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PROPOSED WAREHOUSE DEVELOPMENT, 520 GARDENERS ROAD, ALEXANDRIA

Noise & Vibration Impact Assessment

27 January 2022

Charter Hall Holdings Pty Ltd c/- Project Strategy

TM455-01F01 520 Gardeners Road NVIA (r3)

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Important Disclaimer:

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1 Introduction

1.1 Overview and purpose of report

Renzo Tonin & Associates (RT&A) has been engaged by Charter Hall Holdings Pty Ltd (Charter Hall) to undertake an operational and construction noise and vibration impact assessment (NVIA) to accompany the State Significant Development (SSD) 32489140 for the proposed Ascent Logistics Centre at 520 Gardeners Road, Alexandria (the Proposal).

This report assesses noise and vibration impacts during the construction and operational phases for the Proposal. It proposes mitigation and management measures to reduce impacts during the construction and operational phases of the Proposal. The report has been prepared to address the requirements of the Secretary of the Department of Planning, Industry and Environment (DPIE) ('the Secretary's environmental assessment requirements') (SEARs).

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 Secretary's environmental assessment requirements

The Department of Planning, Industry and Environment (DPIE) 'Rapid Assessment Framework' guidelines were finalised on 1 July 2021. This NVIA has been prepared in accordance with this 'new' framework. The Secretary's environmental assessment requirements relating to the project are based upon the *'Warehouse and distribution centres'* industry specific SEARs which were issued for the project on 30 November 2021, along with the additional assessment requirements identified by DPIE.

These requirements are addressed in this report, as outlined in Table 1-1.

Table 1-1: Secretary's environmental assessment requirements – Noise and vibration

Secretary's environmental assessment requirements	Where addressed
11. Noise and vibration	
Provide a noise and vibration assessment prepared in accordance with the relevant EPA guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures that would be implemented.	Section 1.5 - Nearby noise and vibration sensitive receivers Section 3 – Details of relevant EPA guidelines and objectives Section 4 – Construction Section 3.5 and 5.1 – Operational Road traffic Section 5.2 to 5.5 – Operational – Site emissions and sleep disturbance
Additional assessment requirements	
The Department has identified assessment requirements additional to those attached. These requirements, in addition to the industry-specific SEARs, are provided below and should be taken to be the collective SEARs for the project.	-
Description of the development – including: • details of the proposed use/s being sought and tenancy arrangements • description of the context of the development in relation to other land uses i.e. schools and residential areas.	Section 1.3 - Proposal description Section 5.2.1 - Details of proposed and assessed operations

1.3 Proposal overview

1.3.1 Location

The Proposal location is shown in Figure 1, and is located within the City of Sydney Local Government Area (LGA) and is zoned IN1 General Industrial.

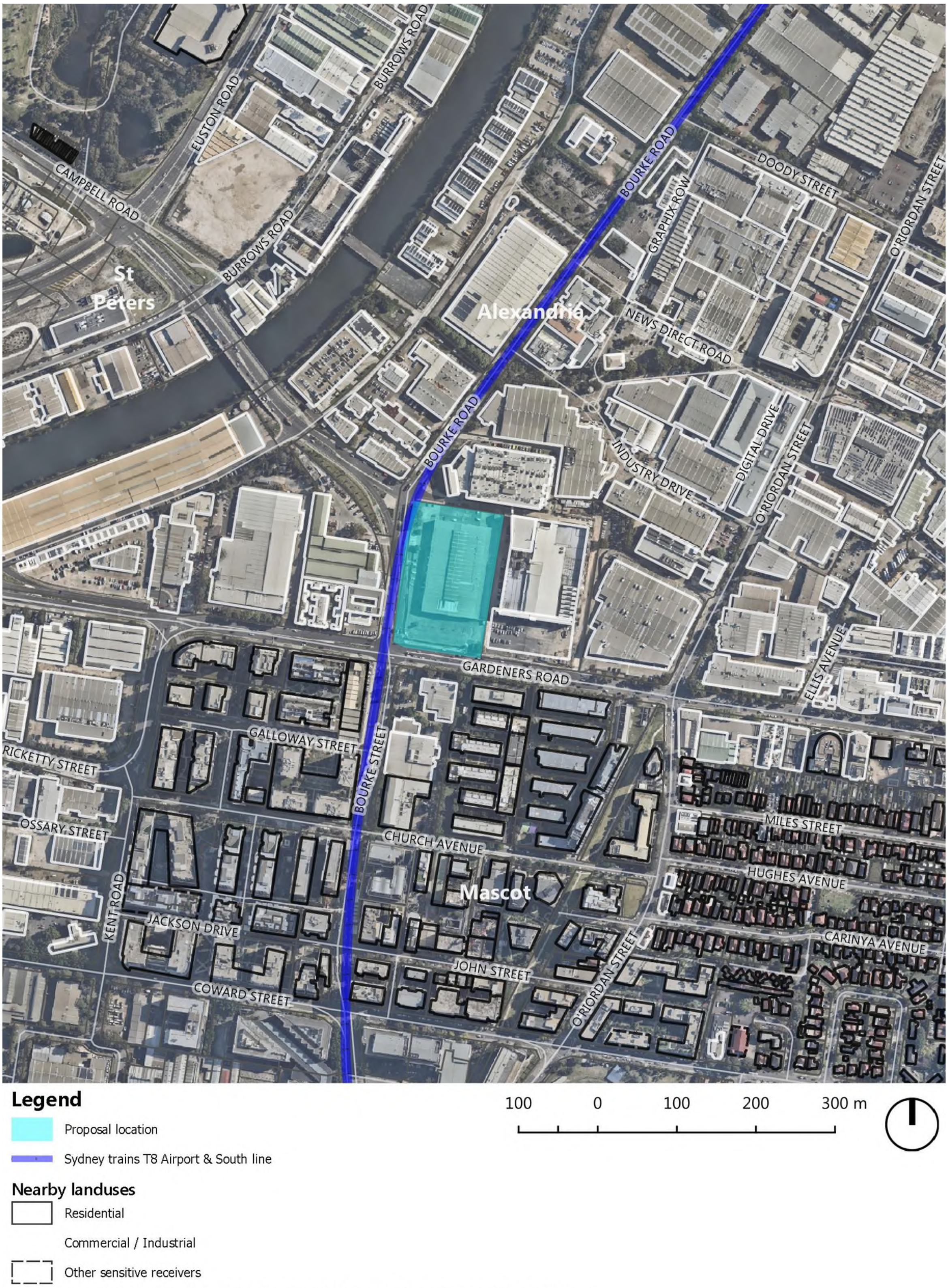
The site is located at 520 Gardeners Road, Alexandria, which is at the north-eastern side of the intersection of Bourke Road and Gardeners Road, Alexandria. On the south side of Gardeners Road, Alexandria is the Bayside LGA.

1.3.2 Access

Access to the site will be via dual access from Bourke Road and Gardeners Road.

Ingress and egress from light vehicles will be by Bourke Road, while access ingress for heavy vehicles will be from Gardeners Road, with egress via Bourke Road.

Figure 1: Proposal location



Imagery source: Nearmap and Sixmaps (NSW Department Finance, Services and Innovation [23/12/2021])

1.3.3 Proposal description

The Proposal is for the construction and operation of a two-storey warehouse and distribution centre, at 520 Gardeners Road, Alexandria (the Proposal). The proposal comprises the redevelopment of the site as summarised below:

- Construction, fit out and operation of a two-storey warehouse and distribution centre comprising approximately 27,509 m^2 GFA including:
  - 21,952 m^2 of warehouse and distribution GFA; and
  - 5,557 m^2 GFA ancillary office space.
- Provision of 64 bicycle parking spaces at ground floor level and 144 car parking spaces at second floor level.
- Approximately 3,342 m^2 of landscaping at ground and second floor levels.
- Replacement of the existing vehicular access from Bourke Road with two new access driveways from Bourke Road.
- Earthworks and upgrades to existing on-site infrastructure.
- Provision of internal vehicle access route and loading docks.
- Building identification signage.
- Operation 24 hours per day seven days per week.

1.3.4 Proposal operations

At this stage, final nature of the warehouse facility operations are not clearly understood as the final tenants of the facility 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.

As such, this assessment has aimed to review potential operations from the potential warehouse and logistics activities in a conservative manner, to allow the necessary flexibility of the potential future tenants.

Traffic volumes and warehouse activities have been based upon similar types of warehousing, with information provided by the project team to review the operations and the potential traffic generation noise impacts by the proposal.

The single confirmed tenant is Schindler Australia, which is currently confirmed for the southern warehouse tenancy 3, and the Level 2 offices above. In addition to typical warehouse and office operations, they will require service vehicles (ie. small delivery vans) which will be parked/stored within the Level 2 carpark area. Night service van movements for Schindler Australia will likely only be required where there is a lift emergency, and as such night movements would not often occur. These have been captured in the assessment for a conservative assessment.

1.3.5 Proposal hours

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

It is expected that future tenants will operate such that the warehouse activities will have reduced intensity during the night period.

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 requirements.

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

- Australian Standard AS 1055:2018 *Acoustics—Description and measurement of environmental noise*
- 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 2013).

In undertaking the assessments, attended and unattended noise monitoring was conducted to measure noise from the existing acoustic environment and potential noise sources.

1.5 Nearby noise and vibration sensitive receivers

1.5.1 Site and surrounding land use

The Proposal site is located on the boundary of the City of Sydney LGA and the Bayside LGA.

On the northern side of Gardeners Road, the land uses are a mixture of commercial and industrial receivers. While on the southern side of Gardeners Road the land uses are predominately multi-storey residential towers, with commercial tenancies on the ground level. There are also commercial and industrial receivers, which include data centre receivers, on the southern side of Gardeners Road directly south of the site. The site is bounded by data centres to the north and east, with the nearest residential receivers located across Gardeners Road directly south (635 Gardeners Road, Mascot) and south-west (653 Gardeners Road, Mascot) from the development.

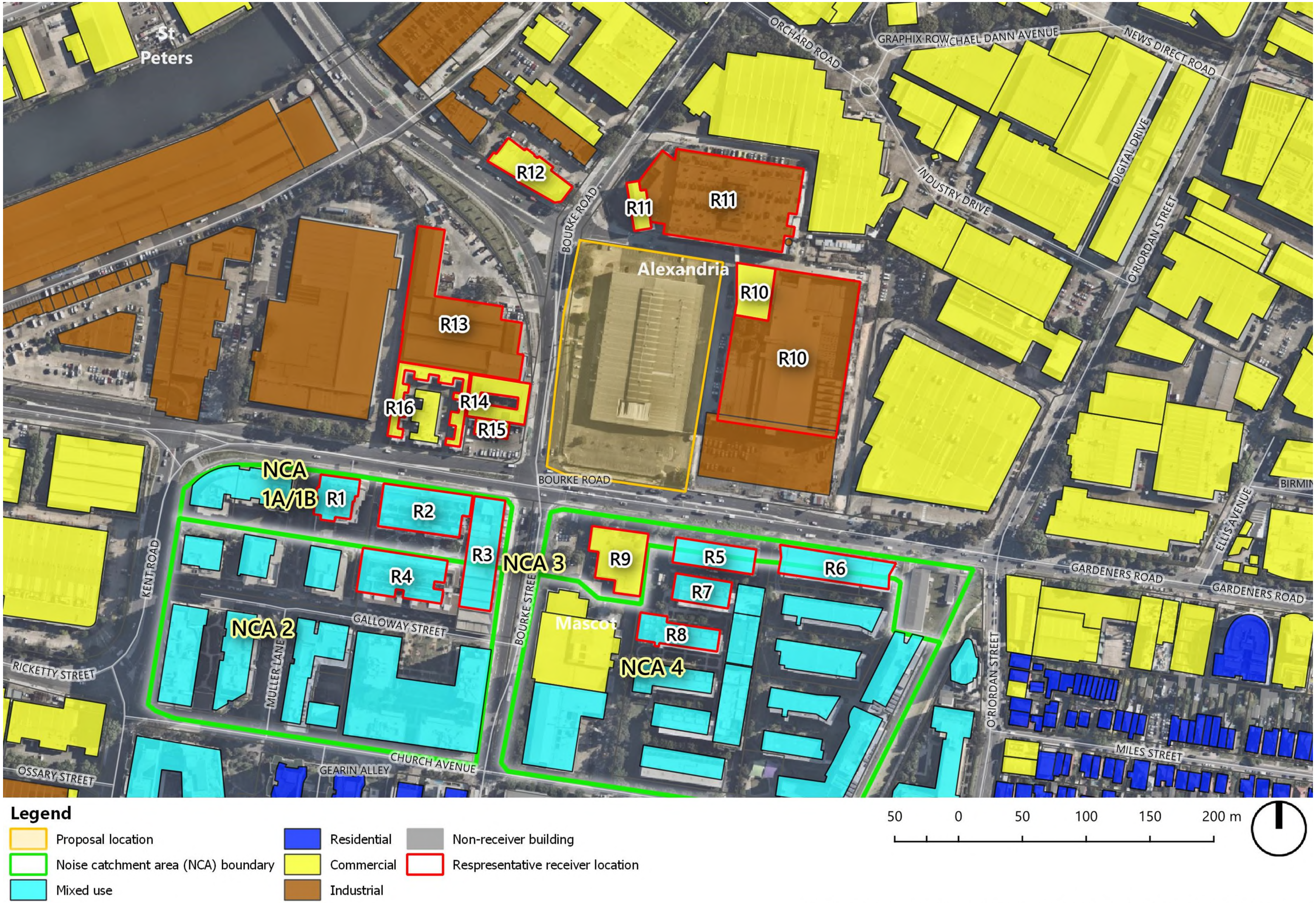
The nearby noise sensitive receivers are presented in Figure 2 and described below:

- Residential properties south and south-west of the site (blue shaded buildings)
  - 653 Gardeners Road, Mascot, is currently a commercial receiver (car hire premises). However, based upon the Bayside Council's DA Tracker a development application was determined for the site 20 December 2016, based upon the Land and Environment Court file number 2016/158972. As such, it has been assumed for assessing potential operational noise impacts, that the proposed 14 storeys mixed use tower would be in place.
- Equinix data centres to the north and east (yellow and brown shaded buildings)
  - Equinix SY5 Stage 2 Data Centre at 506-518 Gardeners Road, Alexandria was approved by City of Sydney 11/11/2021.
- Commercial and industrial receivers to the west across Bourke Road (yellow and brown shaded buildings)

The extent of receiver buildings that have been included in the assessment modelling for the NPfI assessment is presented in Figure 2.

