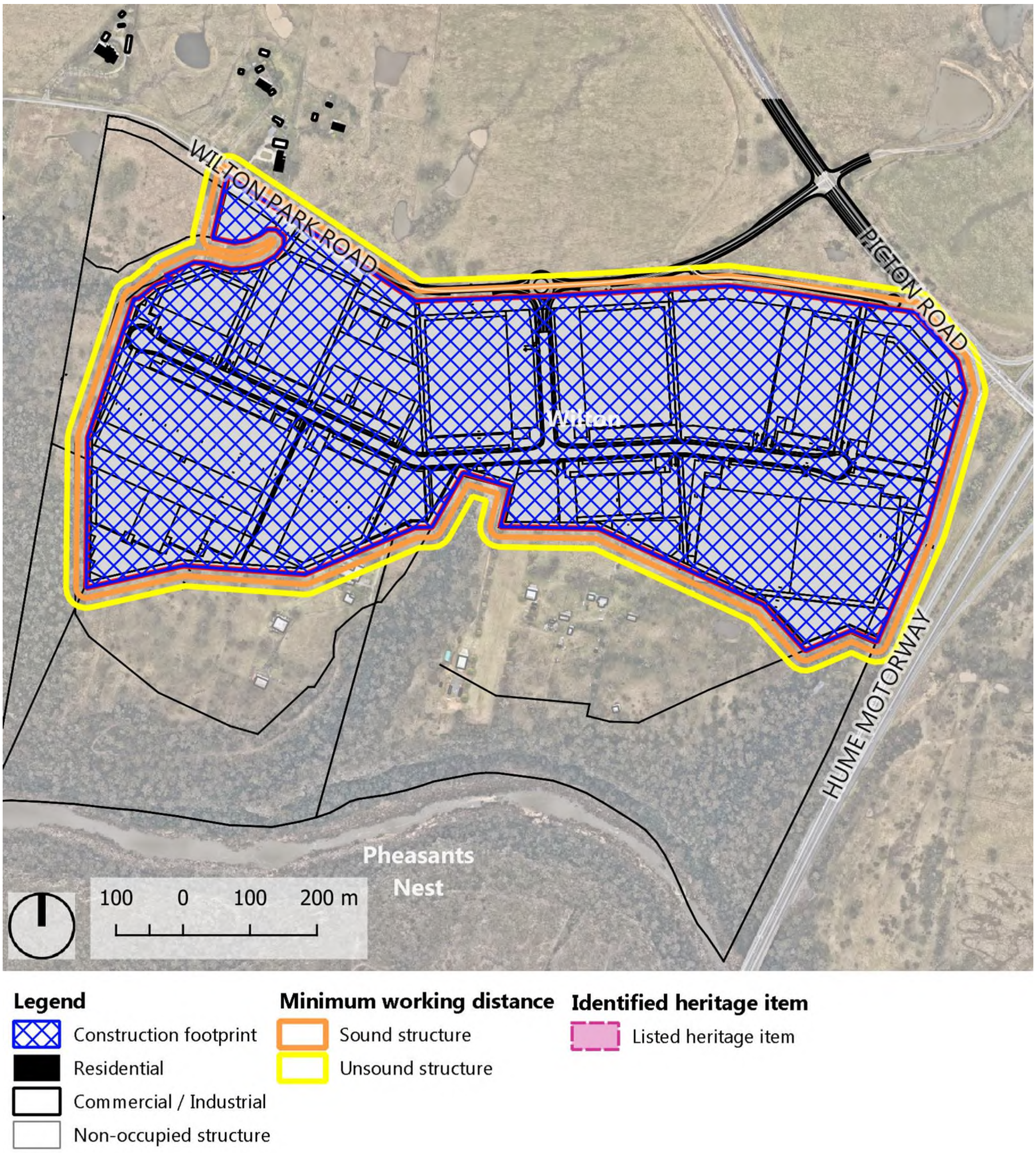
Notes
1. Criteria referenced from British Standard 7385: Part 2 '*Evaluation and measurement of vibration in buildings*'.
2. Criteria referenced from DIN 4150 Part 3, Structural Damage - Safe Limits for Short-term Building Vibration.
3. Initial screening test criteria reduced by 50% due to potential dynamic magnification in accordance with BS7385.
4. A building condition inspection should determine whether a heritage item is structurally unsound.
5. Heritage specialist will be consulted to determine appropriate vibration criteria and associated MWDs, vibration monitoring locations and monitor setup.
6. Minimum working distances are in 5m increments only to account for the intrinsic uncertainty of this screening method.

Potential vibration impacts are to be further reviewed during the construction design planning stages to determine if the final selected plant and equipment could be located within the minimum working distances and/or result in vibration about the applicable vibration limits. Where identified, feasible and reasonable mitigation and management would be implemented to achieve the applicable vibration limits.

As a screening assessment, the greatest of all minimum working distances from the various proposed vibration intensive activities has been mapped from the project construction boundary. Non-heritage structures of heritage items or heritage curtilages were classified as heritage for this review so to map and identify all structures within the minimum working distances.

The minimum working distance from the extent of the construction areas, based upon the most vibration intensive plant and the project construction boundary are presented in Figure 14.

Figure 14: Minimum working distances for cosmetic damage from the construction area extent (most vibration intensive plant)



* Mixed use is shown as residential

1. Heritage data source: State Government of NSW and Department of Planning, Industry and Environment 2015
2. Imagery source: Nearmap (July 2022)

The recommended minimum working distances for vibration intensive plant for human annoyance are presented Table 4-5.

Table 4-5: Minimum working distances (m) for human annoyance (continuous vibration)

Plant item	Minimum working distances (m)				
	Critical areas[2,3] 0.28 mm/s	Residences Day[1] 0.56mm/s	Residences Night[1] 0.40 mm/s	Offices[2] 1.1 mm/s	Workshops[2] 2.2 mm/s
Large excavator with hydraulic hammer attachment (up to 90t)	145	90	115	55	30
Medium excavator with hydraulic hammer attachment (up to 15t)	30	20	25	15	10
Small excavator with hydraulic hammer attachment (up to 5t)	25	20	20	15	10
Vibratory roller (up to 11t)	120	70	90	40	25
Vibratory pile driver	40	30	35	20	15
Pile boring	20	15	15	10	10

Notes:
1. Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am
2. Appliable when in use
3. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992

4.6.2.2 Vibration assessment outcomes

4.6.2.2.1 Cosmetic damage

There are no reinforced, unreinforced or heritage structures within the minimum working distance identified in Table 4-4 above. The closest heritage listed item is approximately 550 metres west of the Proposal site.

4.6.2.2.2 Human annoyance

The nearest residential receiver to the north is approximately 45 metres from the works, at 90 Wilton Park Road (R1). Based on the minimum working distance of up to 90 metres for larger and vibration intensive plant used during the bulk earthworks or retaining wall phases of works during the day period, exceedances of the human annoyance criteria may result at nearby residential receivers when works are occurring close to occupied sensitive receiver buildings. As such, potential human annoyance impacts should be further reviewed when vibration intensive works are proposed to take place within the minimum working distances, and feasible and reasonable mitigation and management measures adopted as detailed in Section 4.7.2.

Attended vibration measurements for human annoyance are proposed to be carried in response to vibration complaints (Section 4.7.2) Reasonable and feasible mitigation measures for the proposed works are summarised in Section 4.7.2.

4.7 Construction noise and vibration mitigation and management measures

4.7.1 Noise management measures

The following recommendations provide feasible and reasonable noise control solutions to reduce noise impacts to nearby sensitive receivers. These should be considered and implemented where feasible and reasonable where there is potential for the noise management levels presented in Section 4.6.1 to be exceeded by the construction works either individually or cumulatively.

Accounting for the predicted noise levels set out in Section 4.6.1, the following noise management measures are recommended for consideration by the contractors and implemented where feasible and reasonable.

Table 4-6 summarises actions that can be applied to manage the potential for noise to impact on sensitive receivers near the Project construction works, which are to be applied where reasonable and feasible.

Table 4-6: Noise mitigation and management measures

Action required	Applies to	Details	Estimated noise benefit
At-source mitigation measures			
Equipment selection	Airborne noise Vibration	Use quieter and less noise/vibration emitting construction methods where feasible and reasonable. Where loud plant and/or equipment are being used in construction works, where feasible and reasonable the selection of alternative quieter plant and/or equipment should be considered for tasks.	Variable. Minimise noise impact and reduce risk of annoyance.
Equipment noise and vibration levels	Airborne noise Vibration	Plant and equipment must be properly maintained. Provide special attention to the use and maintenance of 'noise control' or 'silencing' kits fitted to machines to ensure they perform as intended.	Variable. Minimise noise impact and reduce risk of annoyance.
Rental plant and equipment	Airborne noise	The noise levels of plant and equipment items are to be considered in rental decisions, with quieter and less noise/vibration emitting construction methods where feasible and reasonable.	Variable. Minimise noise impact and reduce risk of annoyance.
Use and siting of plant	Airborne noise Vibration	• Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be avoided. • The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. • Plant used intermittently to be throttled down or shut down. • Noise-emitting plant to be directed away from sensitive receivers. • Any equipment not in use for extended periods during construction work must be switched off.	Up to 20 dB reduction + reduce vibration

Action required	Applies to	Details	Estimated noise benefit
Non-tonal and ambient sensitive reversing alarms	Airborne noise	Where feasible and reasonable, non-tonal movement alarms will be used in place of tonal reversing alarms for construction vehicles and mobile plant regularly used on site and for any out of hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.	5-10 dB reduction
Minimise disturbance arising from delivery of goods	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers if possible. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.	Variable. Reduce noise/ vibration impact + risk of annoyance.
Silencers on mobile plant	Airborne noise	Where possible reduce noise from mobile plant through additional fittings including: - Residential grade mufflers - Air Parking brake engagement is silenced. Ensure plant including the silencer is well maintained.	0-20 dB reduction Reduce annoyance + sleep disturbance.
Prefabrication of materials off-site	Airborne noise	Where practicable, pre-fabricate and/or prepare materials off-site to reduce noise with special audible characteristics occurring on site. Materials can then be delivered to site for installation.	5-20 dB reduction Reduce noise/ vibration impact + risk of annoyance
Engine compression brakes	Airborne noise	Limit the use of engine compression brakes in residential areas. Ensure vehicles are fitted with a maintained original equipment manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'In-service test procedure' and standard.	5-20 dB reduction
Reversing alarms	Airborne noise	Use of broadband "quacker" type of reverse/movement alarms instead of the tonal 'beeping" type.	Minimise noise impact and reduce risk of annoyance.
Path mitigation measures			
Noise bunds, mounds and stockpiles	Airborne noise	Noise bunds, mounds and stockpiles are beneficial when the line of sight is broken between source and receiver. As there are opportunities to use strategically located spoil stockpiles, and plan excavation works to strategically use noise bunds and cutting, these should be incorporated into the construction planning.	Receiver **with** line of site of the works area: 5-10 dB reduction Receiver **without** line of site of the works area: 0-5 dB reduction
Site sheds	Airborne noise	Site sheds to be strategically located to provide shielding to nearby residences.	Receiver **with** line of site of the works area: 5-10 dB reduction
Laydown and stockpiling	Airborne noise	Locate laydown and stock piling as far from residences within the construction works areas. Alternatively, where this is not possible, they should be considered for use as noise mounds.	Variable. Minimise noise impact and reduce risk of annoyance.