Given the large number of nearby receivers, considering the multiple receivers within each multi-storey residential tower, a set of representative receiver locations have been selected and are presented in Figure 2.

Figure 2: Site location, nearby noise sensitive receivers, land uses and NCAs



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 [27/01/2022])

1.5.2 Noise catchment areas

As the existing acoustic environment varies at the nearby residential receivers, these residential receivers have been grouped into Noise Catchment Areas (NCAs) based upon areas with similar acoustic environments. This has been done to logically group the receivers to assist with the assessment and allocate the appropriate project noise trigger levels or management levels to each receiver. The locations of these noise catchment area boundaries are also shown in Figure 2.

1.5.3 Representative receivers

Noise levels have been modelled to all nearby and potentially impacted noise sensitive receiver locations, however for the purposes of simplifying the tabling of results in this report, only the results from critical locations on the 16 identified representative receivers, which includes critical floor locations as many receivers are multi-storey buildings. As such, there has been 32 representative assessment locations included in the assessment. The following representative receivers have been identified:

- NCA1 contains receivers R1 to R3 (also in NCA2), which are residential towers with multiple receivers to the south-west of the Proposal fronting onto Gardeners Road. Due to the variation in background noise levels across the up to 14 floors of the multi-storey residences, NCA1 was separated into NCA1A to represent the lower floors and NCA1B to represent the upper floors. NCA1A being from ground level up to Level 4, and NCA1B being Level 4 and above.

- NCA2 contains receivers R3 (also in NCA1) and R4, which are residential towers with multiple receivers to the south-west of the Proposal set back from Gardeners Road.

- NCA3 contains receivers R5 (also in NCA4) and R6, which are multi-storey residential apartment blocks with multiple receivers to the south and south-east of the Proposal fronting Gardeners Road.

- NCA4 contains receivers R5 (also in NCA3), R7 and R8, which are multi-storey residential apartment blocks with multiple receivers to the south and south-east of the Proposal set back and shielded from Gardeners Road by apartment building structures.

- R9, R10 and R11 are data centre buildings directly surrounding the Proposal site, with R10 and R11 being adjacent to the Proposal, which each contain commercial office receivers in addition to being an industrial receiver.

- R12 to R16 are commercial and industrial receiver to the west of the Proposal.

The locations of the representative receiver points for the operational noise assessment are presented in Table 1-2, and a map of these locations presented in Figure 2.

Table 1-2: Representative receiver locations

Residential noise catchment area (NCA)	Receiver number	Address / location	Receiver type	Number of floors	Approximate distance to the Proposal, metres
1A/1B	R1	671 Gardeners Road, Mascot	Residential (ground floor commercial)	14	140
1A/1B	R2	659 Gardeners Road, Mascot (north tower)	Residential (ground floor commercial)	12	60
1A/1B	R3 (north)	653 Gardeners Road, Mascot	Proposed future residential (ground floor commercial)	14	40
2	R3 (south)	653 Gardeners Road, Mascot	Proposed future residential (ground floor commercial)	14	40
2	R4	659 Gardeners Road, Mascot (south tower)	Residential (Level 2 podium to Level 12)	12	105
3	R5 (north)	635 Gardeners Road, Mascot (north facade)	Residential (ground floor commercial)	5	35
3	R6	629 Gardeners Road, Mascot (north facade)	Residential (ground floor commercial)	6	80
4	R5 (west)	635 Gardeners Road, Mascot (west facade)	Residential (ground floor commercial)	5	35
4	R7	635 Gardeners Road, Mascot (west facade)	Residential	5	60
4	R8	635 Gardeners Road, Mascot	Residential	5	95
-	R9	639 Gardeners Road, Mascot	Commercial	1	35
-	R10	506-518 Gardeners Road, Alexandria	Commercial + Industrial	4	Adjacent
-	R11	200 Bourke Road, Alexandria	Commercial + Industrial	2	Adjacent
-	R12	79 Bourke Road, Alexandria	Commercial	1	30
-	R13	83 Bourke Road, Alexandria	Industrial	2	25
-	R14	85 Bourke Road, Alexandria	Industrial	3	20
-	R15	532-536 Gardeners Road, Alexandria	Commercial	1	30
-	R16	538 Gardeners Road, Alexandria	Commercial	3	65

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 and noise monitoring

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 typical time periods 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.

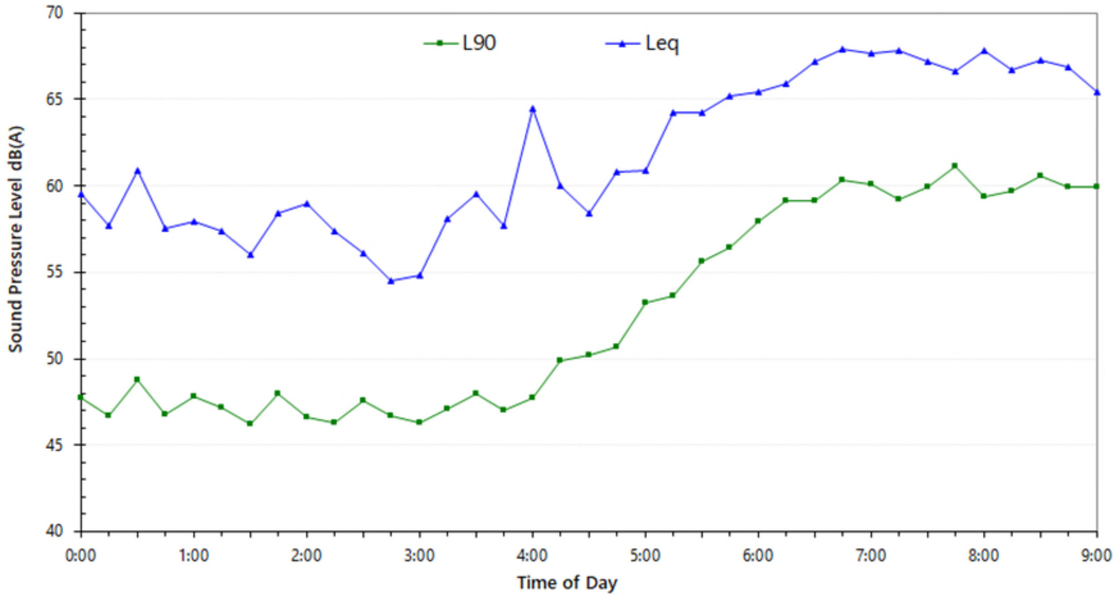
Shoulder periods

Fact Sheet B of the NPfI outlines the methods for determining the background noise level of an area. The NPfI also outlines methods for assessing 'shoulder periods' being shorter periods on either side of a standard period, where the standard period noise levels are not well represented. For example, a 'shoulder period' may be warranted for 5:00am-7:00am or 10:00pm-12:00am during which the night-time period background noise level is not well represented. Fact Sheet A, Section A3 of the NPfI outlines suitable methods to determine the shoulder period background noise level.

Data from Wednesday 1 December 2021 presented in Figure 3 as a representative example from the unattended noise monitoring for the early morning period. This clearly shows the background noise levels are steadily rising in the early morning hours (5:00am-7:00am) at nearby receivers. This pattern is seen in the other long term noise monitoring presented in APPENDIX B.

Because the nearby arterial roads (predominately Gardeners Road and Bourke Road) dominate the ambient noise environment at nearby residential receivers, and these roads have steadily rising traffic noise levels during the early morning period from around 4:00am, it is appropriate to establish a morning shoulder period in accordance with NPfI Section A3.

Figure 3: Sample early morning background noise levels (Apartment 47, 635 Gardeners Road, Mascot, Wednesday 1 December 2021)



Accordingly, 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 5:00am, Monday to Sunday & Public Holidays.
- **Morning shoulder** is defined as 5:00am to 7:00am, Monday to Saturday and 5:00am to 8:00am Sundays & Public Holidays.

2.1 Environmental noise monitoring

Noise measurements have been carried out at both the nearest and potentially most affected locations surrounding the Proposal. This has included residential receiver locations located both further back and shielded from the Gardeners Road but with direct line-of-sight to the Proposal, in addition to receiver locations at different levels in the multi-storey residential towers.

These monitoring locations were adopted to determine the variation in background and ambient noise level at all potentially impacted nearby receivers.

2.1.1 Existing noise environment measurements

2.1.1.1 Unattended noise monitoring

Fact Sheet B of the NSW EPA NPfI outlines two methods for determining the background noise level of an area, being 'B1 – Determining background noise using long-term noise measurements' and 'B2 – Determining background noise using short-term noise measurements'. This assessment has used long-term noise monitoring to determine background noise levels, supported by short-term noise measurements.

Unattended long-term noise monitoring was carried out at five locations for continuous periods during November and December 2021 to measure ambient and background noise levels. Long-term noise monitoring was conducted using the instrumentation presented in Table 2-1. The noise level-vs-time graphs of the data are included in APPENDIX B. Long-term noise monitoring was conducted in general accordance with Fact Sheet B of the NSW EPA NPfI and AS1055:2018.

The equipment used for noise measurements were NTi Audio Type XL2 precision sound level analysers which are a class 1 instruments having accuracy suitable for field and laboratory use. All instrumentation complies with IEC 61672 (parts 1-3) '*Electroacoustics - Sound Level Meters*' and IEC 60942 '*Electroacoustics - Sound calibrators*' and carries current NATA certification (or if less than 2 years old, manufacturers certification).

Table 2-1: Unattended noise monitoring equipment

Reference location	Address	Location	Logger reference	Monitoring period
L1	671 Gardeners Road, Mascot	Level 4 podium	RTA05-008	29/11/2021 – 15/12/2021
L2	659 Gardeners Road, Mascot	Level 12, roof terrace, north facade	RTA06-002	19/11/2021 – 12/12/2021
L3	659 Gardeners Road, Mascot	Level 2 podium	RTA06-011	26/11/2021 – 12/12/2021
L4	635 Gardeners Road, Mascot	Level 4 (north facade)	RTA06-015	26/11/2021 – 3/12/2021
			RTA07-022	3/12/2021 – 9/12/2021
L5	635 Gardeners Road, Mascot	Level 3 (west facade)	RTA07-006	19/11/2021 – 10/12/2021

The equipment calibration was field checked prior and subsequent to the measurement period using a Bruel & Kjaer Type 4231 calibrator, with no significant calibration drift observed. All noise monitoring locations were undertaken in the free field, and representative of the ambient noise environment for the associated residential receivers.

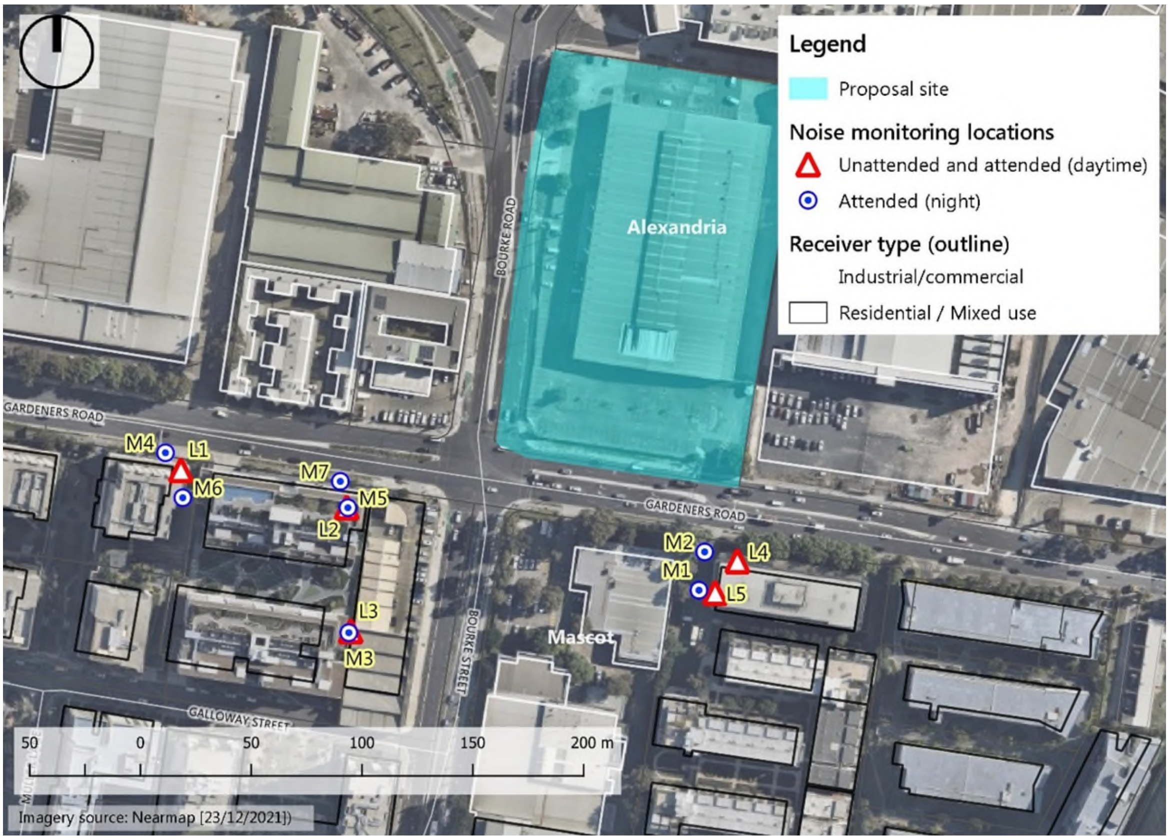
The unattended noise monitoring locations and observed noise environment are summarised in the Table 2-2 below.

Table 2-2: Unattended noise monitoring locations

Reference location	Address and location description	Observed noise environment
L1	671 Gardeners Road, Mascot Representative of lower floor apartments adjacent to Gardeners Road. Noise logger was located on the Level 4 podium level, on the north side of the property. The logger was located adjacent to the podium parapet, with full line of sight to Gardeners Road. Microphone was located 1.5 metres above the local ground level, located to be measuring in the free field.	Day: Controlled by constant road traffic on Gardeners Road (~ 65-72 dB(A) when moving, (~ 60-62 dB(A) when traffic lights stopped). Occasional aircraft fly over. Night: Controlled by intermittent road traffic on Gardeners Road (~ 67 dB(A) with contributions from nearby industrial activities and mechanical plant.
L2	659 Gardeners Road, Mascot Representative of upper floor apartments adjacent to Gardeners Road. Noise logger was located adjacent to the western fence. Microphone was located 2.3 metres above ground level, elevated 0.6 metre above the glass parapet to measure in the free field and have line of sight to Gardeners Road.	Day: Controlled by constant road traffic on Gardeners Road and Bourke Road. Occasional aircraft fly over, and distant aircraft noise. Night: Controlled by intermittent road traffic on Gardeners Road, Bourke Road and Campbell Road with contributions from nearby industrial activities and mechanical plant.
L3	659 Gardeners Road, Mascot (set-back apartment tower) Representative of residential apartments setback from Gardeners Road. Noise logger was located on the Level 2 Podium level, in the 1 metre high raised garden bed on the eastern boundary. Microphone was located 2.5 metres above ground level podium level measuring in the free field. The logger was in line with the set back apartments with line of sight to the intersection of Gardeners Road and Bourke Road.	Day: Controlled by constant road traffic on Gardeners Road and Bourke Road. Night: Controlled by constant road traffic on Gardeners Road and Bourke Road, including the intersection, with some contribution from nearby mechanical plant.
L4	635 Gardeners Road, Mascot (Level 4, Apartment 47, northern facade) Representative of apartments on Gardeners Road, directly facing Gardeners Road. Noise logger was located on the balcony of Apartment 47 on Level 4 on the northern facade. Microphone was located 1.5 metres above local ground level, measuring on the balcony edge in the free field. The location has direct line of sight to Gardeners Road and the Proposal Gardeners Road entrance.	Day: Controlled by constant road traffic on Gardeners Road and Bourke Road (~ 63-66 dB(A) when general traffic is moving, with concrete agitators and truck passbys ~68-83 dB(A), ~ 60-61 dB(A) when traffic stopped by traffic lights). Night: Controlled by intermittent road traffic on Gardeners Road and Bourke Road, with some contribution from nearby mechanical plant.
L5	635 Gardeners Road, Mascot (Level 3, Apartment 22, western facade) Representative of apartments on Gardeners Road, not directly facing Gardeners Road. Noise logger was located on the balcony of Apartment 22 on Level 3 on the western facade. The location has direct line of sight to the Proposal Gardeners Road entrance. Microphone was located 1.5 metres above local ground level, measuring on the balcony edge.	Day: Controlled by road traffic on Gardeners Road and Bourke Road (~ 58-64 dB(A) when general traffic is moving, with motorbike and bus passbys ~64-74 dB(A), ~ 52-56 dB(A) when traffic stopped by traffic lights). Night: Controlled by intermittent road traffic on Gardeners Road and Bourke Road, with some contribution from nearby mechanical plant.

The locations of the unattended long-term noise monitoring are presented in Figure 4.

Figure 4: Noise monitoring locations



The monitored existing ambient and background noise levels measured are presented Table 2-3 below. This table shows results measured at Locations 1 to 5, relevant to the potentially impacted receiver locations.

A summary of the unattended noise monitoring results along with a graphical recorded output from the long-term noise monitoring is included in APPENDIX B. The graphs in APPENDIX B were analysed to determine an assessment background level (ABL) for each day, evening and night period in each 24-hour period of noise monitoring. Based on the median of individual ABLs an overall single Rating Background Level (RBL) for the day, evening and night period is determined over the entire monitoring period in accordance with the NPfI. The RBL values for the morning shoulder period (5:00am to 7:00am) were established in accordance with Fact Sheet A, Section A3 of the NPfI.

Noise measurements affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the NPfI. Determination of extraneous meteorological conditions was based on data provided by the nearest Bureau of Meteorology (BOM) station, which was the Sydney Airport AMO weather station (Station 066037) approximately 3.5 km from the Proposal site. This is considered representative of the noise monitoring locations in accordance with the NPfI. The long-term noise monitoring data was reviewed and all extraneous noise events (eg nearby local noise events and extraneous meteorological conditions) that were identified as not a usual feature of the area, were excluded as shown by the 'greyed' out areas of the graphs presented in APPENDIX B of this report.

Table 2-3: Measured existing background and ambient noise levels, dB(A)

Ref	Address	Location description	Rating background noise levels (RBL), $L_{A90, 15 minute}$				Ambient noise levels[5], $L_{Aeq, 15 minute}$			
			Day[1]	Eve[2]	Night[3]	Shoulder[4,6]	Day[1]	Eve[2]	Night[3]	Shoulder[4]
L1	671 Gardeners Road, Mascot	Level 4 podium, north facade	59	53	47	47	68	65	63	66
L2	659 Gardeners Road, Mascot	Level 12, roof terrace, north facade	56	51	47	49	63	60	56	59
L3	659 Gardeners Road, Mascot	Level 2 podium, eastern boundary	53	49	42	45	61	59	56	59
L4	635 Gardeners Road, Mascot	Apartment 47, Level 4, north facade	57	53	45	49	66	64	61	65
L5	635 Gardeners Road, Mascot	Apartment 22, Level 3, west facade	55	50	45	48	63	61	58	61

Notes:
1. Day: 7.00am to 6.00pm Monday to Saturday and 8.00am to 6.00pm Sundays & Public Holidays
2. Evening: 6.00pm to 10.00pm Monday to Sunday & Public Holidays
3. Night: 10.00pm to 5.00am Monday to Sunday & Public Holidays
4. Morning shoulder: 5.00am to 7.00am Monday to Saturday and 5.00am to 8.00am Sundays & Public Holidays
5. As required by the NPfI, the external ambient noise levels presented are free-field noise levels. [ie. no facade reflection]
6. Shoulder period RBL levels determined as per NPfI Fact Sheet A3

2.1.1.2 Attended noise monitoring

Additionally, attended short-term noise monitoring was undertaken to confirm and characterise the existing ambient noise environment during both daytime and the sensitive night period. The locations of the attended noise monitoring are presented in Figure 4. Attended short-term noise measurements were undertaken nearby the potentially affected receivers and the unattended noise monitoring locations (where accessible at the time) in order to supplement the long-term noise monitoring and provide greater detail about the noise sources that make up the existing noise environment. Attended monitoring was during the deployment of the various unattended noise monitors, and undertaken during the night and early morning period on Tuesday 12th December 2021.

The equipment used for attended noise measurements included a NTi Audio Type XL2 precision sound level analyser, both of which are Class 1 instruments having accuracy suitable for field and laboratory use. The instruments were field checked for calibration prior and subsequent to measurements using a Bruel & Kjaer Type 4231 calibrator. No significant drift in calibration was observed. All instrumentation complies with IEC 61672 (parts 1-3) '*Electroacoustics - Sound Level Meters*' and IEC 60942 '*Electroacoustics - Sound calibrators*' and carries current NATA certification (or if less than 2 years old, manufacturers certification).

Observations made during attended noise measurements confirm that during the night and early morning period, ambient noise levels at all residential receiver locations were generally controlled by nearby traffic noise (generally Gardeners Road and Bourke Road) with background noise levels from nearby arterial roads further afield in addition to industrial noise levels from nearby commercial premises (ie. data centres). A summary of the night period attended noise measurement results is presented in Appendix B.2 Table 6-1.

Appendix B.2 Table 6-1 also presents the typical instantaneous noise levels as measured of different noise events and sources that generated these (ie. loud vehicle passbys) observed during the night period attended monitoring.

2.2 Measured road traffic noise levels

At each of the noise monitoring locations, road traffic noise dominated the existing noise environment, typically from Gardeners Road but with some contribution from Bourke Road at some locations. The existing traffic noise levels were monitored and the results are summarised in Table 2-4. Noise levels are described in accordance with the requirements of the *NSW Road Noise Policy* (RNP) (*Department of Climate Change and Water, 2011*).

As Gardeners Road and Bourke Road are arterial roads, the relevant descriptors for traffic noise are $L_{Aeq(15hr)}$ and $L_{Aeq(9hr)}$, which represent the existing day and night traffic noise levels, respectively.

As the noise monitoring locations were positioned in the free-field (ie. away from buildings), a +2.5 dB(A) correction was applied to the measured road traffic noise levels to represent an equivalent road traffic noise level at one metre from a building facade, in accordance with the requirements of the RNP.

Table 2-4: Measured road traffic noise levels

Ref	Address	Location description	Measured road traffic noise level, dB(A)	
			Day $L_{Aeq,15hour}$ (7:00am to 10:00pm)	Night $L_{Aeq,9hour}$ (10:00pm to 7:00am)
L1	671 Gardeners Road, Mascot	Level 4 podium, north facade	70	65
L2	659 Gardeners Road, Mascot	Level 12, roof terrace, north facade	64	58
L3	659 Gardeners Road, Mascot	Level 2 podium, eastern boundary	63	58
L4	635 Gardeners Road, Mascot	Apartment 47, Level 4, north facade	68	64
L5	635 Gardeners Road, Mascot	Apartment 22, Level 3, west facade	66	60

Notes: 1. Unattended monitoring was undertaken in the acoustic free-field. Noise levels presented are representative of road traffic noise level at one metre from a building facade, as per RNP.

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 2.

Table 3-3: Construction noise management levels

NCA / Rec. Id (see Section 4.5.1 for construction assessment receiver locations)	Location description	Noise management level $L_{Aeq(15min)}$[1] Monday to Fridays (7:00am to 6:00pm) Saturdays (8:00am to 1:00pm)
NCA1A	West of Bourke Road (lower floors fronting Gardeners Road) - Residential premises (R1)	69
NCA1B	West of Bourke Road (lower floors fronting Gardeners Road) - Residential premises (R2)	66
NCA2	West of Bourke Road (receiver set back from Gardeners Road) - Residential premises (R3 and R4)	63
NCA3	East of Bourke Road (lower floors fronting Gardeners Road) - Residential premises (R5 and R6)	67
NCA4	East of Bourke Road (receiver set back from Gardeners Road) - Residential premises (R7 and R8)	65
R11, R13, R15	Commercial premises	70[2]
R9, R10, R12 and R14	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. For multi-storey properties, the assessment point was based upon 1.5m above the local ground.

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.

Within British Standard 7385 Part 1, different levels of structural damage are defined:

- *Cosmetic - The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition the formation of hairline cracks in mortar joints of brick/concrete block construction.*
- *Minor - The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*
- *Major - Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

The vibration limits in Table 1 of British Standard 7385 Part 2 are for the protection against cosmetic damage, however guidance on limits for minor and major damage is provided in Section 7.4.2 of the Standard:

> *7.4.2 Guide values for transient vibration relating to cosmetic damage*
>
> *Limits for transient vibration, above which cosmetic damage could occur are given numerically in Table 1 and graphically in Figure 1. In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to line 2 are reduced. Below a frequency of 4 Hz, where a high displacement is associated with a relatively low peak component particle velocity value a maximum displacement of 0.6 mm (zero to peak) should be used.*
>
> *Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 1, and major damage to a building structure may occur at values greater than four times the tabulated values.*

Within DIN4150-3, damage is defined as "*any permanent consequence of an action that reduces the serviceability of a structure or one of its components*" (p.4). The Standard also outlines:

> *"For buildings as in lines 2 and 3 of Tables 1, 4 or B.1, the serviceability is considered to have been reduced if, for example*
>
> - *cracks form in plastered or rendered surfaces of walls;*
> - *existing cracks in a structure are enlarged;*
> - *partitions become detached from load-bearing walls or floor slabs.*
>
> *These effects are deemed 'minor damage. " (DIN4150.3:2016, p.6)*

While the DIN Standard defines the above damage as 'minor', based on the definitions provided in BS7385, the DIN standard is considered to deal with cosmetic issues rather than major structural failures.

3.2.2.1 British Standard

British Standard 7385: Part 2 '*Evaluation and measurement of vibration in buildings*', can be used as a guide to assess the likelihood of building damage from ground vibration. BS7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur.