Action required	Applies to	Details	Estimated noise benefit
Management measures			
Implement stakeholder consultation measures	Airborne noise	Periodic notification (monthly letterbox drop and website notification) detailing all upcoming construction activities delivered to sensitive receivers at least 7 days prior to commencement of relevant works. In addition to Periodic Notification, the following strategies may be adopted to notify the community of upcoming works: • Project Specific Website • Project Infoline • Email Distribution List • Web-based Surveys • Social Media • Community and Stakeholder Meetings.	Keeps stakeholders informed of the likely impact. Community may identify solution to assist in managing impacts.
Register of noise and vibration sensitive receivers	Airborne noise Vibration	A register of most affected noise and vibration sensitive receivers (NVSRs) would be kept on site. The register would include the following details for each NVSR: • Address of receiver • Category of receiver (e.g. Residential, Commercial etc.) • Contact name and phone number. The register may be included as part of the Project's Community Liaison Plan or similar document.	Assists with keeping stakeholders informed of the likely impact. Assists with planning and reducing potential noise/ vibration impact + risk of annoyance
Site inductions	Airborne noise Vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • All relevant project specific and standard noise and vibration mitigation measures • Permissible hours of work • Any limitations on noise generating activities with special audible characteristics • Location of nearest sensitive receivers • Construction employee parking areas • Designated loading/unloading areas and procedures • Site opening/closing times (including deliveries) • Environmental incident procedures.	Keeps construction workforce informed of actions required to minimise noise and vibration impact.
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors. No excessive revving of plant and vehicle engines. Controlled release of compressed air.	0-20 dB reduction Reduce annoyance + sleep disturbance.
Heavy vehicle routes	Airborne noise	Construction heavy vehicles and delivery vehicles should be scheduled during standard construction hours where feasible and reasonable.	Minimises noise impacts
Verification monitoring	Airborne noise	In response to noise complaints, a noise monitoring program should be carried out for the duration of works in accordance with the Construction Noise and Vibration Management Plan (CNVMP) or CEMP and any approval conditions.	Minimises noise impacts

Action required	Applies to	Details	Estimated noise benefit
Complaints management	Airborne noise Vibration	See Section 4.7.3 for further details. In addition to the noise mitigation measures outlined above, a management procedure will need to be put in place to deal with noise complaints that may arise from construction activities. Each complaint will need to be investigated and appropriate noise amelioration measures put in place to mitigate future occurrences, where the noise in question is in excess of allowable limits.	Minimise noise impact and reduce risk of annoyance.

The advice provided above is in respect of acoustics only. Supplementary professional advice may be needed in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

Additionally, implementation of noise control measures, such as those suggested in Australian Standard 2436-2010 '*Guide to Noise Control on Construction, Demolition and Maintenance Sites*', are expected to reduce predicted construction noise levels. Australian Standard 2436-2010, Appendix C, Table C1 suggests possible remedies and alternatives to reduce noise emission levels from typical construction equipment. Table C2 in Appendix C presents typical examples of noise reductions achievable after treatment of various noise sources. Table C3 in Appendix C presents the relative effectiveness of various forms of noise control treatment.

4.7.1.1 Highly noise affected receivers

Some residential receivers nearest to the construction work areas may be 'highly noise affected' [ie exposed to noise levels that exceed 75 dB(A)] as a result of high noise generating works in close proximity.

As such, where construction noise is likely to be above the 'highly noise affected' level, respite periods should be considered where feasible and reasonable. The following potential respite periods would be considered:

- High noise impact activities carried out in continuous blocks of up to three hours. Respite provided between each block of high noise impact activities for at least one hour. No high noise impact activities carried out during this one hour respite period.
- Where an alternative approach to the above is preferable, a respite period can be agreed upon with the potentially impacted receivers if the premises are occupied during the construction period. Potential respite periods would limit the use of high impact activities, such as hammering, to say 9:00am to 5:00pm with a one hour break during this period.

4.7.1.2 Noise monitoring

The following approach could be adopted regarding noise monitoring procedures during the construction works.

- In the event of a sustained complaint, noise monitoring may be carried out to examine noise impacts.
  - Reasonable and feasible noise reduction measures must be investigated, where necessary.
  - Typically short term (attended) noise monitoring would be undertaken to investigate a complaint as opposed to ongoing noise logging as this will enable a faster response time.
  - Where short term attended noise measurements cannot produce a suitable outcome, long term noise monitoring will be considered. Typically, long term monitoring is useful primarily to check if start/finish times or respite periods have been adhered to. Given this limitation, that are not typically proposed in first instance.

As part of further design development, when a contractor is appointed and the specific construction methodology is known and the likely construction equipment are also known the potential construction impacts are to be reviewed to determine that they are consistent with those presented in Section 4.6 and that the associated mitigation and management measures are appropriate.

4.7.1.3 Cumulative construction noise impacts

The Proposal is located in proximity to the WTC. As such, construction works for this area may be underway concurrently with the Proposal. As such, there will be multiple construction projects undergoing noise generating construction works concurrently with stages of the Proposal.

Further details about potential cumulative noise impacts are provided in Section 3.1.3. As there is potential for cumulative noise impacts from the Proposal combined with other future concurrent construction projects it is recommended that mitigation and management measures are implemented to minimise cumulative impacts, as detailed in Section 4.6.2. In addition, the following measures are to be used to mitigate and manage cumulative noise impacts and reduce the likelihood of construction fatigue:

- Coordinating work between construction sites to minimise cumulative noise impacts, where feasible and reasonable (ie. to ensure that multiple sites are not undertaking high noise generating works concurrently with direct line-of-sight to receivers).
- Community consultation to gauge key noise impacts and issues and identify any unknown impacts from concurrent or consecutive sets of constructions works.
- Consideration of cumulative construction noise impacts during the development of noise mitigation and management measures for the worksites, including coordination between construction projects, where reasonable and feasible.

The incorporation of the above measures into the works program would be further reviewed when a contractor is engaged for the works.

4.7.2 Vibration management measures

The following vibration management measures are provided to minimise vibration impact from construction activities to the nearest receivers.

4.7.2.1 Cosmetic damage

As detailed in Section 4.6.2.2.1, there are no reinforced, unreinforced or heritage structures currently identified within the minimum working distance. However, information may be updated during the construction process, construction methodologies may change, works areas may vary, and noting the changing nature of the area management of potential cosmetic damage impacts may be required. If this is the case, the following can be used to manage these potential cosmetic damage impacts.

1. Where construction activities occur in close proximity to sensitive receivers/structures or on material that will likely cause vibration to any identified receiver/structure, vibration testing of actual equipment on site should be carried out prior to their commencement of site operation to determine site specific acceptable minimum working distance to the nearby sensitive receiver/structures location/s.

   Undertake attended vibration measurements at the commencement of vibration-generating activities to establish site-specific minimum working distances and re-assess potential impacts (if required). This may include further detailed analysis based on the frequency content of the vibration levels.

2. If vibration intensive work is proposed to occur within the site specific acceptable minimum working distance, then the following would be carried out:

   a. Evaluate whether alternative construction methods, plant or equipment can be utilised for the works and re-assess potential impacts (if required).

   b. If there is any risk of exceeding the vibration objectives after all of the above options have been considered, a permanent vibration monitoring system should be installed, to warn plant operators (via flashing light, audible alarm, SMS, etc) when vibration levels are approaching the structural/cosmetic damage limits. It is recommended that for the operator alerts, that multiple alert levels are set. Typically, this would be an alert trigger level at 75% of the vibration criteria (ie. amber alert), and an alert trigger level at 100% of the vibration criteria (ie. red alert).

   c. A management procedure would be developed prior to the works taking place to determine the response to each trigger level. It is recommended that this includes a pause and management measures for an alert trigger level at 75% of the vibration criteria, and stop work at an alert trigger level at 100% of the vibration criteria. Where stop work is triggered, it is recommended that the following are undertaken:

      Stop works actions

      i. Investigate cause of exceedance

ii. Visual inspection of the vibration sensitive building/structure/item including photos

iii. If no cosmetic damage is found, works and vibration monitoring can be resumed

iv. If cosmetic damage has been identified, repair damage or undertake any specific required action (ie. data centre notification) and a different construction method with lower source vibration levels is to be used.

d. If works are proposed within the cosmetic damage minimum working distance, prior to starting work a building/structure condition survey would be carried out on items within the minimum working distances and vibration limits determined to manage cosmetic damage.

3. Dilapidation surveys must be conducted at all receivers within close proximity of the construction site.

4.7.2.2 Human annoyance

Many building occupants assume that building damage is occurring when they feel vibration or observe rattling of loose objects, however the level of vibration at which people perceive vibration or at which loose objects may rattle is far lower than vibration levels that can cause damage to structures. At properties near the construction works, nearby receivers may be able to feel vibration when vibration-generating equipment is being utilised. For this reason, it is appropriate identify properties where there is a probability of adverse comment so that impacts can be managed.

1. A management procedure should be implemented to deal with vibration complaints. Each complaint should be investigated and where vibration levels are established as exceeding the set limits, appropriate amelioration measures should be put in place to mitigate future occurrences.

2. Where vibration is found to be excessive, management measures should be implemented to ensure vibration compliance is achieved. Management measures may include modification of construction methods such as using smaller equipment, establishment of safe buffer zones as mentioned above, and if necessary, time restrictions for the most excessive vibration activities. Time restrictions are to be negotiated with affected receivers.

3. Attended vibration measurements for human annoyance should be carried out as required to appropriately manage the works. The proximity of neighbouring residences will be communicated to subcontractors highlighting the relevant vibration restrictions and criteria for the area. This information will also be communicated during pre-tender meetings, start-up meetings and site inductions of personnel.

4. Notification by letterbox drop would be carried out for all buildings in the vicinity of the construction site. These measures are to address potential community concerns that perceived vibration may cause damage to property. Notification is to be provided to all occupants prior to any works that may cause vibration.

4.7.3 Complaints management

Noise and vibration levels generated by construction activities associated with the construction of the development must aim to comply with the noise and vibration goals set by the relevant regulations and guidelines.

The contractor is responsible for ensuring that all reasonable and feasible mitigation and management measures are implemented such as the provision of a Noise and Vibration Complaints Program, to minimise the generation of excessive noise and/or vibration levels from the site to nearby sensitive areas.

Owners and occupants of nearby affected properties are to be informed by direct mail of a direct telephone line and contact person where any noise and/or vibration complaints related to the construction activities are to be reported.

All noise and/or vibration complaints associated with the construction works shall be investigated in accordance with the Noise / Vibration Complaint Management Procedure identified in APPENDIX B.

5 Operational acoustic review

5.1 Operational road traffic

5.1.1 Existing traffic

Traffic classification surveys were carried out by TTM during June 2022 at three locations along the proposed vehicle routes to and from the Proposal site. The results of the analysed traffic classification surveys are presented in Table 5-1.

Table 5-1: Existing traffic volumes

Road	Traffic monitoring location	Average hourly traffic from[3] 7:00am – 10:00pm (15 hour)				Average hourly traffic from[3] 10:00pm – 7:00am (9 hour)			
		Total Vehicles	Percentage Heavy Vehicles		Speed[2] (km/h)	Total Vehicles	Percentage Heavy Vehicles		Speed[2] (km/h)
			Medium	Heavy			Medium	Heavy	
Wilton Park Road	Wilton Park Road, south of Picton Rd	626	14	1	49	102	13	2	46
Picton Road	Picton Road, east of Wilton Park Road	11,227	10	5	83	2,024	15	9	80
Hume Motorway	Hume Motorway, at Picton Road Overpass	29,772	4	11	110[5]	4,823	6	31	110[5]

Notes:
1. Based upon an analysis of the count data for the period of 23 June 2022 to 29 June 2022.
2. Based on average vehicle speeds from traffic survey.
3. Based upon combined two-way traffic counts
4. Speed data not monitored, based upon posted speed

5.1.2 Proposal vehicle movements and traffic generation

Heavy vehicle movements for operational traffic to and from the Proposal site will be up to approximately 800 metres of the public roads within the Proposal industrial estate, and then along Wilton Park Road connecting to Picton Road, and then to nearby major arterial roads, including the Hume Motorway. These likely routes are shown in Figure 15.

The traffic volumes used for traffic noise predictions and assessment were based on traffic movement data and route distribution data provided by the project team.

At this stage, the traffic volumes are not clearly understood as the final tenants across the industrial estate are not known. As such, the requirement for different types of vehicles, the times of operation, and the volumes are subject to the type of final tenants. As such, indicative traffic volumes for a similar type of warehouse facility have been provided by the project team to review the potential traffic generation noise impacts by the proposal.