The cosmetic damage levels set by BS 7385 are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular building types. Damage comprises minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls. 'Minor' damage is considered possible at vibration magnitudes which are twice those given and 'major' damage to a building structure may occur at levels greater than four times those values.

BS7385 is based on peak particle velocity and specifies damage criteria for frequencies within the range 4Hz to 250Hz, being the range usually encountered in buildings. At frequencies below 4Hz, a maximum displacement value is recommended. The values set in the Standard relate to transient vibrations and to low-rise buildings. Continuous vibration can give rise to dynamic magnifications due to resonances and may need to be reduced by up to 50%. Table 3.5 sets out the BS7385 criteria for cosmetic, minor and major damage.

Regarding heritage buildings, British Standard 7385 Part 2 (1993) notes that "*a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive*" (p.5).

Table 3.5: BS 7385 structural damage criteria

Group	Type of structure	Damage level	Peak component particle velocity, mm/s		
			4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	50		
		Minor*	100		
		Major*	200		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50
		Minor*	30 to 40	40 to 100	100
		Major*	60 to 80	80 to 200	200

Notes: Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.

* Minor and major damage criteria established based on British Standard 7385 Part 2 (1993) Section 7.4.2

3.2.2.2 German Standard

German Standard DIN 4150 - Part 3 (2016) '*Vibration in buildings - Effects on Structures*' (DIN 4150-3:2016), also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are generally recognised to be conservative.

DIN 4150-3:2016 presents the recommended maximum limits over a range of frequencies (Hz), measured at the foundations, in the plane of the uppermost floor of a building or structure or vertically on floor slabs. The vibration limits at the foundations increase as the frequency content of the vibration increases. The criteria are presented in Table 3.6.

Table 3.6: DIN 4150-3:2016 structural damage criteria

Group	Type of structure	Vibration velocity, mm/s				
		At foundation in all directions at frequency of			Plane of floor uppermost storey in horizontal direction	Floor slabs, vertical direction
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz	All frequencies	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	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 under Groups 1 and 2 and are of great intrinsic value (eg listed buildings)	3	3 to 8	8 to 10	8	20

3.2.3 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

3.2.4 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 Existing rail tunnels

Any development that occurs within a distance of 25 metres horizontally from first reserve (dependent on tunnel dimensions), as defined in Asset Standards Authority (ASA) standard *Development Near Rail Tunnels (ASA 2018)*, must consider vibration impacts on existing rail tunnels. The assessment requirement is a maximum peak particle velocity (PPV) of 15 mm/s at the tunnel lining for brick or mass concrete in good condition, or maximum PPV of 20 mm/s at the tunnel lining for cast iron, steel or concrete segment lining.

3.4 Operational noise objectives

3.4.1 Sydney Development Control Plan 2012

The City of Sydney council DCP 2012 does not outline provisions specifically applicable for controlling noise from large industrial/warehouse facilities.

However, it does identify a number of applicable requirements for noise for the Proposal, including:

- controlling environmental impacts such as noise to achieve design excellence (Clause 6.21)
- reviewing development in areas subject to aircraft noise (Clause 7.17) (see Section 3.6)
- noise management in the Southern Employment Lands (Clause 5.8.6.3), which states:
    - *A development application for a new building or for a change of use of an existing building, for a land use that is likely to generate external noise, must be accompanied by a Noise Impact Assessment prepared by a suitably qualified acoustic consultant. The Noise Impact Assessment is to include mitigation strategies, which must be implemented, to mitigate the impacts of noise generated by the new development on other activities in the vicinity. Mitigation strategies may include, for example, landscape buffers, sound locks, the use of specific building materials or sound walls.*
- Acoustic Privacy (Clause 4.2.3.11 and 4.2.5.3).

By assessing potential noise impacts against the NSW EPA guidelines required by the SEARs, as detailed in Section 1.2 and 1.4, this will also achieve the outcomes as required by the City of Sydney DCP for this type of development, including assessing impacts against the provisions of the NSW Environment Protection Authority (EPA) Noise Policy for Industry (NPfI). Refer to see Section 3.6 in regard to aircraft noise.

3.4.2 NSW EPA Noise Policy for Industry

This assessment aims to quantify the potential operational noise emissions from the Proposal in accordance with the NPfI. 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.

3.4.2.1 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 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)

For the purposes of assessing operational noise impacts, rating background noise levels representative of the nearby affected residential receivers were described and presented in Section 2.1.1. The intrusiveness noise levels for residential receivers are reproduced in Table 3-9 below.

Table 3-9: Intrusiveness noise levels

Receiver	Logger	Intrusiveness noise level, $L_{Aeq,15min}$			
		Day	Evening	Night	Shoulder period (morning)[4]
NCA1A (West, fronting Gardeners Road) (Apartments, Level 4 and below)	L1	59 + 5 = 64	53 + 5 = 58	47 + 5 = 52	47 + 5 = 52
NCA1B (West, fronting Gardeners Road) (Apartments, above Level 4)	L2	56 + 5 = 61	51 + 5 = 56	47 + 5 = 52	49 + 5 = 54
NCA2 (West, set-back from Gardeners Road)	L3	53 + 5 = 58	49 + 5 = 54	42 + 5 = 47	45 + 5 = 50
NCA3 (West, fronting Gardeners Road)	L4	57 + 5 = 62	53 + 5 = 58	45 + 5 = 50	49 + 5 = 54
NCA4 (East, set-back from Gardeners Road)	L5	55 + 5 = 60	50 + 5 = 55	45 + 5 = 50	48 + 5 = 53

Notes: 1. Day: 7:00am to 6:00pm Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays
2. Evening: 6:00pm to 10:00pm Monday to Sunday & Public Holidays
3. Night: 10:00pm to 7:00am Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays
4. Shoulder period 5:00am to 7:00am Monday to Saturday and 5:00am to 8:00am Sundays & Public Holidays

3.4.2.2 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 3-10 below.

Table 3-10: 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 playground, golf course)	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	70
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 LAeq noise level may be increased to 40 dB LAeq(1hr)

3.4.2.2.1 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).

Recent clarification sought from the NSW EPA identified that selecting the appropriate amenity category would follow the above order from top to bottom of the above list. Assigning a noise category based on planning zoning alone provides for a conservative assessment without giving any consideration to the existing acoustic environment, and so following this the noise environment should be considered if appropriate for the situation.

The nearest residential receivers are located south of Gardeners Road. The residences here are located in areas zoned B4 'Mixed use', which is identified as **Urban residential** category in column 2 of NPfI Table 2.3. As such, these residential receivers have been categorised as urban.

3.4.2.2.2 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 is determined as follows:

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

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.

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

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	Recommended noise level, dB(A)	
			$L_{Aeq, Period}$	$L_{Aeq, 15min}$
Residence	Urban	Day	60 – 5 = 55	55 + 3 = **58**
		Evening	50 – 5 = 45	45 + 3 = **48**
		Night[1]	45 – 5 = 40	40 + 3 = **43**
		Morning shoulder[4]	60 – 5 = 55	55 + 3 = **58**
Commercial Premises	All	When in use	65 – 5 = 60	60 + 3 = **63**
Industrial premises	All	When in use	70 – 5 = 65	65 + 3 = **68**

Notes:
1. Daytime 7:00am to 6:00pm; Evening 6:00pm to 10:00pm; Night-time 10:00pm to 5:00am, and Morning-shoulder 5:00am - 7:00am. On Sundays and Public Holidays, Daytime 8:00am - 6:00pm; Evening 6:00pm - 10:00 pm; Night-time 10:00pm - 5:00am, Morning-shoulder 5:00am - 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)
4. Based upon recently clarifications from NSW EPA (Noise), as the NPfI is unclear about should period amenity requirements, it was clarification that the NSW EPA expects that where a morning shoulder period has been justified that the corresponding day-time period amenity level would be applicable.

3.4.2.2.3 Amenity noise levels in areas of high traffic noise

Where the levels of transport noise, in particular road traffic noise are high enough to make noise from an industrial source effectively inaudible, even though the L_{Aeq} noise level from that industrial noise source may exceed the project amenity noise level, the NPfI sets out criteria to take this into account.

In such cases NPfI Section 2.4.1 details that the project amenity noise level may be derived from the $L_{Aeq, period(traffic)}$ minus 15 dB(A). It is noted that in a similar manner to the derivation of the project amenity noise level in 3.4.2.2.2, this minus 15 dB(A) includes a 5 dB(A) reduction to take into account cumulative other industrial noise contributions, to ensure that the total industrial noise level (existing plus new) remains within the recommended amenity noise levels for an area.

This high traffic project amenity noise level may be applied only if all the following apply:

- traffic noise is identified as the dominant noise source at the site
- the existing traffic noise level (determined using the procedure outlined in A2, Fact Sheet A, that is, measuring traffic instead of industrial noise) is 10 dB or more above the recommended amenity noise level for the area
- it is highly unlikely traffic noise levels will decrease in the future.

The applicability of these traffic noise provisions needs to be determined for each assessment period (that is, day, evening and night).

Due to the dominance of Gardeners Road to the ambient noise levels at the nearby residential receivers, presented in Section 2.1.1.2, amenity noise levels in areas of high traffic noise are applicable for a number of receiver locations during different assessment periods for this NVIA. With considering the nearby recent road projects that have recently commenced operation and the road traffic projections detailed in the associated EIS documentation, such as the Westconnex M8, it is highly unlikely that traffic noise will reduce on these arterial roads over time.

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.

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

Therefore, Table 3-12, reviews and determines where applicable, that the high traffic noise provisions in the Noise Policy for Industry, Section 2.4.1 should be adopted to derive the project amenity trigger levels.

Table 3-12: High traffic project amenity noise level

NCA	Existing traffic noise levels[1], $L_{Aeq, 15 minute}$				Existing traffic noise levels 10 dB(A) or more above ANL?				High traffic project amenity noise level[2], $L_{Aeq, 15 minute}$			
	Day[1]	Eve[2]	Night[3]	Shoulder[4]	Day[1]	Eve[2]	Night[3]	Shoulder[4]	Day[1]	Eve[2]	Night[3]	Shoulder[4]
NCA1A	68	65	63	66	No	Yes	Yes	No	-[3]	53	51	-[3]
NCA1B	63	60	56	59	No	Yes	Yes	No	-[3]	48	44	-[3]
NCA2	61	59	56	59	No	No	Yes	No	-[3]	-[3]	44	-[3]
NCA3	66	64	61	65	No	Yes	Yes	No	-[3]	52	49	-[3]
NCA4	63	61	58	61	No	Yes	Yes	No	-[3]	49	46	-[3]

Notes:

1. Noise levels measured as per NPfI Section 2.4.1, which noted that the traffic noise levels are to be determined using the procedure outlined in A2, Fact Sheet A, that is, measuring traffic instead of industrial noise
2. High traffic project amenity noise level is existing traffic levels minus 15 dB(A) plus 3 dB(A) to convert from a period level to a 15-minute level.
3. High traffic project amenity noise level does not apply

3.4.2.3 Project noise trigger levels

The project noise trigger levels have been converted to $L_{Aeq\ 15min}$ values in accordance with Section 3.4.2.2.2 and these are presented in Table 3-13. The project intrusive noise levels have been presented for reference purposes only as per Section 3.4.2.1, and have not been used to determine the final project noise trigger levels.

Table 3-13: Project noise trigger levels for residential receivers

Receiver location	$L_{Aeq, 15min}$ Project noise trigger levels, dB(A)							
	Day		Evening		Night		Morning shoulder	
	Intrusive	Amenity	Intrusive	Amenity	Intrusive	Amenity	Intrusive	Amenity
NCA1A	64	**58**	58	**53**	52	**51**	**52**	58
NCA1B	61	**58**	56	**48**	52	**44**	**54**	58
NCA2	58	**58**	54	**48**	47	**44**	**50**	58
NCA3	62	**58**	58	**52**	50	**49**	**54**	58
NCA4	60	**58**	55	**49**	50	**46**	**53**	58

Notes: 1. **Bold** font indicates the controlling project noise trigger level (the more stringent of the two trigger levels).

In accordance with the NPfI the project noise trigger levels (PNTL), are presented in Table 3-14 below.

Table 3-14: Summary of project noise trigger levels

Receiver location	$L_{Aeq, 15min}$ Project noise trigger levels, dB(A)			
	Day	Evening	Night	Morning shoulder
Residential receivers[3]				
NCA1A	58	53	51	52
NCA1B	58	48	44	54
NCA2	58	48	44	50
NCA3	58	52	49	54
NCA4	58	49	46	53
Other sensitive receivers[2,4]				
Commercial	63	63	63[2]	63[2]
Industrial	68	68	68[2]	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, Morning-shoulder 5.00 am - 7.00 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 - 5.00 am, Morning-shoulder 5.00 am -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.
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.

3.4.2.4 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 DPIE guideline "*Cumulative Impact Assessment Guidelines for State Significant Projects*" (DPIE, 2021) 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 in Section 3.4.2.2 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 development has been considered in the assessment through the derivation of criteria in accordance with the NPfI, and assessment against these levels.

3.4.2.5 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.

The sleep disturbance noise trigger levels for the Proposal are presented in Table 3-15.