As tenants apply to operate at the facility, these assumed volumes and their associated potential noise impacts would require review to determine that the proposed operations are consistent with the assumptions in this NVIA and the associated noise emissions outcomes. Table 5-2 presents a summary of the forecasted vehicles assumed for the Proposal provided by the project team.

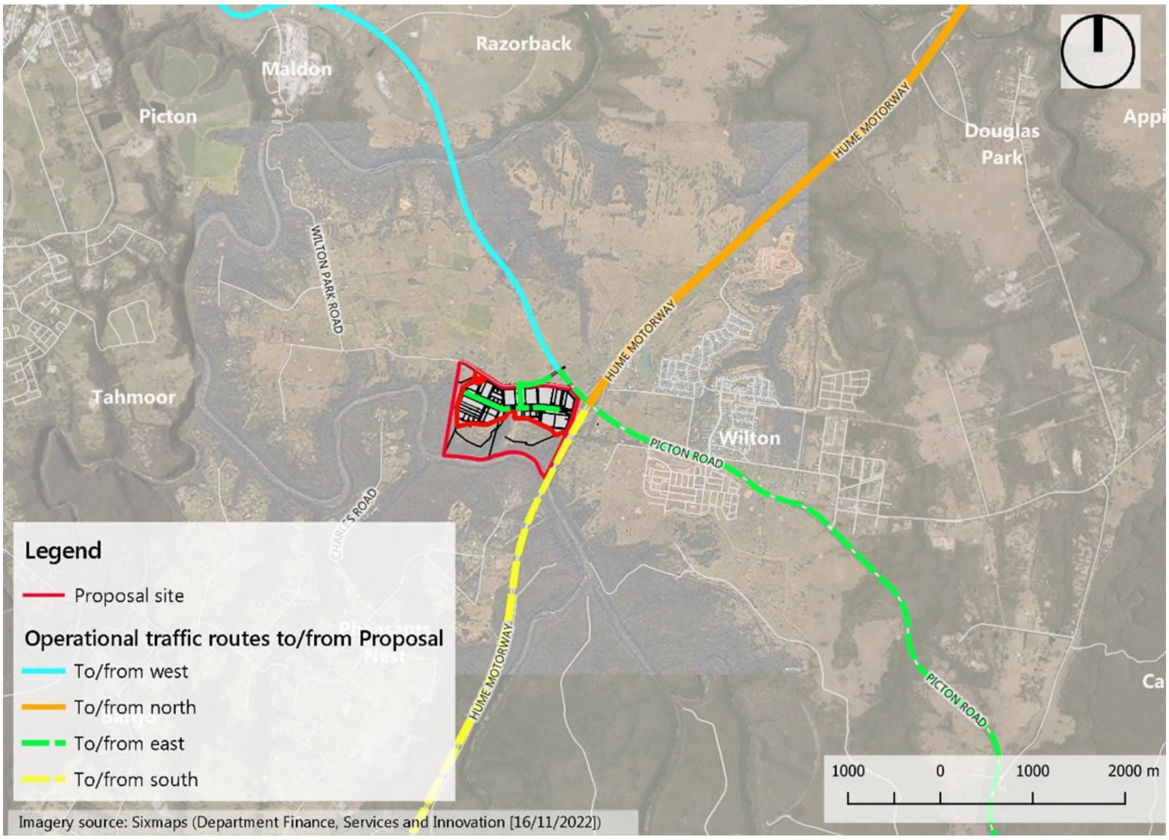
Table 5-2: Assumed vehicle movements and composition

Period	Inbound or outbound movements				Total heavy vehicles (inbound + outbound)[1]	Total vehicles (inbound + outbound)[1]
	Light vehicle	Rigid	Semi-trailer	A-double / B-double		
Day (7am-10pm)	3,472	922	94	377	1,393	4,866
Night (10pm-7am)	1,106	193	20	79	291	1,397

Notes: 1. It has been assumed that both an inbound and outbound movement may occur within the same assessment period in the noise modelling as a conservative approach, and to address the different receiver locations. As such, the above movements have been modelled either entering or leaving the facility in the same assessment period. For the public road traffic assessment, the total number of movements represent these vehicles on the public road and so an inbound + outbound movement equals two movements on the public road.

2. Conservatively, it has been assumed that similar heavy movements may occur during the evening or shoulder periods.

Figure 15: Operational truck routes



5.1.3 Road traffic noise assessment outcome

The potential road traffic noise levels from predicted Proposal traffic were modelled using the *Federal Highway Administration Model 2004 (TNM 2.5)* (FHWA-TNM method) to review the potential change in traffic noise levels at future residential receivers adjacent to the sub-arterial roads that will be used by the Proposal.

This model has been selected as it is identified in Appendix B4 of the RNP as a suitable road traffic noise model that has been validated under specific Australian conditions, while also allowing for a greater level of break-down and categorisation of heavy vehicle types, compared with the relatively simplistic corrections for the percentage of heavy vehicles in the *Calculation of Road Traffic Noise (1988)* (CoRTN88) method. Considering the number of heavy vehicle movements per day as part of the Proposal, adopting an approach with a greater level of accuracy and consideration for heavy vehicles is appropriate. It has conservatively been assumed that all heavy vehicles associated with the Proposal are classified as heavy trucks for the purpose of the FHWA-TNM method assessment inputs.

5.1.3.1 Wilton Park Road

The Proposal vehicles presented in Table 5-2 were modelled along internal Proposal public roads and Wilton Park Road along the future ultimate alignment, which is still under development, as shown in Figure 3.

Based upon the WGA DCP (see Section 3.5), a minimum setback distance from the road of 20 metres was assumed for receivers adjacent to the roads noting that the future sub-arterial traffic volumes are not known.

This modelling did not consider the potential future terrain or cuttings as these are not known. Additionally, the existing Wilton Park Road is lower than the future WTC residential receivers, therefore the final alignment and location of residences could alter the predicted noise levels.

This modelling predicted that the Proposal traffic would likely result in road traffic noise levels above the criteria presented in Table 3-15, being $L_{Aeq,(15\ hour)}$ 60 dB(A) for daytime (7:00am to 10:00pm), and $L_{Aeq,(9\ hour)}$ 55 dB(A) for night time (10:00pm and 7:00am) at the future residential receivers adjacent to Wilton Park Road.

Road traffic noise levels should be assessed cumulatively and not only for a Proposal in isolation. Noting the changing nature of the area, in particular Wilton Park Road, as per Section 3.5 "*Cumulative impacts from traffic generating developments*" of the RNP it is important to consider the cumulative impacts of transport and land use development. However, as the potential traffic noise volumes along Wilton Park Road are not finalised, and the future plans for West Wilton and WTC are not finalised, along with the Picton Road upgrade, it is recommended that a further review of potential road traffic noise impacts at a strategic planning level should be undertaken once these details are known.

However, it is recommended that consistent with the WGA DCP (see Section 3.5), that the residential properties in proximity of Wilton Park Road should be designed to achieve suitable internal amenity noise levels taking into consideration the future road traffic volumes along Wilton Park Road and considering the future West Wilton and WTC plans and likely traffic generated by the Proposal.

5.1.3.2 Picton Road and Hume Motorway

The traffic volumes presented in Table 5-2 have been distributed across the likely routes to and from the Proposal in accordance with advice from the project team, as shown in in Table 5-3. The results of the road traffic noise potential increase predictions for Picton Road and Hume Motorway are presented in Table 5-3.

Table 5-3: Predicted road traffic noise level differences along public roads

Loc.	Road	Existing			Future			Predicted increase, dB(A)	Compliance
		Traffic volume	% Medium	% Heavy	Traffic volume	% Medium	% Heavy		
Day (15 hour - 7:00am to 10:00pm)									
L1	Picton Road (west of Wilton Park Road)	11,227	10	5	12,670	11	6	0.7	Yes
L2	Picton Road (east of Wilton Park Road)				12,818	11	6	0.7	Yes
L3	Hume Motorway (north of Picton Road)	2,024	15	9	30,727	4	11	0.2	Yes
L4	Hume Motorway (south of Picton Road)				30,775	4	11	0.2	Yes
Night (9 hour - 10:00pm to 7:00am)									
L1	Picton Road (west of Wilton Park Road)	29,772	4	11	2,390	15	9	0.7	Yes
L2	Picton Road (east of Wilton Park Road)				2,428	15	9	0.7	Yes
L3	Hume Motorway (north of Picton Road)	4,823	6	31	5065	6	30	0.1	Yes
L4	Hume Motorway (south of Picton Road)				5,077	6	30	0.1	Yes

From the above tables, it can be seen that road traffic noise level contributions from the vehicle movements associated with the Proposal are not expected to increase the existing traffic noise levels by more than 2 dB(A) as required by the RNP.

5.2 Operations noise emissions

5.2.1 Overview of noise generating activities

The noise sources associated with the operation of future development of the site are expected to be those of typical warehousing and distribution activities with 24/7 operations. There will also be minor contributions from the commercial tenancies, recreational facilities (indoor and outdoor) and cafes or restaurants. Based upon RTA's experience with similar warehouse and distribution facilities, the noise sources associated with the operation of the Proposal will likely include the following:

- truck movements within the warehouse facilities
- loading dock receiving and dispatching activities associated with the warehouses, which could potentially include temperature-controlled warehouse/distribution activities
- internal warehouse activities, which can breakout via roller doors and façade elements
- passenger vehicle movements and car parking
- office related activities (fixed mechanical plant)

Typically, across the Proposal the following types of tenants are likely to be expected:

- The larger warehouses are likely to be tenanted by logistics and distribution tenants.
- The smaller warehouses, tenanted by small manufacturers, trade offices/workshops (i.e. mechanics, plumbers, electricians, carpenters), or small retailers.

5.2.2 Consideration of noise emissions

As detailed in Section 1.5, the closest existing residential receivers are located north and north-west from the proposal between approximately 30 to 320 metres from the Proposal boundary along Wilton Park Road, while the land directly north, which has been rezoned for the Wilton Town Centre, could have residential receivers located across Wilton Park Road approximately 160 metres from the Proposal boundary.

Based upon the Proposal concept masterplan shown in Figure 2, the distance to the nearest residential receivers, and the noise objectives detailed in Section 3.3, it is expected that noise mitigation and management measures will likely be required to be incorporated into the design of any future development applications, this will be important where future tenant activities are required to take place during the night period.

Potential noise emission from future operations and tenants will require consideration and management as part of further design development to minimise impacts on nearby residences. As part of future masterplan designs, through a review and updates to the in warehouse design footprint, orientation, layout, height, further noise reductions can be achieved to minimise impacts on nearby residences. This combined with the inclusion of noise source and noise barrier controls, in addition to consideration of likely tenant operational hours and schedules, will further reduce noise emission levels.

A combination of mitigation and management measures will be required to minimise impacts on nearby residences. Source and path controls, combined with consideration of likely tenant operations hours should be reviewed as part of future designs so that the Proposal can operate within the project noise trigger levels identified in Section 3.3 derived in accordance with the NSW EPA NPfI for noise sources that are located within the Proposal boundary.

For other related noise sources, trucks operating to and from warehouses in the Proposal would do so as detailed in Section 5.1. Once these trucks depart the public road and enter each of the warehouse lots within the Proposal, they are assessed in accordance with the NPfI, as per NPfI Section 1.4. While operating on the public roads within the industrial estate, they are assessed using the RNP, as per Section 5.1.

Additionally, emergency plant and equipment are expected to be required, such as fire pumps, smoke clearance fans, emergency generators. Due to the infrequent and non-typical operating nature of this emergency plant and equipment, they do not operate as part of normal reasonable worst-case operations as they are for emergency and stand-by usage only. Noise emissions from these items to minimise the potential noise impacts on nearby sensitive receivers

Noise emissions should be assessed during any future development application, in accordance with the guidelines and policies detailed in Section 3.3.

5.2.3 Noise control measures to be considered during development applications

As the Proposal provides general details of the likely Masterplan layout, by the details of specific noise generating tenancies is not known, including the likely noise generation from tenancies and likely operating hours and schedules for the various tenants across the Proposal, it is not possible to evaluate in detail the specific noise generating activities within the development, and then the associated feasible and reasonable mitigation measures.