Table 3-15: EPA NPfI Sleep disturbance assessment trigger levels

Receiver location	Night (10:00pm to 5:00am)		Morning shoulder period (5:00am to 7:00am)	
	Assessment level $L_{Aeq,15min}$	Assessment level L_{AFmax}	Assessment level $L_{Aeq,15min}$	Assessment level L_{AFmax}
NCA1A	47 + 5 = 52	47 + 15 = 62	47 + 5 = 52	47 + 15 = 62
NCA1B	47 + 5 = 52	47 + 15 = 62	49 + 5 = 54	49 + 15 = 64
NCA2	42 + 5 = 47	42 + 15 = 57	45 + 5 = 50	45 + 15 = 60
NCA3	45 + 5 = 50	45 + 15 = 60	49 + 5 = 54	49 + 15 = 64
NCA4	45 + 5 = 50	45 + 15 = 60	48 + 5 = 53	48 + 15 = 63

Notes:
1. As per NPfI Section 2.5, minimum screening level is the greater of L_{Aeq} 40 dB(A) of RBL + 5dB.
2. As per NPfI Section 2.5, minimum screening level is the greater of L_{AFmax} 52 dB(A) of 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 (RNP) (see Section 3.4.2.5.1).

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 3.4.2.5.1).

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

3.4.2.5.1 Current reference literature

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.

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. $L_{night\ (outside)}$.

3.4.2.5.2 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 3-16 below.

Table 3-16: Sleep disturbance project assessment noise levels[5]

Receiver location	Sleep disturbance project assessment noise levels, dB(A)					
	EPA NPfI sleep disturbance assessment levels, L_{Amax}		Awakening reaction[3], L_{Amax}	EPA NPfI sleep disturbance assessment levels, $L_{Aeq,15min}$		WHO 2018 $L_{Aeq,15min}$[2]
	Night[1]	Morning shoulder period[1]		Night[1]	Morning shoulder period[1]	
NCA1A	62	62	65	52	52	48
NCA1B	62	64	65	52	54	48
NCA2	57	60	65	47	50	48
NCA3	60	64	65	50	54	48
NCA4	60	63	65	50	53	48

Notes:
1. Night-time 10:00pm to 5:00am. The morning shoulder period is 5:00am to 7:00am.
2. 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).
3. As per the NSW RNP, as detailed in Section 3.4.2.5.1.

3.5 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 are assessed in accordance with the 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.

The Proposal will be using sub-arterial / arterial roads and not local roads. Therefore, for existing residences affected by additional traffic on existing sub-arterial / arterial roads generated by land use developments, the following RNP road traffic noise criteria would apply.

Table 3-17: 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.

3.6 Aircraft noise intrusion

As required by the City of Sydney DCP, Proposed developments potentially impacted by aircraft noise should be assessed to determine that they can achieve the noise level requirements of *Australian Standards AS2021 – Acoustics Noise Intrusion – Building Siting and Construction*.

Based on the Sydney Airport ANEF 2039 chart the Proposal site is located within the ANEF 20 to 25 contours.

3.6.1 AS2021-2015 - aircraft noise intrusion

Aircraft noise intrusion from take-off, landing and circuit training operations at civil aerodromes or military airfields is assessed using Australian Standard A2021-2015 – '*Acoustics – Aircraft Noise Intrusion – Building Siting and Construction*' ('AS2021'). This section of the report outlines the application of AS2021. The scope of AS2021-2015 is stated as:

This standard, together with the relevant Australian Noise Exposure Forecast (ANEF) chart provides guidelines for determining-

> a. *whether the extent of aircraft noise intrusion makes building sites 'acceptable', 'unacceptable' or 'conditionally acceptable' for the types of activity to be, or being, undertaken (Clause 2.3);*
>
> b. *for 'conditionally acceptable' sites, the extent of noise reduction required to provide acceptable noise levels indoors for the types of activity to be, or being, undertaken; and*
>
> c. *the type of building construction necessary to provide a given noise reduction, provided that external windows and doors are closed.*

3.6.2 Building site acceptability

AS2021 contains advice on the acceptability of building sites based on Australian Noise Exposure Forecast (ANEF) zones. The ANEF chart provides a predicted cumulative exposure to aircraft flyover noise in communities near aerodromes. The chart presents zones represented by noise contours overlaid on a locality map specific to an airport. The ANEF system was developed as a land use planning tool aimed at controlling encroachment on airports by noise sensitive buildings.

Table 2.1 of AS2021 sets acceptability zones for different building types and land uses. Table 3-18 reproduces the sections of AS2021 Table 2.1 relevant to the Proposal and given it is situated between the 20 and 25 contour it is classified as acceptable.

Table 3-18: Building site acceptability based on ANEF zones (Table 2.1 of AS2021)

Building type	ANEF zone of site		
	Acceptable	Conditional	Unacceptable
Commercial building	Less than ANEF 25	25 to 35 ANEF[2]	Greater than 35 ANEF
Light industrial	Less than ANEF 30[1]	30 to 40 ANEF[2]	Greater than 40 ANEF
Other industrial	Acceptable in all ANEF zones		

Section 2.3 of AS2021 details the actions resulting from the acceptability determination. Table 3-19 presents the outcomes as a result of the Proposal building being classified as acceptable.

Table 3-19: Description of building site acceptability

Zone	Description
Acceptable	If from Table 2.1, the building site is classified as 'acceptable', there is usually no need for the building construction to provide protection specifically against aircraft noise. However, it should not be inferred that aircraft noise will be unnoticeable in areas outside the ANEF 20 contour. (See Notes 1, 2 and 3 of AS2021:2015 Table 2.1.)

3.6.3 Site consideration

Based on the Sydney Airport ANEF 2039 chart the Proposal site is located within the ANEF 20 to 25 contours. As such the Proposal has been assessed as acceptable and it is determined that no further assessment is required to address the requirements of AS2021:2015.

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.

The demolition of the existing structures on the site will be undertaken under a separate application/approval.

4.2 Proposal construction works

The following construction works will be required to construct the Proposal, as detailed in Section 1.3.3.

- Site establishment
- Surface preparation works
- Piling works
- Utility and services augmentation works
- Construction of building
- Internal fit out of building

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 Construction noise and vibration activities and assumptions

4.4.1 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 and duration of works are presented in Table 4-1.

Table 4-1: Approximate construction phases and duration of works

Construction phase	Construction activities	Approximate duration (subject to approval)
Site establishment	• Installation of enviro controls • Establishment of construction facilities	1 week (April 2022)
Surface preparation works	• Surface preparation works	3 months (April 2022 to Early June 2022)
Piling works	• Piling works	1 month (May 2022 to June 2022)
Utility, stormwater, infrastructure and services augmentation works	• Utility modification works • Stormwater civil works • Infrastructure and services augmentation works	2 months (June 2022 to August 2022)
Building construction	• Construction of the main building structure	14 months (April 2022 to July 2023)
Building fit-out	• Deliveries and fitout of the facility office and manufacturing areas • Deliveries of operational plant and equipment • Commissioning and testing	3 months (March 2023 to May 2023)

4.4.2 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 4.4.1. 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.

Considering the existing traffic volumes of the primary potential routes to/from the site presented in Section 5.1.1, this volume of construction traffic as a result of this Proposal is not expected to significantly alter existing traffic noise.

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.

4.4.3 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

Plant Item	Estimated number of items	Individual source/activity sound power level (Lw re. 1pW), LAeq,15min, dB(A)
Site preparation work		
Tracked excavator with bucket	1	107
Hand tools	1	107
Elevated work platform	1	106
Small truck	4 per hour	104
Franna crane	1	99
Truck with Hiab	1	96
Surface preparation and piling		
Concrete agitator – discharging [or padfoot roller (11 tonne)]	1	108
Hand tools	1	107
Small piling rig (rotary bored piling) (<6 tonne)	2	104
Concrete pump	1	103
Compressor for small piling rig	2	103
Tracked excavator with bucket (19 tonne)	1	103
Concrete pump	1	103
Utility and services augmentation works		
Concrete saw	1	119
Vacuum truck	1	108
Hand tools	1	107
Tracked excavator with bucket	1	103
Franna crane	1	99
Truck with Hiab	1	96
Elevated Work Platform (EWP)	2	95

Plant Item	Estimated number of items	Individual source/activity sound power level (Lw re. 1pW), LAeq,15min, dB(A)
Concrete pump	1	103
Building construction		
Mobile crane	1	110
Mobile crane	1	110
Concrete trucks	1	108
Delivery trucks	1	108
Hand tools	Various	107
Bobcat	2	104
Concrete pump	2	102
Concrete vibrator	8	99
Non-powered hand tools	Various	98
Building fit-out		
Delivery trucks	1	108
Hand tools	Various	107
Bobcat	2	102
Scissor lift	2	99
Non-powered hand tools	Various	98

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.

4.5 Construction noise and vibration assessment

4.5.1 Assessed receivers

For the assessment of construction noise, representative residential and other noise receivers were identified surrounding the development. The assessed receivers are detailed in Table 4-3 below and shown on Figure 5.

Table 4-3: Construction noise assessment representative receivers

ID	NCA	Address	Receiver type
R1	NCA1A	659 Gardeners Road, Mascot, NSW – Level 1	Residential
R2	NCA1B	659 Gardeners Road, Mascot, NSW – Level 12	Residential
R3	NCA2	659 Gardeners Road, Mascot, NSW – Podium Level (Level 2)	Residential
R4	NCA2	659 Gardeners Road, Mascot, NSW – Level 11	Residential
R5	NCA3	635 Gardeners Road, Mascot, NSW	Residential
R6	NCA3	629 Gardeners Road, Mascot, NSW	Residential

ID	NCA	Address	Receiver type
R7	NCA4	635 Gardeners Road, Mascot, NSW	Residential
R8	NCA4	635 Gardeners Road, Mascot, NSW	Residential
R9	OSR	200 Bourke Road, Alexandria, NSW	Industrial
R10	OSR	506-518 Gardeners Rd, Alexandria NSW	Industrial
R11	OSR	639 Gardeners Road, Mascot, NSW	Commercial
R12	OSR	653 Gardeners Road, Alexandria, NSW[1]	Industrial
R13	OSR	85 Bourke Road, Alexandria, NSW	Commercial
R14	OSR	83 Bourke Road, Alexandria, NSW	Industrial
R15	OSR	79 Bourke Road, Alexandria, NSW	Commercial

Notes: 1. As detailed in Section 1.5.1, 653 Gardeners Road is currently a commercial receiver (car hire premises). However, a 14 storeys mixed use tower was determined for the site 20 December 2016, based upon the Land and Environment Court file number 2016/158972. Based upon construction not having commenced on the site, it has been assumed to remain as a commercial receiver, and not be built during the construction stages. As such, this location has been assessed as a commercial receiver, and would not provide any shielding to the residential towers to the west of this location during the construction stages. This assumption should be reviewed during further design development.

Figure 5: Construction noise assessment representative receivers

4.5.2 Predicted 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 4.4.1.

Table 4-4 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 worst affected receivers are typically the receivers with direct line-of-sight to the construction work area. Receivers located without direct line-of-sight to the construction area would typically be exposed to construction noise levels 5 to 10 dB(A) lower than the levels predicted for the worst affected receivers.

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

Receiver ID	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
NCA	**NCA1A**	**NCA1B**	**NCA2**	**NCA2**	**NCA3**	**NCA3**	**NCA4**	**NCA4**	**OSR**	**OSR**	**OSR**	**OSR**	**OSR**	**OSR**	**OSR**
Receiver type[2]	**RES**	**RES**	**RES**	**RES**	**RES**	**RES**	**RES**	**RES**	**IND**	**IND**	**COM**	**IND**	**COM**	**IND**	**COM**
Noise management level (external) Standard construction hours[1]	**69**	**66**	**63**	**63**	**67**	**67**	**65**	**65**	**75**	**75**	**70**	**75**	**70**	**75**	**70**
Site preparation work															
Tracked excavator w bucket	56	57	52	52	60	56	59	56	66	69	63	57	63	61	60
Hand tools	56	57	52	52	60	56	59	56	66	69	63	57	63	61	60
Elevated work platform	55	56	51	51	59	55	58	55	65	68	62	56	62	60	59
Small Truck	53	54	49	49	57	53	56	53	63	66	60	54	60	58	57
Franna Crane	48	49	44	44	52	48	51	48	58	61	55	49	55	53	52
Truck with Hiab	45	46	41	41	49	45	48	45	55	58	52	46	52	50	49
Up to 3 (noisiest) plant operating concurrently	**60**	**61**	**56**	**57**	**64**	**60**	**64**	**61**	**71**	**74**	**67**	**61**	**67**	**66**	**65**
Surface preparation and piling															
Concrete agitator - discharging	57	58	53	53	61	57	60	57	67	70	64	58	64	62	61
Hand tools	56	57	52	52	60	56	59	56	66	69	63	57	63	61	60
Small piling rig (rotary bored piling) (<6 tonne)	53	54	49	49	57	53	56	53	63	66	60	54	60	58	57
Concrete pump	52	53	48	48	56	52	55	52	62	65	59	53	59	57	56
Compressor for small piling rig	52	53	48	48	56	52	55	52	62	65	59	53	59	57	56
Tracked excavator w bucket (19 tonne)	52	53	48	48	56	52	55	52	62	65	59	53	59	57	56
Concrete pump	52	53	48	48	56	52	55	52	62	65	59	53	59	57	56
Up to 3 (noisiest) plant operating concurrently	**60**	**61**	**56**	**57**	**64**	**60**	**64**	**61**	**71**	**74**	**67**	**61**	**67**	**66**	**65**
Utility and services augmentation works															
Concrete saw	68	69	64	64	72	68	71	68	78	81	75	69	75	73	72
Vacuum truck	57	58	53	53	61	57	60	57	67	70	64	58	64	62	61
Hand tools	56	57	52	52	60	56	59	56	66	69	63	57	63	61	60
Tracked excavator w bucket	52	53	48	48	56	52	55	52	62	65	59	53	59	57	56
Franna Crane	48	49	44	44	52	48	51	48	58	61	55	49	55	53	52