The following sections detail the noise control strategies that should be considered as part of future design development stages and when tenants and noise generating activities become known.

The following mitigation and management measures have been included for the purpose of providing the indicative and strategic measures to assist the proposed warehouse lots and overall masterplan. They provide in-principal solutions only, to minimise noise emission from the Proposal for the purpose of the consent authority approvals process. Services of an appropriately qualified acoustic consultant should be sought for any Development Application or equivalent process for future noise generating tenants associated with the Proposal once the Proposal has been approved.

The mitigation and management measures provided are in respect of acoustic considerations only, and additional professional advice should be sought in respect to requirements of other disciplines such as planning, fire requirements, structural design, buildability, fitness for purpose and the like when considering the various mitigation and management options.

Where the project noise trigger levels are exceeded, feasible and reasonable noise mitigation measures should be evaluated, with the aim of reducing noise to the project noise trigger levels.

The typical hierarchy of noise control strategies, through either mitigation or management are as follows:

- Reducing noise emissions at the source (ie. noise source control)
- Reducing noise in transmission to the receiver (ie. noise path control)
- Reducing noise at the receiver (ie. at-receiver control)

When determining whether noise mitigation is 'feasible and reasonable', the starting point is identifying mitigation measures that would result in achieving the relevant project noise trigger levels, and then identifying if the measures may be feasible and reasonable.

The following sections detail the noise control strategies that should be considered as part of future design development stages and when tenants and noise generating activities become known. These are to achieve the noise goals detailed in Section 3.3.

5.2.3.1 Noise source controls and management

The following are potential strategies for mitigating and managing noise emissions at source, and may a combination of several measures may be incorporated where feasible and reasonable:

Table 5-4: Operational noise control strategies – At source

Item	Details
Site layout and design adjustments	Reorientating warehouses so that the key areas of noise generation (ie. loading docks) are facing away from critical sensitive receivers, and the warehouse built structure is providing acoustic shielding to nearby residences.
	Adjusting truck access points and internal vehicle routes to maximise acoustic shielding to nearby residences warehouse structures.
	Designs should locate key noise generating areas (ie. hardstand, ramps, internal truck routes), so that noise generating operations/activities in these areas/locations are shielded from nearby residences.
	Noise generating activities during the night period are undertaken in locations shielded from nearby residences.
	Where feasible, subject to visual requirements, increasing the height of some warehouses can provide additional acoustic shielding to residences.

Item	Details
Shielding or enclosing of key areas of noise generation	Where the location of key noise generating areas cannot be adjusted, then shielding (see Section 5.2.3.3) or enclosing key areas of noise generation should be considered, especially where they have line-of-sight to the nearby residence, and/or are proposed to occur during the sensitive night-time period. Noise controls in the transmission path typically take the form of noise barriers. Barriers are more effective if they are near the source or the receiver. Their effectiveness is also determined by their height, the materials used (absorptive or reflective), and their density. Where noise reductions from feasible barriers do not sufficiently reduce noise emissions, enclosing of noise generating spaces should be considered. For any enclosed area, noise breakout via the façade elements (ie. building facade and roof cladding, including windows or transparent elements) should be considered, in addition to breakout via openings (ie. driveways or ventilation openings) or penetrations (ie. louvres) need to be considered and mitigated where required.
Strategic tenant allocation	Strategic tenant allocation or planning approaches such as recommending or creating incentives for potential warehouse lot operators that have lower noise emitting uses or only daytime operations to take up lot locations closest to the residential receivers on Wilton Park Road, This is to provide noise buffer distances and create shielding to future louder operators which can take up on the lots further away. Similarly, locate noise intensive, or 24/7 noise generating operations in tenancies away from sensitive receivers (ie. along southern warehouse lots).
Temperature controlled warehouses and distribution centres	There is potential for temperature-controlled tenants to occupy some of the warehouses within the Proposal. These facilities have noise sources that are additional to typical warehouse operations and can operate 24/7, including fixed facility refrigeration condenser units and truck or trailer condenser units. These facilities should be appropriately acoustically designed to incorporate noise controls and operational strategies to achieve their allocated noise goal (see Section 5.2.4) so to allow the overall Proposal to achieve the project noise trigger levels cumulatively. If such facilities are proposed, they should be acoustically assessed and designed if proposed to include at minimum: • Careful facility site selection, by placing these facilities in warehouses located away from nearby residences (eg. on the southern side of the Proposal) with loading docks that face away or acoustically shielded from nearby residences. • Acoustic assessment and design of trailer/truck cooling areas should be undertaken to ensure that trailer/truck cooling operations can occur during proposed noise-sensitive hours (ie. night). • Fixed facility refrigeration condenser units should be acoustically designed. This includes selection of quieter units, locating the units so that they are shielded from nearby receivers, and incorporating acoustic mitigation measures (ie. partial enclosures, noise screens, packaged silencers, etc).
Reduce concurrent noise intensive activities	Reducing peak 15 minute heavy vehicles movements across the site by staggering delivery times.
	Where practicable, do not locate tenants in adjacent warehouse lots, if they have similar noise intensive periods that will impact a shared receiver concurrently.
Mechanical plant and equipment locations	Locating fixed mechanical plant away from the most-affected sensitive receivers, such as ground-level locations away from receivers instead of rooftop locations, and/or shielded from receiver locations behind the warehouse/office structures.
Selection of quiet plant and equipment	The use of quieter mobile plant, such as electric forklifts instead of gas-powered forklifts. The use of quieter fixed mechanical plant and equipment options, noting that this assessment assumes an indicative noise level for modelled mechanical plant. When selecting plant and equipment items for the warehouses, noise emission levels should be a factor considered in purchasing/hiring.

Item	Details
Mechanical plant and equipment noise review	See Section 5.2.3.2. Undertake an acoustic assessment of building services, mechanical plant and plantroom spaces to ensure that noise emissions from mechanical plant and equipment are controlled by appropriate mechanical system design and implementation of common engineering methods, minimising noise emissions and ensure that the cumulative noise of all equipment does not exceed the applicable noise criteria cumulatively with all other noise generating activities.
Minimise high noise event sources at night	Ensure hardstand surfaces, roadways and vehicular access points are smooth as to not result in high noise events from truck operations. This would include: - Transitions from the external public road to the site are smooth, as to not result in jolting, or unnecessary accelerating of the truck the truck is required. - Drainage grates are designed to not result in noise events. - Ensure that trucks do not have to stop/brake and then accelerate (ie. pedestrian crossing points, security gates). Where practicable, design elements should also ensure that trucks do not have to stop/brake and then accelerate (ie. pedestrian crossing points) outside of dock areas with line of sight to nearby residential receivers, where they are required to operate during the night period.
Management and minimisation of internal noise breakout	Closing of loading dock roller doors at night where noise generating internal activities are taking place. Consideration of noise emissions during tenant warehouse designs and fitout, to avoid locating noise intensive plant/equipment or activities near façade openings and penetrations (ie. louvres). Where this is not practicable, then additional noise controls implemented to minimise noise emissions.
Minimise annoying sources of noise	Any PA systems required as part of normal operation that emit sound within the facility, are to be designed so that they would result in a negligible increase in overall noise emissions from the facility. PA announcements as part of normal operations would be restricted to within the enclosed areas of the facility during the night period.
	Alternate methods and practices to the use of horns as a safety warning for onsite moving forklifts should be reviewed and incorporated into site operations and safety practices. Where forklift operating areas have direct line of sight to residence.
Warehouse design	Materials of the warehouse facility facade would be selected during detailed design, so that any noise break-out from internal activities would result in a negligible increase in overall noise emissions from the facility. This would include noise breakout via the façade elements (ie. building facade and roof cladding, including windows or transparent elements) in addition to breakout via openings (ie. driveways or ventilation openings) or penetrations (ie. louvres) where required.

Operational Noise Management Plan (ONMP)

An Operational Noise Management Plan (ONMP) should be prepared for the Proposal. Additionally, operational noise management measures can be considered to further reduce noise at the source where feasible and reasonable. The NPfI presents the implementation of ‘best management practice’ (BMP) which is the adoption of operational procedures that minimise noise while retaining productive efficiency. Application of BMP can include the following types of practice where feasible and reasonable:

- Reducing peak 15-minute heavy vehicles movements across the site by staggering delivery / pickup times.
- Minimising concurrent use of mobile plant outside warehouses and/or limiting their use to the less sensitive daytime and evening periods.

- Minimising use of reversing alarms by providing forward manoeuvring where practicable. Where practicable, tenants would implement broadband reversing alarms for heavy vehicles and plant items that operate within the Proposal. This should be adopted for all permanent and tenant owned/controlled vehicles.
- Switching vehicles and plant off when not in use.
- Keeping equipment well-maintained and operating it in a proper and efficient manner.
- Training staff and drivers on the effects of noise and the use of quiet work practices (eg. informing drivers of the noise impacts from sudden braking or accelerating, bangs and clangs, etc).
- Closing of loading dock roller doors at night where noise generating internal activities are taking place.

In conjunction with BMP, the NPfI refers to 'best available technology economically achievable' (BATEA) with which equipment and plant incorporate the most advanced and affordable technology to minimise noise output. Examples of uses of BATEA include:

- The use of quieter mobile plant, such as electric forklifts instead of gas-powered forklifts.
- Using equipment with efficient muffler design.
- Fitting and maintaining noise reduction packages on plant and equipment.
- Ensure hardstand surfaces, roadways and vehicular access points are smooth as to not result in jolting of the truck (ie. at entrance to site).

It is recommended that noise compliance measurements are conducted once operations commence, to determine that noise emissions are consistent with those documented in this assessment, and to determine that the mitigation measures are effective. The method for measuring the performance and/or noise compliance of the Proposal should be undertaken in accordance with Section 7 'Monitoring performance' of the NPfI.

As part of the site's Operational Noise Management Plan, there should also be regular reviews of on-site noise mitigation and management practices to incorporate and capture opportunities for reductions of site noise emissions, with considerations of the following:

- Review of noise reduction opportunities during changes or refinements of site noise generating activities.
- Reviewing noise levels of plant, equipment and activities, during both ongoing compliance checks and in response to complaints.
- Improvements in Best Management Practice (BMP).
- Improvements in Best Available Technology Economically Achievable (BATEA).

5.2.3.2 In principle mechanical plant measures

Building services and mechanical plant and equipment associated with the development has the potential to impact on nearby noise sensitive properties if not designed or selected correctly. To carry out a quantitative assessment of mechanical equipment, a complete specification of equipment is required, which is not known at this project stage. Indicative plant and equipment have been assumed as part of the assessment The following in-principle noise management measures should be considered during detailed design:

- Acoustic assessment of mechanical services equipment should be undertaken during the detailed design phase of the development to ensure that the cumulative noise of all equipment does not exceed the applicable noise criteria. This includes the detailed specification and location of mechanical plant on site.
- Mechanical plant noise emission can be controlled by appropriate mechanical system design and implementation of common engineering methods, which may include:
  - procurement of 'quiet' plant
  - strategic positioning of plant away from sensitive neighbouring premises to maximise intervening acoustic shielding between the plant and sensitive neighbouring premises
  - commercially available acoustic attenuators for air discharge and air intakes of plant
  - acoustically lined and lagged ductwork
  - acoustic barriers between plant and sensitive neighbouring premises
  - partial or complete acoustic enclosures over plant

5.2.3.3 Noise path controls

Noise control in the transmission path typically takes the form of noise barriers. Barriers are more effective if they are near the source or the receiver. Their effectiveness is also determined by their height, the materials used (absorptive or reflective), and their density.

Continuous noise barriers or tall continuous solid structures (ie. sheds, storage buildings) with no gaps or openings that will be located between the noise generating activity and the receiver should be considered for the noise generating areas within the warehouse lots (ie loading dock hardstand areas) with line of sight to receivers. Where an acoustic barrier breaks line of sight between the source and receiver it can provide between 5 to 10 dB(A) noise reduction.

Any noise barrier should be made from any durable material with sufficient mass to prevent direct noise transmission (eg. masonry, steel, fibrous-cement, timber, acrylic or polycarbonate) selected to withstand weather elements. In addition to the above, all noise barriers should give regard to the following to maintain acoustic integrity and to perform effectively as noise barriers:

- any penetrations through the fabric of the fence should be sealed airtight
- all joints and gaps between fence panels and adjacent structures should be sealed airtight

- any gaps between the noise barrier and the ground / retaining walls should be filled to ensure that the noise barrier provides appropriate noise attenuation

5.2.3.4 At-receiver noise controls

At-receiver mitigation measures can be utilised to reduce noise impacts where residual noise impacts remain after the implementation of feasible and reasonable noise source and path controls. At receiver treatments are the last items to consider in the hierarchy of noise control, as it is more effective for all nearby receivers to control the noise at source in or the transmission path. At-receiver treatment ay comprise:

- Fresh air ventilation systems that allow existing windows and doors to remain closed
- Sealing of wall vents and facade openings
- Upgrading window and door seals, and/or
- Upgraded windows and glazing and solid core doors

These allow the facade constructions reduce external noise levels to appropriate internal noise levels. For these to be effective, the residence needs alternative means of ventilation to enable windows to be maintained in the closed position so that facade construction treatments can be effective.

Additionally, in the context of the changing area of West Wilton, there is potential for the existing residential receivers to no longer be located as they currently are or occupied in the same manner. If these receivers are only there for a temporary period, it may be preferable for permanent onsite mitigation (ie. noise barriers) to not be installed, and instead at-receiver treatments investigated.

5.2.4 Cumulative noise management

5.2.4.1 Considerations for managing individual warehouse lot noise goals

There are two aspects of cumulative noise that are applicable for large or multiple industrial developments/clusters such as the Proposal. The first being the cumulative build-up of noise from other nearby developments impacting the same receiver location, which has already addressed by the process of deriving the NPfI amenity trigger levels in Section 3.3.2, and the consideration of existing or future ambient industrial noise being present.

However, the second cumulative noise aspect is the issue of the total cumulative noise from the multiple operations within a proposed development (ie. a warehouse estate with multiple warehouse operations) such as the Proposal. The noise trigger levels derived in Section 3.3.3 apply cumulatively for all noise generating activities within the Proposal.

If the first tenant was to generate noise levels up to the Proposal limits, this would result in no noise allowance for any subsequent tenant. If this was to occur, it would prevent or significantly restrict other activities from taking place, or will require more noise control measures than might be expected. As such, future warehouse tenants could not operate concurrently without a risk of exceeding the Proposal noise limits. It is for this reason that it is important that prior to the first tenant commencing operations, that a noise allocation strategy is in place, and all tenants likely noise emissions are reviewed as part of the commencement of operations.

The NPfI Section 2.4 provides general guidance for addressing potential cumulative industrial noise from multiple developments, including NPfI Section 2.4.2 (*Amenity noise levels in areas near an existing or proposed cluster of Industry*) and NPfI Section 2.8 (*Noise management precincts*).

However, these approaches represent the two extremes of addressing cumulative operational noise. The approach in NPfI Section 2.8 of establishing a noise management precinct applies where a single entity has control over all or the majority of industrial operations. At the other extreme, the approach detailed in NPfI Section 2.4.2, sets out a simplistic method of allocation of noise criteria where a development is proposed adjacent to a cluster of industrial operations. It is understood that it is currently not known for the Proposal if there will be a single entity or individual separate operators.

The approach to allocate noise quotas for large multipurpose industrial sites can range from simple division by the number of sites or division based upon the lot/tenancy floor space area, or by more intricate approaches with consideration of other factors (i.e. site noise generation, mitigation options/viability, commercial considerations, etc.), depending on the potential future use (if known) of the project area.

Suitable approaches for proportioning noise criteria and allocating individual warehouse lot goals in order to appropriately manage cumulative noise emissions will depend upon a range of factors for the development, such as but not limited to the number and types of operations, and the existence and power of an overall owner or controlling entity.

Considering that it is currently not known if a single entity will manage the Proposal or it will consist of individual separate operators, and that this could change over the life of the Proposal, any approach should provide clear guidance through the allocation of the develop noise budgets (or noise quotas), but also provide flexibility in order to allow for more efficient uses of the overall approved criteria.

Furthermore, the initial noise quota allocation can be updated, based on any changes in operations, noise measurement results or criteria changes (ie. the implementation of a shoulder period). Trading or reallocating quotas between developments or updating quotas following strategic mitigation measures (ie. common noise barriers) is possible to maximise the use of developable land within the Proposal.

5.2.4.2 Recommended cumulative noise management

It is recommended that potential cumulative operational noise from the Proposal is proactively managed. In order to do this it is recommended that:

- A methodology to manage the individual contributions of tenants within the project noise trigger levels for the Proposal is developed as part of the Operational Noise Management Plan/ Operational Management Plan developed for the Proposal. This could take the form of either a noise management precinct approach or allocated fixed noise quotas. Care should be taken either way so that any allocated noise limits established are reasonable and not too onerous for some warehouse lots (for example, the ones closest to the receivers with minimal acoustic shielding) while also allowing for efficient use of all warehouse lots within the Proposal as desired by the owners.

- During the preparation for occupancy of a warehouse tenancy (ie. warehouse fit-out design stage) for any specific tenant that is to operate within the Proposal, the potential noise emissions from the tenant's proposed operations are to be reviewed to confirm that:

  - The tenant operational noise emissions will satisfy any noise emission allowances and noise mitigation/management measures for the individual tenant identified in the Proposal Operational Noise Management Plan/ Operational Management Plan, and if there are any further mitigation and/or management measures required to do so.

  - Confirm if any further mitigation and/or management measures are required so that noise emissions from the warehouse tenancy will be consistent with the noise emissions outcomes in this NVIA.

6 Conclusion

Renzo Tonin & Associates (RTA) has been engaged by Altis Property Partners Holdings Pty Ltd (Altis) on behalf of Altis ARET Sub Trust 26 to undertake a construction and operation noise and vibration impact assessment (NVIA) to support the Planning Proposal for the rezoning of the land directly to the south of Wilton Park Road and Berwick Park Road, Wilton, for a proposed warehouse/distribution centre masterplan (the Proposal).

The Proposal site is located within the Wilton Growth Area. The land surrounding the Proposal area has a number of existing residential receivers, however, the land directly north of the Proposal has been rezoned for the Wilton Town Centre, which includes low density residential directly north of the Proposal across Wilton Park Road. As such, potential future residential receivers are located along the northern boundary of the proposal site, across Wilton Park Road.

This acoustic assessment has been carried out to review acoustic matters relevant to the Planning Proposal with consideration of the relevant policies, guidelines and standards required by the NSW government, NSW EPA and Wollondilly Council. The study includes the following:

- Identify nearby existing and future sensitive receivers surrounding the Planning Proposal site
- Identify the relevant site context and considerations in relation to the noise environment at nearby residences, and likely changes in noise surrounding noise environment noting the future planning outcomes for the surrounding area.
- Identify the relevant acoustic policies and standards that are likely to govern the future development and the related acoustic objectives, to be confirmed at later application stages, and establish the requirements for operational noise emissions from the Proposal.
- Undertake a review of the acoustic factors that may influence the future assessment and design of the site, covering both construction and future operations, with reference to the Proposal masterplan, and potential noise emissions and key features affecting noise impacts.

The noise and vibration assessment has been carried out in accordance with the policies, guidelines and standards presented in Section 3 of this report addressing construction noise and vibration and operational noise, respectively

6.1 Operational acoustic review

Noise objectives for noise emissions from the Planning Proposal site were established in Section 3.3 with the in accordance with the NSW EPA *Noise Policy for Industry* (NPfI), and potential noise emissions from the Proposal concept masterplan reviewed in Section 5. It was identified that as part of future development applications, noise mitigation and management measures will likely be required to be incorporated into the design to achieve these noise objectives.

Potential noise emissions from future operations and tenants will require consideration and management as part of further design development to minimise impacts on nearby residences. As part of future masterplan designs, a combination of mitigation and management measures will be required to minimise impacts on nearby residences. A range of mitigation and management measures that are to be considered have been provided in Section 5.2.3. These will include source and path controls in addition to operational tenant management, so that the Proposal can operate within the project noise trigger levels identified in Section 3.3.

As future tenants are determined, it is important that the overall proposal is reassessed to determine that the noise emissions can be managed consistent with the objectives detailed in Section 3.3 and consistent with the outcomes and recommendations detailed in this report.

Potential increases in road traffic noise by heavy vehicles generated by the Proposal on public roads has been reviewed. Generally, the road traffic noise level contributions from the vehicle movements associated with the Proposal are not expected to increase existing traffic noise levels by more than 2 dB(A) and so would meet the NSW Road Noise Policy (RNP) requirements.

The Proposal vehicles were also modelled along the future ultimate alignment (under development) along Wilton Park Road, to review their potential impact on the future Wilton Town Centre residences. Road traffic noise levels could potentially be above the RNP criteria considering typical expected residential setbacks, and so further review when these receivers and roads are finalised is recommended.

6.2 Construction noise and vibration assessment

An assessment of construction noise impact from the Proposal's construction works has been undertaken. Noise emissions from the proposed construction works have been predicted and assessed against the relevant noise management levels set by the ICNG during the recommended standard hours for construction. Construction works for the Proposal are proposed to take place during the ICNG standard construction hours.

Predicted noise levels found that the noise levels during all construction stages when they are occurring nearby the closest receivers along Wilton Park Road, then the construction noise levels may be above the NML. However, when construction works are taking place at other locations within the Proposal site, the construction noise levels are often below the NML.

Exceedances are predicted to be highest during these works when high noise generating plant and equipment are being used. During the other building construction and fitout phases of works, construction noise is generally predicted to comply with the relevant NMLs. Construction noise mitigation and management measures have been recommended to aid in providing additional noise reduction benefits where exceedance of the objectives occurs.

If vibration intensive equipment is required, and vibration sensitive structures are nearby (ie. existing rural residences) management measures have been presented in Section 4.7.1 to aid in minimising any potential vibration impacts.

The noise impact of construction traffic on the existing road network has been reviewed and are considered not to be significant.

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APPENDIX A Technical terms and concepts

A.1 Glossary of terminology - Noise

The following is a brief description of the technical terms used to describe noise and to assist in understanding the technical issues presented.