Receiver ID	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**	**R12**	**R13**	**R14**	**R15**
NCA	**NCA1A**	**NCA1B**	**NCA2**	**NCA2**	**NCA3**	**NCA3**	**NCA4**	**NCA4**	**OSR**	**OSR**	**OSR**	**OSR**	**OSR**	**OSR**	**OSR**
Receiver type[2]	**RES**	**RES**	**RES**	**RES**	**RES**	**RES**	**RES**	**RES**	**IND**	**IND**	**COM**	**IND**	**COM**	**IND**	**COM**
Noise management level (external) Standard construction hours[1]	**69**	**66**	**63**	**63**	**67**	**67**	**65**	**65**	**75**	**75**	**70**	**75**	**70**	**75**	**70**
Truck with Hiab	45	46	41	41	49	45	48	45	55	58	52	46	52	50	49
Elevated Work Platform (EWP)	44	45	40	40	48	44	47	44	54	57	51	45	51	49	48
Concrete pump	52	53	48	48	56	52	55	52	62	65	59	53	59	57	56
Up to 3 (noisiest) plant operating concurrently	**68**	**69**	**65**	**65**	**72**	**68**	**72**	**69**	**79**	**82**	**75**	**69**	**75**	**74**	**73**
Building construction															
Mobile crane	59	60	55	55	63	59	62	59	69	72	66	60	66	64	63
Mobile crane	59	60	55	55	63	59	62	59	69	72	66	60	66	64	63
Concrete trucks	57	58	53	53	61	57	60	57	67	70	64	58	64	62	61
Delivery trucks	57	58	53	53	61	57	60	57	67	70	64	58	64	62	61
Hand tools	56	57	52	52	60	56	59	56	66	69	63	57	63	61	60
Bobcat	53	54	49	49	57	53	56	53	63	66	60	54	60	58	57
Concrete pump	51	52	47	47	55	51	54	51	61	64	58	52	58	56	55
Concrete vibrator	48	49	44	44	52	48	51	48	58	61	55	49	55	53	52
Non-powered hand tools	47	48	43	43	51	47	50	47	57	60	54	48	54	52	51
Up to 3 (noisiest) plant operating concurrently	**63**	**64**	**59**	**60**	**67**	**63**	**67**	**64**	**73**	**77**	**70**	**64**	**70**	**68**	**68**
Building fit-out															
Delivery trucks	57	58	53	53	61	57	60	57	67	70	64	58	64	62	61
Hand tools	56	57	52	52	60	56	59	56	66	69	63	57	63	61	60
Bobcat	51	52	47	47	55	51	54	51	61	64	58	52	58	56	55
Scissor lift	48	49	44	44	52	48	51	48	58	61	55	49	55	53	52
Non-powered hand tools	47	48	43	43	51	47	50	47	57	60	54	48	54	52	51
Up to 3 (noisiest) plant operating concurrently	**60**	**61**	**56**	**57**	**64**	**60**	**63**	**60**	**70**	**74**	**67**	**61**	**67**	**65**	**65**

Notes:

1. Standard construction hours - Mon-Fri – 7:00am to 5:00pm, Sat – 8:00am to 1:00pm
2. RES = Residential, IND = Industrial, COM = Commercial

4.5.3 Discussion of construction noise results

The predicted noise levels presented above indicate that the noise levels during the utility and services phases of work, exceed the NMLs at the nearby surrounding residential, commercial and industrial receivers.

Construction noise is predicted to reach 72 dB(A) $L_{Aeq,15min}$ at residences adjacent to the works in NCA3 and NCA4 during the utility and services augmentation works. These predicted noise levels are approaching the limit where residences are considered 'highly noise affected'. However, for all other construction phases, construction noise at residential receivers are predicted to be well below 75 dB(A) $L_{Aeq,15min,}$ and therefore are not predicted to be highly noise affected.

During the building construction and fit-out phases of works, construction noise is generally predicted to comply with the relevant NMLs, with minor exceedances of up to 2 dB(A) at the nearby residences in NCA4.

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 4.5.6 below.

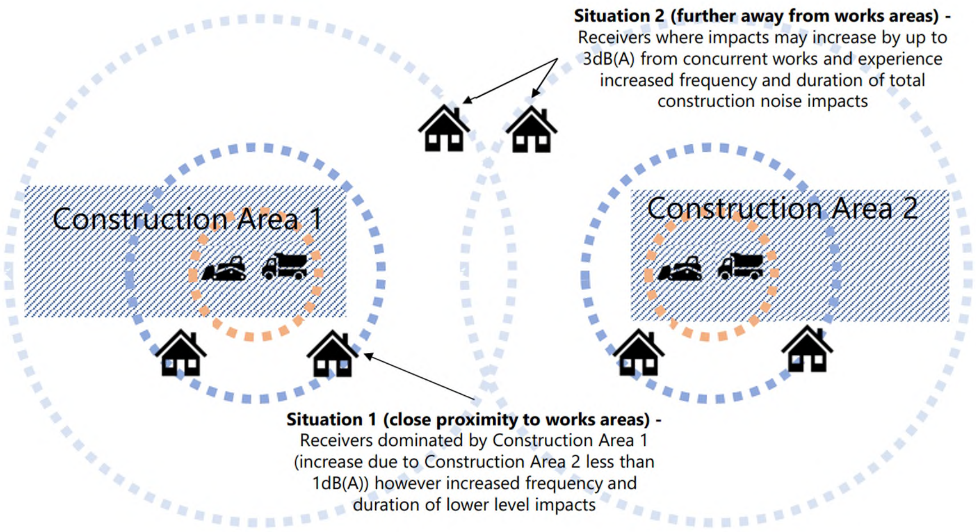
4.5.4 Cumulative noise impacts

A number of construction projects are taking place in the vicinity of the Proposal during the March 2022 to May 2023 period. The following construction projects have been identified as potentially undertaking noise generating works during the construction of the Proposal:

- WestConnex M8 St Peters Interchange
- 506-518 Equinx SY5 Data Centre Stage 2 (potentially)
- 653 Gardeners Road, Alexandria 14 storey mixed use tower (potentially).

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 [by up to 3 dB(A)], 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 4-2.

Figure 6: Cumulative construction



As there is potential for cumulative noise impacts from the Proposal combined with other concurrent construction projects it is recommended that mitigation and management measures are implemented to minimise cumulative impacts, as detailed in Section 4.5.6. In addition, he following measures are to be used to mitigate and manage cumulative noise impacts along with potential construction fatigue:

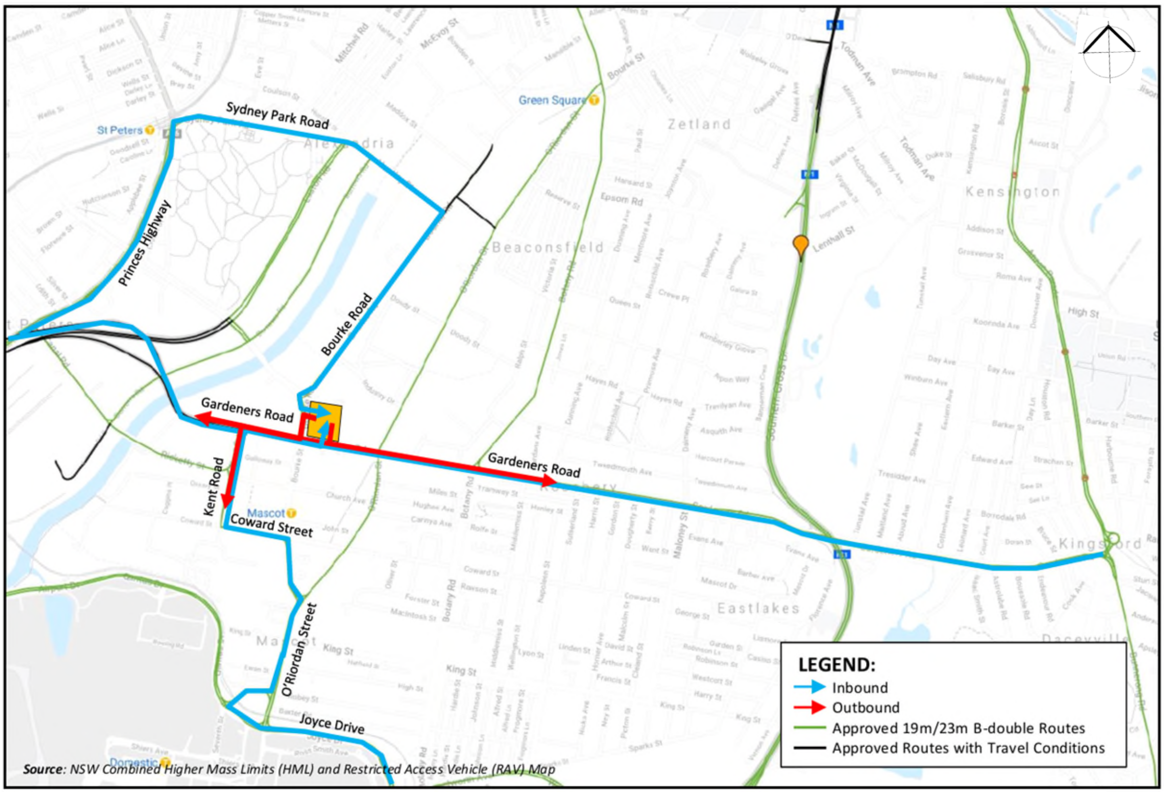
- Coordinating work between construction sites to minimise cumulative noise impacts, where feasible and reasonable (ie. to ensure that multiple sites are not undertaking noise intensive works concurrently with direct line-of-sight to receivers).
- Community consultation to gauge key noise impacts and 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.

These mitigation measures would be included in the CNVMP or CEMP and would include how the above measures would be incorporated during the works.

4.5.5 Construction-related road traffic

Construction related heavy vehicles would include deliveries of accommodate site offices, amenities, plant and equipment, and stockpiling of materials. The majority of the proposed construction traffic would access the site via Princes Highway, Sydney Park Road, Bourke Road, Gardeners Road and Kent Road and depart along Gardeners Road and Kent Road / Coward Street / O'Riordan. These routes are shown on Figure 7 below.

Figure 7: Construction heavy vehicle truck routes



Based upon the traffic volumes for the surrounding assessed roads obtained from the WestConnex New M5 (WestConnex M8) (TfNSW 2015), existing monitored traffic volumes (see Section 5.1.1) and traffic movement data provided by the project traffic engineers, the roads used to access and depart the site have an AADT of over 10,000 vehicles per day.

Given the low number of construction vehicles associated with the project, construction related road traffic noise level is not predicted to increase traffic noise levels by more than 2 dB on the surrounding roads. Construction related road traffic noise is therefore predicted to comply with the requirements of the RNP and is not expected to cause any adverse impacts.

4.5.6 Construction noise mitigation measures

4.5.6.1 General engineering noise controls

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.

Reference to 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.

Table 4-5 below presents noise control methods, practical examples and expected noise reductions according to AS2436 and according to Renzo Tonin & Associates' opinion based on experience with past projects.

Table 4-5: Relative effectiveness of various forms of noise control

Noise control method	Practical examples	Typical noise reduction possible in practice, dB(A)		Maximum noise reduction possible in practice, dB(A)	
		AS 2436	RT&A	AS 2436	RT&A
Distance	Doubling of distance between source and receiver	6	6	6	6
Screening	Acoustic barriers such as temporary or permanent noise barriers where barrier breaks line-of-sight between the source and receiver	5 to 10	5 to 10	15	15
Acoustic enclosures	Engine casing lagged with acoustic insulation and plywood	15 to 25	10 to 20	50	30
Engine Silencing	Residential class mufflers	5 to 10	5 to 10	20	20
Substitution by alternative process	Use electric motors in preference to diesel or petrol	-	15 to 25	-	40

The Renzo Tonin & Associates' listed noise reductions are conservatively low and should be referred to in preference to those of AS2436.

Table 4-6 below identifies possible noise control measures, which are applicable on the construction plant likely to be used on site.

Table 4-6: Possible noise control measures for likely construction plant

Plant Description	Screening	Acoustic enclosures	Silencing	Alternative process
Concrete truck	✔	✖	✔	✖
Delivery trucks	✔	✖	✔	✖
Electric / mobile crane	✔	✔	✖	✖
Hand tools	✔	✖	✔	✖

4.5.6.2 Noise management measures

The following recommendations provide feasible and reasonable noise control solutions to reduce noise impacts to sensitive receivers. **These should be considered and implemented where feasible and reasonable where there is potential for the noise management levels presented in Section 3.2 to be exceeded by the construction works either individually or cumulatively**.

General noise management measures

The following general noise management measures are recommended for all receiver locations:

- Use less noisy plant and equipment, where feasible and reasonable.
- 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.
- Strategically position plant on site to reduce the emission of noise to the surrounding neighbourhood and to site personnel.
- Avoid any unnecessary noise when carrying out manual operations and when operating plant.
- Any equipment not in use for extended periods during construction work must be switched off.
- Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be limited/avoided where possible.
- The offset distance between noisy plant and adjacent sensitive receivers is to be maximised where practicable.
- Plant used intermittently to be throttled down or shut down when not in use where practicable.
- Noise-emitting plant to be directed away from sensitive receivers where possible.
- Staging of construction works so as to erect solid external walls first and utilising them to provide noise shielding to the noise sensitive receivers.
- 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.
- Good relations with people living and working in the vicinity of a construction site should be established at the beginning of a project and be maintained throughout the project, as this is of paramount importance. Keeping people informed of progress and taking complaints seriously and dealing with them expeditiously is critical. The person selected to liaise with the community must be adequately trained and experienced in such matters.