Absorption Coefficient α	The absorption coefficient of a material, usually measured for each octave or third-octave band and ranging between zero and one. For example, a value of 0.85 for an octave band means that 85% of the sound energy within that octave band is absorbed on coming into contact with the material. Conversely, a low value below about 0.1 means the material is acoustically reflective.
Adverse weather	Weather effects that enhance noise (particularly wind and temperature inversions) occurring at a site for a significant period of time. In the NSW INP this occurs when wind occurs for more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of nights in winter.
Air-borne noise	Noise which is fundamentally transmitted by way of the air and can be attenuated by the use of barriers and walls placed physically between the noise source and receiver.
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Amenity	A desirable or useful feature or facility of a building or place.
AS	Australian Standard
Assessment period	The time period in which an assessment is made. e.g. Day 7am-10pm & Night 10pm-7am.
Assessment Point	A location at which a noise or vibration measurement is taken or estimated.
Attenuation	The reduction in the level of sound or vibration.
Audible Range	The limits of frequency which are audible or heard as sound. The normal hearing in young adults detects ranges from 20 Hz to 20 kHz, although some people can detect sound with frequencies outside these limits.
A-weighting	A filter applied to the sound recording made by a microphone to approximate the response of the human ear.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the LA90 noise level if measured as an overall level or an L90 noise level when measured in octave or third-octave bands.
Barrier (Noise)	A natural or constructed physical barrier which impedes the propagation of sound and includes fences, walls, earth mounds or berms and buildings.
Berm	Earth or overburden mound.
Buffer	An area of land between a source and a noise-sensitive receiver and may be an open space or a noise-tolerant land use.
Bund	A bund is an embankment or wall of brick, stone, concrete or other impervious material, which may form part or all of the perimeter of a compound.
BS	British Standard
CoRTN	United Kingdom Department of Environment entitled "Calculation of Road Traffic Noise (1988)"
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of common sounds in our environment:

	threshold of hearing	0 dB	The faintest sound we can hear, defined as 20 micro Pascal
		10 dB	Human breathing
	almost silent	20 dB	
		30 dB	Quiet bedroom or in a quiet national park location
	generally quiet	40 dB	Library
		50 dB	Typical office space or ambience in the city at night
	moderately loud	60 dB	CBD mall at lunch time
		70 dB	The sound of a car passing on the street
	loud	80 dB	Loud music played at home
		90 dB	The sound of a truck passing on the street
	very loud	100 dB	Indoor rock band concert
		110 dB	Operating a chainsaw or jackhammer
	extremely loud	120 dB	Jet plane take-off at 100m away
	threshold of pain	130 dB	
		140 dB	Military jet take-off at 25m away

dB(A)	A-weighted decibel. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies. The dB(C) level is not widely used but has some applications.
Deemed-to-Satisfy Provisions	The Deemed-to-Satisfy Provisions are an optional means of achieving compliance with the mandatory Performance Requirements of the National Construction Code. (also see Alternate Solution)
Diffraction	The distortion of sound waves caused when passing tangentially around solid objects.
DIN	German Standard
Discontinuous Construction	A wall system having a minimum 20mm cavity between two separate leaves, where, for other than masonry there is no mechanical linkage between leaves except at the periphery.
DnT,w	Weighted Standardised Field Level Difference A measure of sound insulation performance of a building element. It is characterised by the difference in noise level on each side of a wall or floor. It is measured in-situ. It is a field measurement that relates to the Rw laboratory measured value but is not equal to it because an in-situ space is not of the same quality as a laboratory space. The value is indicative of the level of speech privacy between spaces. The higher its value the better the insulation performance.
ECRTN	Environmental Criteria for Road Traffic Noise, NSW, 1999
ENMM	Environmental Noise Management Manual, Roads and Maritime Services (Transport for NSW)
EPA	Environment Protection Authority
Field Test	A test of the sound insulation performance in-situ. See also 'Laboratory Test' The sound insulation performance between building spaces can be measured by conducting a field test, for example, early during the construction stage or on completion. A field test is conducted in a non-ideal acoustic environment. It is generally not possible to measure the performance of an individual building element accurately as the results can be affected by numerous field conditions.

FIIC	Field Impact Isolation Class. A measure of the noise impact performance of a floor. The value indicates the resistance of the floor to the transmission of impact sound and is measured using a standard tapping machine. It is measured in-situ and is therefore subject to the inherent accuracies involved in such a measurement. The term is defined in ASTM E492 and E1007. It is a field measure of the level of impact sound transmitted to a space via a floor. The equivalent measurement in a laboratory is termed the IIC. The higher the value the better the performance.
Flanking	Flanking is the transfer of sound through paths around a building element rather than through the building element material directly. For example, sound travelling through a gap underneath a door or a gap at the top of a wall.
Fluctuating Noise	Noise that varies continuously to an appreciable extent over the period of observation.
Free-field	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
FSTC	Field Sound Transmission Class A measure of the sound insulation performance of a building element. It is characterised by the difference in noise level on each side of a wall or floor. It is measured in the field and is therefore subject to the inherent inaccuracies involved in such a measurement. The term was referred to in older superseded versions of the Building Code of Australia and has now been replaced with the term DnT,w.
Ground-borne noise	Vibration propagated through the ground and then radiated as noise by vibrating building elements such as wall and floor surfaces. This noise is more noticeable in rooms that are well insulated from other airborne noise. An example would be vibration transmitted from an underground rail line radiating as sound in a bedroom of a building located above.
Habitable Area	Includes a bedroom, living room, lounge room, music room, television room, kitchen, dining room, sewing room, study, playroom, family room, home theatre and sunroom. Excludes a bathroom, laundry, water closet, pantry, walk-in wardrobe, corridor, hallway, lobby, photographic darkroom, clothes drying room, and other spaces of a specialised nature occupied neither frequently nor for extended periods.
Heavy Vehicle	A truck, transporter or other vehicle with a gross weight above a specified level (for example: over 8 tonnes).
IGANRIP	Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects, NSW DEC 2007
IIC	Impact Isolation Class A measure of the noise impact performance of a floor. It is measured in very controlled conditions in a laboratory and is characterised by how much sound reaches the receiving room from the operation a standard tapping machine placed on the floor. The term is defined in ASTM E492 and E1007. The higher the number the better the performance.
Impact Noise	The noise in a room, caused by impact or collision of an object onto the walls or the floor. Typical sources of impact noise are footsteps on the floor above a tenancy and the slamming of doors on cupboards mounted on the common wall between tenancies.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
INP	NSW Industrial Noise Policy, EPA 1999
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation.
Intertenancy wall	Walls that separate buildings or units within a building. They may provide sound resistance or serve as a fire wall. Synonymous with 'party wall'.
Intrusive noise	Refers to noise that intrudes above the background level by more than 5 dB(A).

ISEPP	State Environmental Planning Policy (Infrastructure), NSW, 2007
ISEPP Guideline	Development Near Rail Corridors and Busy Roads - Interim Guideline, NSW Department of Planning, December 2008
L1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L10	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L10(1hr)	The L10 level measured over a 1 hour period.
L10(18hr)	The arithmetic average of the L10(1hr) levels for the 18 hour period between 6am and 12 midnight on a normal working day.
L90	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
LAeq or Leq	The “equivalent noise level” is the summation of noise events and integrated over a selected period of time, which would produce the same energy as a fluctuating sound level. When A-weighted, this is written as the LAeq.
LAeq(1hr)	The LAeq noise level for a one-hour period. In the context of the NSW EPA’s Road Noise Policy it represents the highest tenth percentile hourly A-weighted Leq during the period 7am to 10pm, or 10pm to 7am (whichever is relevant).
LAeq(8hr)	The LAeq noise level for the period 10pm to 6am.
LAeq(9hr)	The LAeq noise level for the period 10pm to 7am.
LAeq(15hr)	The LAeq noise level for the period 7am to 10pm.
LAeq (24hr)	The LAeq noise level during a 24 hour period, usually from midnight to midnight.
Lmax	The maximum sound pressure level measured over a given period. When A-weighted, this is usually written as the LAmax.
Lmin	The minimum sound pressure level measured over a given period. When A-weighted, this is usually written as the LAmin.
Ln,w	Weighted Normalised Impact Sound Pressure Level A measure of the sound level transmitted from impacts on a floor to a tenancy below. It is measured in very controlled conditions in a laboratory and is characterised by how much sound reaches the receiving room from a standard tapping machine. A lower value indicates a better performing floor.
LnT,w	Weighted Standardised Field Impact Sound Pressure Level As for Ln,w but measured in-situ and therefore subject to the inherent accuracies involved in such a measurement. The equivalent measurement in a laboratory is the Ln,w. A lower value indicates a better performing floor.
Laboratory Test	The performance of a building element when measured in a laboratory. The sound insulation performance of a building element installed in a building however can differ from its laboratory performance for many reasons including the quality of workmanship, the size and shape of the space in which the measurement is conducted, flanking paths and the specific characteristics of the material used which may vary from batch to batch.
Loudness	A rise of 10 dB in sound level corresponds approximately to a doubling of subjective loudness. That is, a sound of 85 dB is twice as loud as a sound of 75 dB which is twice as loud as a sound of 65 dB and so on. That is, the sound of 85 dB is four times or 400% the loudness of a sound of 65 dB.
Microphone	An electro-acoustic transducer which receives an acoustic signal and delivers a corresponding electric signal.
NCA	Noise Catchment Area. An area of study within which the noise environment is substantially similar.
NCG	Noise Criteria Guideline, Roads and Maritime Services (Transport for NSW)

NMG	Noise Mitigation Guideline, Roads and Maritime Services (Transport for NSW)
Noise	Unwanted sound
Normalised	A method of adjusting the measured noise indices in a laboratory so that they are independent of the measuring space. The noise level in a room is affected by reverberation in the room. For example, the Ln,w impact sound pressure level measured in a laboratory is dependent upon the amount of absorptive material in the receiving room. The value is adjusted to what would be measured if the sound absorption in the receiving room is set at 10m2. This enables all laboratories to report the same value when measured under slightly different conditions. See also 'Standardised'.
NRC	Noise Reduction Coefficient. A measure of the ability of a material to absorb sound. The NRC is generally a number between 0 and 1 but in some circumstances can be slightly greater than 1 because of absorption at the edges of the material. A material with an NRC rating of 1 absorbs 100% of incoming sound, that is, no sound is reflected back from the material. The NRS is the average of the absorption coefficient measured in the octave bands 250Hz, 500Hz, 1kHz & 2kHz which correspond to the predominant frequencies associated with the human voice.
Partition wall	A wall dividing two rooms.
Party wall	A wall dividing two tenancies. Synonymous with 'Intertenancy Wall'.
Pre-construction	Work in respect of the proposed project that includes design, survey, acquisitions, fencing, investigative drilling or excavation, building/road dilapidation surveys, minor clearing (except where threatened species, populations or ecological communities would be affected), establishing ancillary facilities such as site compounds, or other relevant activities determined to have minimal environmental impact (e.g. minor access roads).
RBL	Rating Background Level is the representative LA90 background noise level for a period, as defined in the NSW EPA's noise policies.
Reflection	Sound wave reflected from a solid object obscuring its path.
RING	Rail Infrastructure Noise Guideline, NSW, May 2013
RMS	Root Mean Square value representing the average value of a signal.
Rw	Weighted Sound Reduction Index A measure of the sound insulation performance of a building element. It is measured in very controlled conditions in a laboratory. The term supersedes the value STC which was used in older versions of the Building Code of Australia. Rw is measured and calculated using the procedure in ISO 717-1. The related field measurement is the DnT,w. The higher the value the better the acoustic performance of the building element.
R'w	Weighted Apparent Sound Reduction Index. As for Rw but measured in-situ and therefore subject to the inherent accuracies involved in such a measurement. The higher the value the better the acoustic performance of the building element.
RNP	Road Noise Policy, NSW, March 2011
Sabine	A measure of the total acoustic absorption provided by a material. It is the product of the Absorption Coefficient (alpha) and the surface area of the material (m2). For example, a material with alpha = 0.65 and a surface area of 8.2m2 would have 0.65 x 8.2 = 5.33 Sabine. Sabine is usually calculated for each individual octave band (or third-octave).
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sole-occupancy Unit	An area within a building for the exclusive use of the owner or occupier.
Sound	A fluctuation of air pressure which is propagated as a wave through air.

Sound absorption	The ability of a material to absorb sound energy by conversion to thermal energy.
Sound Insulation	Sound insulation refers to the ability of a construction or building element to limit noise transmission through the building element. The sound insulation of a material can be described by the Rw and the sound insulation between two rooms can be described by the DnT,w.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 pico watt.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone referenced to 20 micro Pascal.
Spoil	Soil or materials arising from excavation activities.
Standardised	A method of adjusting the measured noise indices in-situ so that they are independent of the measuring space. The noise level in a room is affected by reverberation in the room. For example, the L'n,w impact sound pressure level measured in a room is dependent upon the amount of absorptive material in the receiving room. The value is adjusted to what would be measured if the reverberation time in the receiving room is set at 0.5 seconds. This enables the same value to be reported independent of whether the room contains carpet and furnishings and the like. See also 'Normalised'.
STC	Sound Transmission Class A measure of the sound insulation performance of a building element. It is measured in controlled conditions in a laboratory. The term has been superseded by Rw.
Structure-borne Noise	Audible noise generated by vibration induced in the ground and/or a structure. Vibration can be generated by impact or by solid contact with a vibrating machine. Structure-borne noise cannot be attenuated by barriers or walls but requires the isolation of the vibration source itself. This can be achieved using a resilient element placed between the vibration source and its support such as rubber, neoprene or springs or by physical separation (using an air gap for example). Examples of structure-borne noise include the noise of trains in underground tunnels heard to a listener above the ground, the sound of footsteps on the floor above a listener and the sound of a lift car passing in a shaft. See also 'Impact Noise'.
Tonal Noise	Sound containing a prominent frequency and characterised by a definite pitch.
Transmission Loss	The sound level difference between one room or area and another, usually of sound transmitted through an intervening partition or wall. Also the vibration level difference between one point and another. For example, if the sound level on one side of a wall is 100dB and 65dB on the other side, it is said that the transmission loss of the wall is 35dB. If the transmission loss is normalised or standardised, it then becomes the Rw or R'w or DnT,w.