<u>**Additional measures to be considered**</u>

Other potential mitigation measures include:

- Use of broadband "quacker" type of reverse/movement alarms instead of the tonal 'beeping" type.
- All employees, contractors and subcontractors are to receive site induction and toolbox talks and ongoing training so that the above noise management measures are implemented accordingly. Content within toolbox talks will include, location of nearest sensitive receivers; relevant project specific and standard noise and vibration mitigation measures; permissible hours of work, truck route and truck loading restrictions and construction employee parking areas.

<u>**Highly noise affected receivers**</u>

As some residential receivers nearest to the construction support sites and/or construction work sites are close to the 'highly noise affected' noise levels [ie exposed to noise levels that exceed 75 dB(A)] as a result loud works in close proximity, there is the potential that during works noise levels may go above this level.

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

- High noise impact activities should be carried out in continuous blocks of up to three hours. Respite from high noise impact activities would be provided between each block for at least one hour. No high noise impact activities should be carried out during this one hour respite period.

4.5.6.3 Noise monitoring

The following approach could be adopted with regard to noise monitoring procedures during the construction works.

- Where potential noise impacts are predicted to be up to 10 dB(A) above the noise criteria, all feasible and reasonable noise reduction measures must be investigated, where necessary.
- Where potential noise impacts are predicted to be more than 10 dB(A) above the noise criteria, the potential construction noise nuisance is considered to be moderate. In the event of a compliant, noise monitoring may be carried out to confirm predicted noise impacts. Reasonable and feasible noise reduction measures must be investigated, where necessary.

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 this SSDA NVIA and that the associated mitigation and management measures are appropriate.

This will include review the potential noise impacts to determine which sets of works or stages may be more than 10 dB (A) above the applicable noise management levels and noise monitoring should be undertaken.

4.6 Construction vibration assessment

4.6.1 Vibration sources

The pattern of vibration radiation is very different to the pattern of airborne noise radiation and is very site specific as final vibration levels are dependent on many factors including the actual plant used, its operation and the intervening geology between the activity and the receiver. Potential vibration generated to receivers is dependent on separation distances, the intervening soil and rock strata, dominant frequencies of vibration, and the receiver structure.

The recommended minimum working distances for vibration intensive plant are presented in Table 4-7 and Table 4-8. These distances are conservatively based on excavation of hard rock. 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 4-7.

Unlike noise, vibration cannot be readily predicted. There are many variables from site to site, such as soil type and conditions, sub surface rock, building types and foundations, and actual plant on site.

The data relied upon in this assessment (tabulated below) 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 proposal as final vibration levels are dependent on many factors including the actual plant used, its operation and the intervening geology between the activity and the receiver.

As such, 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 levels about the applicable vibration limits. Where then identified, and feasible and reasonable mitigation and management would be implemented to achieve the applicable vibration limits.

Table 4-7: Minimum working distances (m) for cosmetic damage (continuous vibration)

Plant item	Minimum working distance (m)		
	Reinforced or framed structures (e.g. commercial buildings)[1]	Unreinforced or light framed structures (e.g. residential buildings)[1]	Sensitive structures (e.g. heritage structures)[2]
Place compactor/Wacker packer	5	5	5
Small percussive drill	5	5	5
Truck-mounted drill rig / bored piling	5	5	10
Light hydraulic hammer (up to 5t)	5	5	10
10-15t excavator with hydraulic hammer attachment	5	5	10

Notes 1) Initial screening test criteria reduced by 50% due to potential dynamic magnification in accordance with BS7385.
2) A site inspection should determine whether a heritage structure is structurally unsound.
3) Minimum working distances are in 5m increments only to account for the intrinsic uncertainty of this screening method.

Table 4-8: Minimum working distances (m) for human annoyance (continuous vibration)

Plant item	Minimum working distances (m)				
	Critical areas 0.28 mm/s	Residences		Offices 1.1 mm/s	Workshops 2.2 mm/s
		Day 0.56mm/s	Night 0.40 mm/s		
Place compactor/Wacker packer	20	10	15	5	5
Truck-mounted drill rig / bored piling	30	20	20	10	10
Light hydraulic hammer (up to 5t)	25	20	20	15	10
10-15t Excavator with hydraulic hammer attachment	30	20	25	15	10

4.6.2 Vibration assessment

4.6.2.1 Cosmetic damage

There are no reinforced, unreinforced or heritage structures within the minimum working distance identified in Table 4-7 above.

4.6.2.2 Data centres

Located directly adjacent to the site on the northern and eastern boundaries are data centre facilities. Due to the usage of these facilities, there is potential that there may be vibration sensitive equipment located within the data centres and could be impacted by vibration intensive works when works occur in close proximity.

Section 3.2.3 identified typical acceptable vibration limits for building structures that house sensitive equipment, which could be used as a guide to determine if there could be potential vibration impacts from vibration intensive construction works.

However, it is recommended that the data centre operators be consulted as part of the construction planning, to determine the locations of any vibration sensitive items and determine suitable vibration levels that could be generated at these items from construction activities. These limits should then be implemented into the construction design, planning and management in a feasible and reasonable manner.

4.6.2.3 Sydney trains T8 Airport & South line

The Sydney trains T8 Airport & South line tunnel is located adjacent to the site under Bourke Road. Based upon the current construction methodology, piling and use of hydraulic hammers could occur within the minimum distance of 25 metres horizontally as detailed in Section 3.3. It is understood that piling could occur within two metres of the tunnel lining.

The assessment requirement is a maximum peak particle velocity (PPV) of 15 mm/s at the tunnel lining for brick or mass concrete in good condition, or maximum PPV of 20 mm/s at the tunnel lining for cast iron, steel or concrete segment lining.

An assessment would be required during the detailed design phase to determine the slant distance from the works to the tunnel lining to identify areas of the site that are within the minimum working distances, and further review of the potential vibration impacts to the tunnel, and any required mitigation and management that is to be implemented during the construction works.

4.6.2.4 Human annoyance

The nearest residential receiver is approximately 60 metres from the works. While, located 10-15 metres north and east of the site are the offices for the adjacent data centres.

Based on the minimum working distance of up to 20 metres for larger and vibration intensive plant used during the utility and services and surface preparation phases of work during the day period, exceedances of the human annoyance criteria are generally not predicted at nearby residential receivers but may occur for the adjacent data centres offices.

As such, potential human annoyance impacts should be reviewed when vibration intensive works are proposed to take place within the minimum working distances, in close proximity to the data centre office spaces.

4.6.3 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 E.

5 Operational noise assessment

5.1 Operational road traffic

5.1.1 Existing traffic

Traffic classification surveys were carried out by Trans Traffic Survey over a three week period during November and December 2021 at four locations along the proposed vehicle routes to and from the Proposal site and to the nearby major arterial roads with a focus on the key heavy vehicle routes. These locations are presented in Figure 8, and are used as the assessment locations. 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	
Gardeners Road	Between Dunning Ave and Sutherland Street	23,884	6	1	43	3,743	6	1	48
Gardeners Road	West of O'Riordan Street	28,702	6	3	35	4,895	7	2	43
Gardeners Road	Between Kent Road and Bourke Road	23,361	8	2	45	3,932	9	2	48
Kent Road	Between Ossary Street and Jackson Drive	11,698	14	6	43	2,323	12	8	47

Notes: 1. Based upon an analysis of the count data for the period of Saturday 20 November 2021 to Saturday 27 November 2021.
2. Based on average vehicle speeds from traffic survey.
3. Based upon combined two-way traffic counts

5.1.2 Proposed vehicle movements

5.1.2.1 Proposal vehicle routes

Heavy vehicle movements for operational traffic to and from the Proposal site will be along three major routes connecting to the nearby major arterial roads. These are shown in Figure 8.

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. The breakdown of the heavy vehicles utilising the three routes presented in Figure 8 and Table 5-2.

Table 5-2: Vehicle route distribution

Route	Proportion of heavy vehicles (%)[1]	
	Inbound	Outbound
Heavy vehicles		
West (Westconnex M8)	70	50
South (Kent Road / Coward Street / O'Riordan / Joyce Drive)	15	25
East (Gardeners Road / Anzac Parade)	15	25
Light vehicles		
West (Campbell Road)	55	-
North (Bourke Road)	45	-
West (Gardeners Road)	-	60
East (Gardeners Road)	-	10
East (O'Riordan Street)	-	20
South (Bourke Road)	-	10

Notes: 1. Based upon Gardeners Road access open scenario

Figure 8: Operational vehicle routes

To determine the potential change in road traffic noise levels as a result of additional traffic generated by the Proposal on these roads, the existing traffic data has been based upon traffic counts, including vehicle classifications, presented in Section 5.1.1.

This assessment has been undertaken to determine if there is the potential for a significant change in traffic noise levels [>2.0 dB(A)] at the residences adjacent to the key routes that the Proposal traffic will operate along.

Heavy vehicles will enter the site from the south via a turning lane on Gardeners Road, directly opposite the residential receivers on Gardeners Road, which has been directly assessed separately in Section 5.1.4.

5.1.2.2 Proposal traffic volumes and composition

At this stage, the traffic volumes are not clearly understood as the final tenants of the facility have not been determined (except for Schindler Australia who will be one of the tenants). 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 have been provided by the project team to review the potential traffic generation noise impacts by the proposal.

As part of any tenant proposing to operate at the facility, these assumed volumes, and the 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 and mitigation and management outcomes. Table 5-3 presents a summary of the forecasted vehicles assumed for the Proposal provided by the project team.

Table 5-3: 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	B-double		
RNP (whole of period)						
Day (7am-10pm)	554	143	8	22	173	727
Night (10pm-7am)	32	12	0	0	12	44
NPfI (worst case 15-minute)						
Day	34	6	1	1	8	42
Evening	14	2	0	1	3	17
Night	4	1	0	0	1	5
Morning shoulder	6	1	0	0	3	9

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.

5.1.2.3 Carpark activities

The expected carparking activities are described in in Table 5-6.

Noise generated by car park activities includes vehicle doors closing, vehicle engines starting, vehicles accelerating and vehicles moving. To assess this noise, the $L_{Aeq\ 15\text{-minute}}$ noise level at the nearest affected residential premises was determined for each relevant period based on the number of vehicle movements expected to occur during that period. This also includes the addition of service vehicles.

For this assessment, potential 15-minute light vehicle movements likely associated with the Proposal have been provided. These light vehicle movements are summarised in Table 5-3.

Additionally, Schindler Australia will require service vehicles (ie. small delivery vans) to be parked/stored within the Level 2 carpark area. Night service van movements for Schindler Australia will likely only be required where there is a lift emergency, and as such night movements would not often occur. These have been capture in the assessment for a conservative assessment. During other periods, it has been assumed that up to 16 movements per hour (or 4 per 15-minute period) may occur to or from the Proposal site.

5.1.3 Predicted road traffic noise changes on arterial roads

The potential increase in road traffic noise levels has been calculated using the *Federal Highway Administration Model 2004 (TNM 2.5) (*FHWA-TNM method) model to review the potential change in traffic noise levels at residential receivers adjacent to the sub-arterial/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 purposes of the FHWA-TNM method assessment inputs.

The traffic volumes presented in Section 5.1.2.2 have been distributed across the likely routes to and from the Proposal as shown in Section 5.1.2.1 (Figure 8). The results of the road traffic noise predictions are presented in Table 5-4.

Table 5-4: 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	Gardeners Road (Between Dunning Ave and Sutherland Street)	23,884	6	1	24,064	6	1	0.3	Yes
L2	Gardeners Road (West of O'Riordan Street	28,702	6	3	28,937	6	4	0.1	Yes
L3	Gardeners Road (Between Kent Road and Bourke Road	23,361	8	2	24,026	8	3	0.6	Yes
L4	Kent Road (Between Ossary Street and Jackson Drive)	11,698	14	6	12,100	13	6	0.2	Yes
Night (9 hour - 10:00pm to 7:00am)									
L1	Gardeners Road (Between Dunning Ave and Sutherland Street)	3,743	6	1	3,754	6	1	0.1	Yes
L2	Gardeners Road (West of O'Riordan Street	4,895	7	2	4,909	7	2	0.0	Yes
L3	Gardeners Road (Between Kent Road and Bourke Road	3,932	9	2	3,974	9	2	0.2	Yes
L4	Kent Road (Between Ossary Street and Jackson Drive)	2,323	12	8	2,347	12	9	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.

Additionally, the traffic volumes on Campbell Road presented in Appendix E of the New M5 (SSI 6788) Environmental Impact Statement (TfNSW, 2015) shows that in 2021 Campbell Road would experience traffic volumes of 14,155 AADT, with 12,851 movements with 4.7% heavy vehicles during the daytime and 1,304 movements with 6.6% heavy vehicles during the night. Considering these volumes, and that the Proposal is likely to generate around 586 light vehicle movements to and from the Proposal over an entire day period, and with light vehicles travelling to the site via Campbell Road and Bourke Road and departing via different routes, light vehicles on these routes are not expected to increase the existing traffic noise levels by more than 2 dB(A) as required by the RNP.

Therefore, following the above assessments, the traffic noise levels as a result of the operational traffic from the Proposal project on public roads would meet the RNP requirements.

5.1.4 Gardeners Road site access

The review of potential noise impacts of west bound heavy vehicles turning right off Gardeners Road into the site across the east bound lane. Heavy vehicles would often need to stop and then accelerate from this location, and it is directly opposite the residential receivers at 635 Gardeners Road. As such, this review was undertaken to determine if this operation could result in increases in road traffic noise levels above the RNP requirement of limited any change to 2 dB(A). Modelling of these vehicles were based upon attended measurements of similar heavy vehicles undertaking the movement of accelerating from an intersection.