A.2 Glossary of terminology - Vibration

The following is a brief description of the technical terms used specifically to describe vibration and to assist in understanding the technical issues presented.

Acceleration	The rate of change of velocity, often measured in m/s2 or g's. 1 g = 9.81 m/s2. Commonly used to assess human response to vibration and for machine condition monitoring.
Accelerometer	A vibration transducer sensor that is used to measure acceleration.
ANC	The Association of Noise Consultants, UK.
Ambient vibration	The all-encompassing vibration occurring at a given location, at a given time, composed of all vibration sources near and far.

Amplification	Vibration amplification refers to an increase in vibration. Amplification may occur due to resonance, when an object or structure is excited at its natural frequency.
Attenuation	Attenuation refers to a reduction in vibration. This may occur due to damping of a vibration system, the inclusion of attenuating devices or, in the case of ground vibration, during propagation through the ground. Ground attenuation is determined by the dynamic properties of the site's soil and rock.
AVTG	Assessing Vibration: A Technical Guideline. NSW Department of Environment and Conservation's (DEC) 2006 guideline for assessing human responses to vibration. Based on BS 6472–1992.
Axis	A fixed reference line for the measurement for the measurement of vibration in a particular direction. Vibration is commonly measured in transverse (T), longitudinal (L) and vertical (V) axes (or X, Y and Z).
Background vibration	The underlying level of vibration present in the ambient environment, measured in the absence of the vibration sources of interest.
Blasting	Excavation or demolition using explosives.
Borehole transducer	A geophone transducer rigidly mounted at the bottom of a borehole (either permanently or temporarily) to measure underground vibration.
Broadband vibration	The overall vibration level which encompasses a wide range of frequencies. As opposed to vibration levels for specific frequency bands (see Octave) or narrowband vibration levels as produced by FFT.
BS	British Standard.
Continuous vibration	Vibration that continues uninterrupted over a defined period.
Cosmetic damage	Damage to a structure due to vibration that only affects the appearance of the structure and can be easily repaired, e.g. hairline cracks in mortar joints of brick or concrete constructions, or cracks in plasterwork.
Coupling loss	The change in vibration level when vibration is transmitted from the ground to a building's foundations.
Crest factor	The ratio of the peak value of a vibration event to the RMS value of a vibration event.
Damping	Reduction of vibrational energy due to friction or other forces.
DEC	NSW Department of Environment and Conservation, now the Department of Planning, Industry and Environment.
Decibel [dB]	The logarithmic unit used to represent sound and vibration levels. A vibration level in dB equals 20 times the logarithm to the base 10 of the ratio of the vibration level relative to the reference level. For vibration velocity, the reference level is commonly 1 nm/s. For vibration acceleration, the reference level is commonly 1 $\mu m/s^2$. Other reference values are commonly used. The reference value should always be stated.
DIN	German Standard.
Displacement	Change in position of a body from a reference point. Usually measured in m or mm.
EPA	Environment Protection Authority.
eVDV	Estimated Vibration Dose Value. See also VDV.
Filter	An electrical circuit that allows signals of certain frequency ranges to pass through, and blocks all other frequencies. Types of filters include low pass filters, high pass filters, and band pass filters.
FFT	Fast Fourier Transform. An algorithm that converts a signal from the time domain to the frequency domain.
Frequency	In the case of vibration, frequency is the number of oscillations that occurs per second. Frequency is measured in units of Hertz (Hz).
Geophone	A vibration transducer sensor that is used to measure velocity.

Ground-borne noise	Vibration propagated through the ground and then radiated as noise by vibrating building elements such as wall and floor surfaces. This noise is more noticeable in rooms that are well insulated from other airborne noise. An example would be vibration transmitted from an underground rail line radiating as sound in a bedroom of a building located above.
Ground spike	A metal stake with a flat top that is driven into the ground and used to mount a vibration transducer to measure vibration levels.
Habitable Area	Includes a bedroom, living room, lounge room, music room, television room, kitchen, dining room, sewing room, study, playroom, family room, home theatre and sunroom. Excludes a bathroom, laundry, water closet, pantry, walk-in wardrobe, corridor, hallway, lobby, photographic darkroom, clothes drying room, and other spaces of a specialised nature occupied neither frequently nor for extended periods.
Intermittent vibration	Either interrupted periods of continuous vibration or repeated periods of impulsive vibration.
Impulsive vibration	Vibration that rapidly builds up to a peak followed by a damped decay. May consist of multiple impulsive events, typically less then 2 seconds in duration.
Isolation	The process of reducing the vibrational energy transmitted to an object, such as a piece of equipment or building, from the source of vibrations.
Minor damage	Damage to a structure due to vibration that affects the serviceability of residential style buildings or other sensitive structures but does not affect the structural elements. E.g. cracks in plastered or rendered surfaces, existing cracks enlarged or partitions detached.
Mode	A mode of vibration is a characteristic pattern or shape in which a mechanical system will vibrate. The actual vibration of a structure is a combination of all the vibration modes, but to varying degrees, depending on the vibration source.
Natural frequency	The frequency at which a system tends to oscillate in the absence of any driving or damping force.
Noise floor	The residual level of unwanted signal measured by an instrumentation system. The signal of interest must be above the noise floor to be measured accurately. See also Signal to noise ratio.
Octave	An octave represents a doubling or halving in frequency. Noise or vibration levels across a frequency spectrum are commonly given in octave or one-third octave frequency bands.
Peak-to-peak	The difference between the highest positive peak level and the lowest negative peak of a vibration event.
Peak vibration velocity	The absolute maximum value of the vibration velocity signal measured in the X, Y or Z axis during a given time interval. Also referred to as the peak component particle velocity.
PPV	Peak Particle Velocity. The absolute maximum value of the vibration velocity signal measured in any axis during a given time interval.
PVS	Peak Vector Sum. The vector sum of the peak vibration velocities measured in the three orthogonal axes.
Resonance	The phenomenon of increased amplitude that occurs when the frequency of an applied force is equal or close to the natural frequency of the system.
RMS	Root Mean Square value representing the average value of a signal.
Sampling rate	The number of samples per second taken from a continuous signal to make a discrete or digital signal. Measured in Hertz. To accurately record the signal and determine the spectrum, the sampling rate must two or more times the maximum frequency of interest.
Settlement	The movement of soil due to vibration or other forces, often in relation to a building's foundations. The indirect effect of settlement and ground movement may cause building damage, separately from the direct of effect of building vibration.
Signal to noise ratio	A ratio of the level of a desired signal to the level of the background, often expressed in decibels.
Source vibration	A source that generates vibration. Can be quantified by the amplitude, frequency content and duration of the vibration. Common sources of vibration include rail and road traffic, construction and demolition activities and blasting.
Spectrum	The result of transforming a signal from the time domain to the frequency domain.

Structural damage	Damage to a structure due to vibration that may affect its serviceability due to damage to structural elements. May result in the reduced stability of the building and/or reduction in load-bearing capacities.
Structural fatigue	The weakening of a material caused by cyclic loading that results in progressive and localised structural damage and the growth of cracks.
Structure-borne Noise	Audible noise generated by vibration induced in the ground and/or a structure. Vibration can be generated by impact or by solid contact with a vibrating machine. Structure-borne noise cannot be attenuated by barriers or walls but requires the isolation of the vibration source itself. This can be achieved using a resilient element placed between the vibration source and its support such as rubber, neoprene or springs or by physical separation (using an air gap for example). Examples of structure-borne noise include the noise of trains in underground tunnels heard to a listener above the ground, the sound of footsteps on the floor above a listener and the sound of a lift car passing in a shaft.
Tactile vibration	Vibration of a level that can be felt by humans, dependant on the amplitude and frequency of the source. Note that vibration may also be perceived through indirect effects such as ground-borne noise or the shaking of building elements.
Transducer	A device that converts energy from one form to another. Vibration transducers convert either acceleration, velocity or displacement to an electrical signal that is processed by the monitoring system.
Triaxial	Three axes. Measurement systems often consist of three vibration transducers arranged triaxially – oriented at 90° from each other.
VDV	Vibration Dose Value. A measure of tactile vibration levels used to assess intermittent vibration.
Velocity	The rate of change of vibration displacement, usually measured in mm/s.
Vibration	A mechanical phenomenon whereby oscillations occur about an equilibrium point; a periodic back-and-forth motion of an elastic body or medium, commonly resulting when almost any physical system is displaced from its equilibrium condition.
Vrms	Root mean square (RMS) vibration level for the train passby, typically expressed in mm/s
Waveform	A graphical representation of a vibration event in the time domain, showing the measured vibration levels for each sample.

A.3 Acoustic concepts

A.3.1 Sound and noise

The terms 'sound' and 'noise' are almost interchangeable, except that in common usage 'noise' is often used to refer to unwanted sound. Sound is a vibration that travels as an audible wave of pressure through the air from a source to a receiver location such as the human ear. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) is a unit of measurement used to express the ratio of a quantity to another on a logarithmic scale to make the wide range of sound pressure more manageable.

Sound power is the rate at which a source emits acoustic energy and is unaffected by the environment. It is a property of the source that is emitting acoustic energy.

In contrast, **sound pressure** is the effect, and it is affected by factors associated with the built and natural environment such as distance, direction, obstacles etc. The sound pressure is the acoustic energy or 'noise level' at a distance away from the noise source. The relationship between sound power and sound pressure can be explained by considering the analogy of an electric heater, which radiates heat into a room and temperature is the effect. Like sound pressure, temperature also reduces with distance from the source following the inverse square law.

In this technical working paper, **sound power level** is identified by the symbols **SWL** or **L_w,** while **sound pressure level** is represented by **SPL** or **L_p**, and both have the same scientific unit in dB.

A.3.2 Individual's perception of sound

The loudness of sound depends on its sound pressure level. The A-weighted decibel [dB(A)] is generally used for the purposes of environmental noise impact assessment as it has been adjusted to account for the varying sensitivity of the human ear to different frequencies of sound. People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dB(A) is a good measure of the loudness of environmental noise to the human ear as it considers this frequency dependant sensitivity.

Different noise sources having the same dB(A) level generally sound equally loud. However, the frequency of a sound is what gives it a distinctive pitch or tone – for example, the rumble of distant thunder is an example of a low frequency sound and a whistle is an example of a high frequency sound. Most sounds we hear in our daily lives have sound pressure levels in the range of 30 to 90 dB(A). The following table provide some points of reference, measured in dB(A), of familiar sounds and those from construction activities.

Table A-1 Perception of sound - familiar sounds and construction noise

Common sounds	Construction noise	Sound pressure level
Leaf blower at operator's ear	Concrete saw or jack hammer 7 metres away	90 dB(A)
Airplane cabin during cruise (Airbus 321)	Excavator (with bucket) 7 metres away	80 dB(A)
General traffic noise kerbside next to Military Road	Towable compressor 7 metres away	75 dB(A)
Normal conversation at 1 metre		60 dB(A)
Outdoor air conditioning unit 1 metre away	Towable compressor 50 metres away	55 dB(A)
General office		50 dB(A)
Inside private office	Ground-borne noise from road header tunnel excavation between depths of 20 metres to 50 metres	40 dB(A)
Inside bedroom		30 dB(A)

In terms of sound perception, a change of 1 dB(A) or 2 dB(A) in the sound pressure level is difficult for most people to detect, whilst a 3 dB(A) to 5 dB(A) change corresponds to a small but noticeable change in loudness. An increase in sound level of 10 dB(A) is perceived as a doubling of loudness. However, individuals may perceive the same sound differently since many factors can influence an individual's response, including:

- The specific characteristics of the noise (eg. frequency, intensity, duration of the noise event)
- Time of day noise events occur
- Individual sensitivities and lifestyle
- Reaction to an unfamiliar sound
- Understanding of whether the noise is avoidable and the notions of fairness.

A.3.3 Environmental noise assessment indicators

Environmental noise is an accumulation of noise pollution that occurs outside and is most commonly attributed to various modes of transport as well as industrial and construction activities. Environmental noise has been shown to have an adverse effect on the quality of life, especially following long-term exposure. The focus of the present technical assessment is on annoyance and sleep disturbance as they constitute most of the burden related to the impact of environmental noise on health outcomes. Noise annoyance is defined by the World Health Organization as a feeling of displeasure, nuisance, disturbance or irritation caused by a specific sound. Sleep disturbance relates to difficulty with sleep initiation, consolidation as well as awakening and reduced quality of sleep.

In New South Wales, contemporary environmental noise assessment criteria for addressing noise annoyance and sleep disturbance are specified by the Environment Protection Authority (EPA). Potential road traffic noise impact is assessed in accordance with the NSW Road Noise Policy. For industrial facilities that are permanently fixed, and associated noise emissions are long-term in nature, noise criteria have been adopted in accordance with the Noise Policy for Industry. For enabling construction activities which are temporary in nature and highly variable, EPA's Interim Construction Noise Guideline provides the underlying assessment principles for the determination of potential construction noise impact. These policies use the following noise indicators.

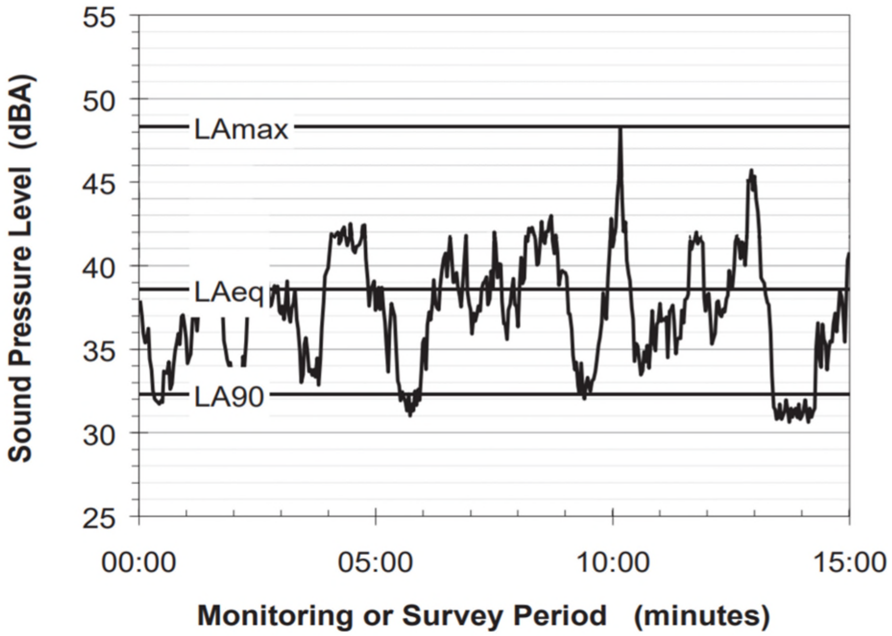
L_{Aeq} - To protect against long-term repeated noise exposure, the indicator for assessing the cumulative noise exposure level over a specific time interval is the equivalent sound pressure level, denoted as L_{Aeq}. The L_{Aeq} indicator accounts for the total energy content from all sources of sound under consideration. The fact that the L_{Aeq} is a cumulative measure means that louder activities have greater influence over the L_{Aeq} level than do quieter ones, and activities that last longer in time have greater L_{Aeq} than do shorter ones. An increase in the number of events also increases the L_{Aeq}. Further, people react to the duration of noise events, judging longer events to be more annoying than shorter ones, assuming equal maximum noise levels.

L_{Amax} - It is important to note that L_{Aeq} levels are numerically lower than maximum noise levels (denoted as L_{Amax}). None of the noise is ignored, just as all the rain that falls in the rain gauge in one hour counts toward the total. In the case of noisy but short-lived maximum noise events, which can sometime result in immediate short-term awakening reaction, potential impact is assessed using the L_{Amax} indicator in which its emergence above the background noise environment is evaluated.

L_{A90} - The L_{A90} is the level of noise that is present almost constantly, or for 90 per cent of the time and is commonly referred to as the background noise. Typical examples of what types of noise may contribute to the background noise levels are continuously flowing traffic or air conditioner noise.

These three noise indicators of L_{Amax}, L_{Aeq} and L_{A90} are presented in Figures A-1 for a sample noise monitoring survey period showing the sound pressure level of a varying noise environment such as environmental noise.

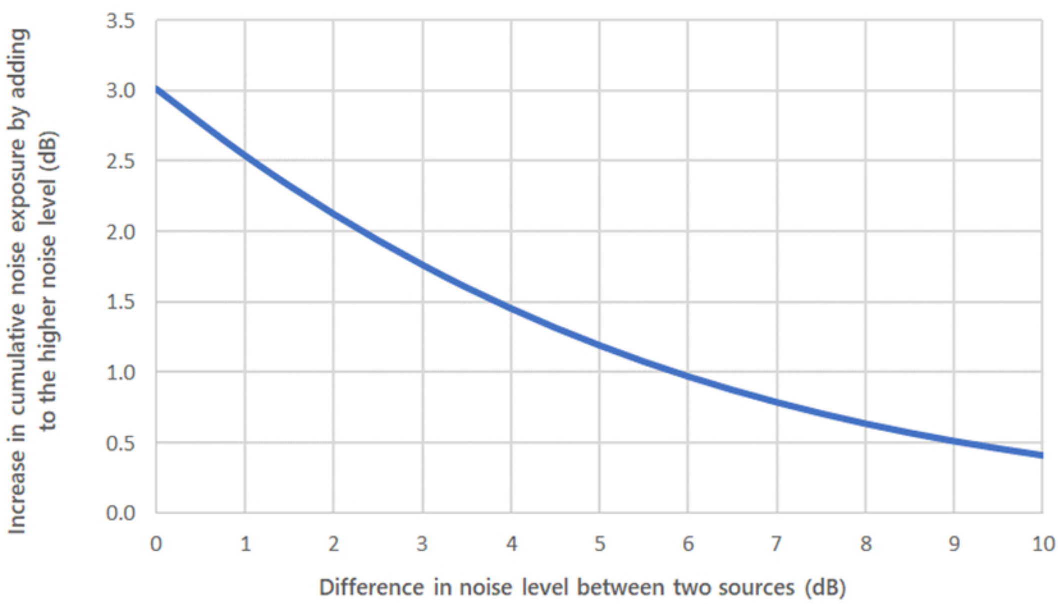
Figure A-1: Environmental noise assessment indicators



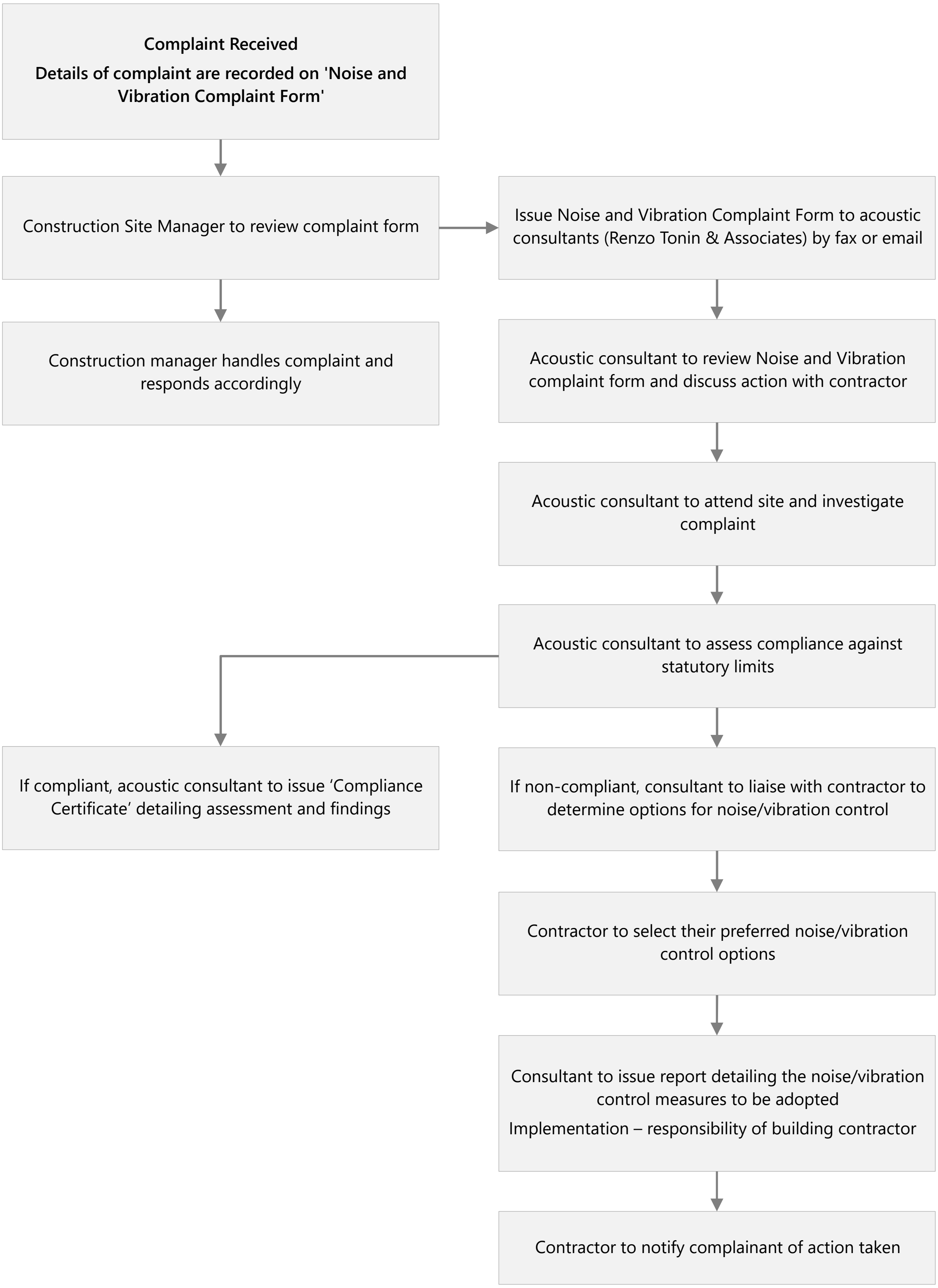
A.3.4 Cumulative sound exposure

As illustrated in Figure A-2, for two activities that result in the same amount of acoustical energy or noise level at a receiver location, the cumulative sound exposure level would be 3 dB higher than the level of just one single activity. This is because the decibel (dB) scale is logarithmic. Conversely, if the activity closer to your home results in noise exposure level that is 10 dB higher than the activity occurring further away, the quieter works would contribute very little to the cumulative noise exposure level.

Figure A-2: Difference in noise level between two sources



APPENDIX B Noise / vibration complaint management procedure



NOISE/ VIBRATION COMPLAINT FORM

Project title: ______________________ **Date:** ______________

Site contractor: ______________________ **Phone:** ______________

Site contact: ______________________ **Email:** ______________

Complaint details

Received by (circle): Phone / Email / In person / Other: ______________

Name: ______________________ H Ph: ______________

Address: ______________________ W Ph ______________

Email: ______________________ M Ph ______________

Describe when the problem occurred (date and time), what equipment caused the complaint (if known) and where person was standing when he/she experienced the noise/vibration:

____

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____

____

Investigation

Question foreman responsible on site and obtain information on what equipment or processes would most likely have caused the complaint:

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Following approval from the Project Manager, email/fax this form to Renzo Tonin & Associates