The FHWA-TNM method was used, as the method allows for vehicle speeds to be varied along the road string to take into account acceleration and deceleration speeds, in addition to applying an increase to the modelled noise source level to take into account the use of vehicles 'throttle' when accelerating. Throttle was applied for the potential movement of a truck once stopped to turn right into the Proposal site.

This review is based upon modelling accelerating truck movements turning into the site at 10km/h with throttle, compared against the unattended monitored road traffic noise levels measured at 635 Gardeners Road. The number of movements was based upon 100% of the potential truck entry movements presented in Table 5-3. As a conservative assessment, all heavy vehicle movements were assumed to make this turn, however, as per Table 5-2 this will likely be much lower, around 15% of inbound heavy vehicles.

The results of road traffic noise predictions and potential increases are presented in Table 5-4.

Table 5-5: Predicted road traffic noise level differences from movements at the Gardeners Road access points at 635 Gardeners Road, Mascot, dB(A)

Time period	Proposed truck movements[1]	Road traffic noise level, dB(A)		Predicted increase, dB(A)	Compliance
		Existing	Future		
Northern facade					
Day (7:00am – 10:00pm)	173	68	69	1.0	Yes
Night (10:00pm – 7:00am)	12	64	64	0.3	Yes
Western facade					
Day (7:00am – 10:00pm)	173	66	66	0.4	Yes
Night (10:00pm – 7:00am)	12	60	60	0.2	Yes

Notes: 1. Conservatively assumes that 100% of the potential truck entry movements enter via Gardeners Road coming from an eastbound direction. As per Table 5-2, this will more likely be about 15% of heavy vehicles.

From the above tables, it can be seen that road traffic noise level contributions from the heavy vehicle movements associated with the Proposal access off Gardeners Road 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 sources

To undertake a noise and vibration assessment for the facility, the NPfI requires a comprehensive assessment of the potential operational noise emissions from the Proposal. The basis of these noise emissions is what would be the "reasonable worst case 15-minute period" noise emissions for each of the Day (7:00am to 6:00pm), Evening (6:00pm to 10:00pm) and Night (10:00pm to 7:00am) periods.

Currently the Proposal only has one confirmed tenant (Schindler Australia) that will operate out of the southern Level 1 warehouse tenancy 3 and the office space above on Level 2. Schindler Australia intend to occupy the office space as their head office and will use the warehouse to primarily serve the Sydney CBD market. Schindler Australia will use the warehouse to act as a maintenance and servicing hub for sites and products within the Sydney CBD. Service vehicles, parts and tools etc will be stored at the warehouse for employees to take on to Sydney sites as required. As Schindler Australia intend to use the site as their head office, training of staff will also be a key part of their operations. To support this, the southern Level 1 warehouse tenancy is proposed to contain three lifts internal to the warehouse for training purposes only (noting the lifts do not extend full height and are fully contained within the warehouse). The lifts are proposed to be used to teach engineers how the components of the lifts operate. This is part of the engineers' training and apprenticeship program. There is no testing or manufacturing of the lift components, as it is only a training school.

In addition to Schindler Australia, there is potential for up to six further warehouse tenants within the development. As such, indicative conservative assumptions have been made to capture the potential worst case noise emissions from potential warehouse operations. As part of any tenant proposing to operate at the facility, the assumed vehicle volumes and the 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 and mitigation and management outcomes.

The noise sources associated with the operation of the Proposal have been based upon typical warehousing and distribution activities with 24/7 operations. The assessment has not assumed that these facilities will include temperature-controlled warehouse/distribution activities, which can include noise sources such as temperature-controlled trailers and additional temperature control mechanical plant and equipment.

The warehouse activities can be separated into the following categories:

- truck movements within the warehouse facility, including receiving and dispatching trucks
- passenger vehicle movements and car parking
- warehouse loading dock receiving and dispatching activities
- internal warehouse activities
- office related activities

The following sections detail the key noise generating plant and equipment that will operate as part of typical operations of the warehouse facility. This section is separated into the following two parts:

1. Description of operational assumptions
2. Summary of reasonable worst-case assessment scenarios

All noise generating activities modelled for the warehouse operations have been sourced from the RT&A database of previous measured levels that are representative of the proposed warehouse and distribution facility noise generating activities.

The noise source levels used for modelling are presented in APPENDIX C. The type and quantity for each of the various noise sources assessed across the operational scenarios are detailed in Table 5-10. The locations for the various modelled noise sources across the Proposal site are presented in Figure 9 and Figure 10.

5.2.1 Description of operational assumptions

5.2.1.1 Overview of noise generating activities

A general description of external noise source operations is presented in Table 5-6, to provide a picture of the typical proposed operations within the facility. Based upon these operations, 'reasonable' worst-case scenarios (15-minute period) have been developed to undertake an assessment of site noise emissions in accordance with the NPfI and are detailed in Section 5.2.2.

Table 5-6: Description of external noise generating activities

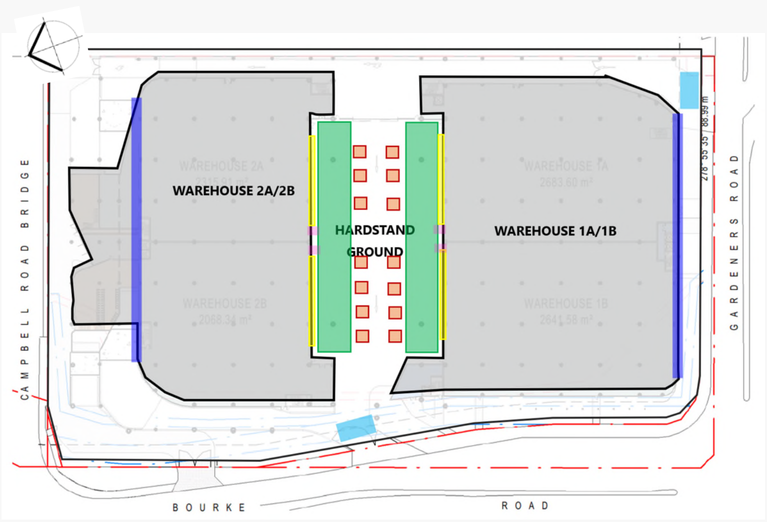
Operational element	Description of operation	Typical quantity and timing of operation
Warehouse loading dock receiving and dispatching along central breezeway on Ground and Level 1	Typically, various truck types from small (small rigid), medium or large trucks (ie. B-Double), enter facility off Gardeners Road, move along the eastern entry corridor and then move to: - Ground level central breezeway and warehouses - Ramp on northern boundary to Level 1 central breezeway and warehouses The trucks would then move to a warehouse loading dock, and reverse into the required parking location, with ramp egress from Level 1 down to western exit. Loading and unloading would take place at warehouse doors or within the warehouse spaces. Warehouses can accommodate rear-in parking. As such, trucks could be side loaded with forklifts, or loaded from rear via alternative methods (ie. pallet loader and elevated tray). Schindler Australia will use the warehouse as a maintenance and servicing hub for sites and products within the Sydney CBD. Service vehicles, parts and tools etc will be stored at the warehouse for employees to take on to Sydney sites as required.	Loading dock activities could occur 24/7. It is assumed that general peak periods of activity would be expected to typically be during the period of 5:00AM to 9:00PM, but the loading activities could occur outside of these hours.
Warehouse internal activities	The noise generating internal warehouse and distribution activities would likely include: • Receipt and despatch of goods	Warehouse activities could occur 24/7. It is assumed that the internal activities could occur with similar

Operational element	Description of operation	Typical quantity and timing of operation
	• Packing and unpacking of goods • Loading and unloading of good to delivery trucks • Internal product moving and loading activities, including use of forklifts • General forklift operations • General office administrative and support functions. Schindler Australia will use the warehouse as a maintenance and servicing hub and for training of staff - all operations will occur inside and there will be no testing or manufacturing of lift components on site.	intensity 24/7. However, it is likely that general peak periods of activity would be expected to typically be during the period of 5:00AM to 9:00PM, but the loading activities could occur outside of these hours. Some noise sources such are warehouse exhaust fans would operate 24/7.
Office activities	General office operations (both main Level 2 office areas, warehouse office and breezeway dock offices,) 5,557 m^2 GFA OF ancillary office space	It would be expected that office hours and associated noise generating activities would typically occur between 7:00AM to depart 6:00PM Monday to Friday.
Carparking	General carparking activities (144 parking spaces provided) Operation of service vans (47 parking spaces provided)	Peak carpark activities would occur during 7:00am to 8:30am and 4:45pm and 6:30pm. Up to 32 cars could operate to the carpark in the morning period, and from the carpark during a 15-minute period. Car and service van movements could occur outside of these hours.
Mechanical plant and equipment and building services	The key mechanical plant and equipment and building services component the would be required to typically operate and should be considered in the noise assessment would be: • Warehouse exhaust system (including intake louvres) • Breezeway/Hardstand exhaust system (ie. jet fans) • Enclosed internal roads/ramp areas exhaust systems • Office and building condensing plant areas • Internal office air conditions systems • Smoke clearance fan system • Natural ventilation openings (ie. voids to Level 2 from Level 1 hardstand)	Key mechanical plant and equipment noise sources could operate 24/7.

Figure 9 and Figure 10 present the Proposal plans showing the assumed locations of noise generating activities as part of the noise modelling based upon the operational information provided by the client and project team in preparation of this NVIA.

Figure 9: Indicative modelled noise generating components diagram (for vehicle movements see Figure 10)

a) Ground floor

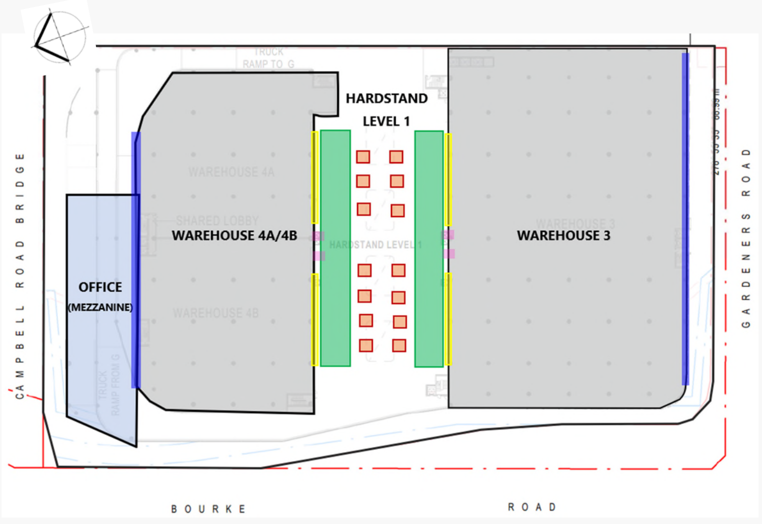


Loading dock and delivery activities
- Hardstand and warehouse loading dock activities (*this includes modelling of truck reversing into dock, truck airbrake full release, truck idling after arrival or prior to departure, and truck acceleration on departure*)
- Potential stopping locations (use of working brakes)

Internal warehouse activities
- Internal warehouse activities (breakout via dock doors)

Building services
- Hardstand jet fans
- Warehouse exhaust fans
- Warehouse intake air louvres

b) Level 1

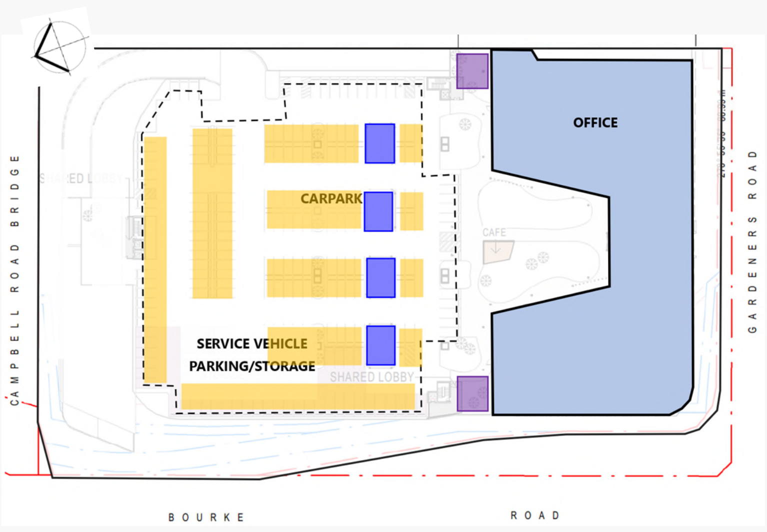


Loading dock and delivery activities
- Hardstand and warehouse loading dock activities (*this includes modelling of truck reversing into dock, truck airbrake full release, truck idling after arrival or prior to departure, and truck acceleration on departure*)

Internal warehouse activities
- Internal warehouse activities (breakout via dock doors)

Building services
- Hardstand jet fans
- Warehouse exhaust fans
- Warehouse intake air louvres

c) Level 2



Staff vehicle movements and car parking
- Carparking / service can activities (ie. car door slam and engine start)

Building services
- Void to Level 1 hardstand
- Condenser unit plant area

5.2.1.2 Truck movements

The assumed number of trucks that are proposed to move through the facility are presented Section 5.1.2.2.

Current project estimates are that over the entire day period there would be potentially 771 vehicle movements (to or from the Proposal site), with 586 light vehicle movements and 185 heavy vehicle movements. This equates to 90-100 trucks moving through the facility each day. The large majority of heavy vehicle movements are expected during the daytime period, with reduced numbers during the morning shoulder and evening periods. Minimum truck movements are typically expected during the night period.

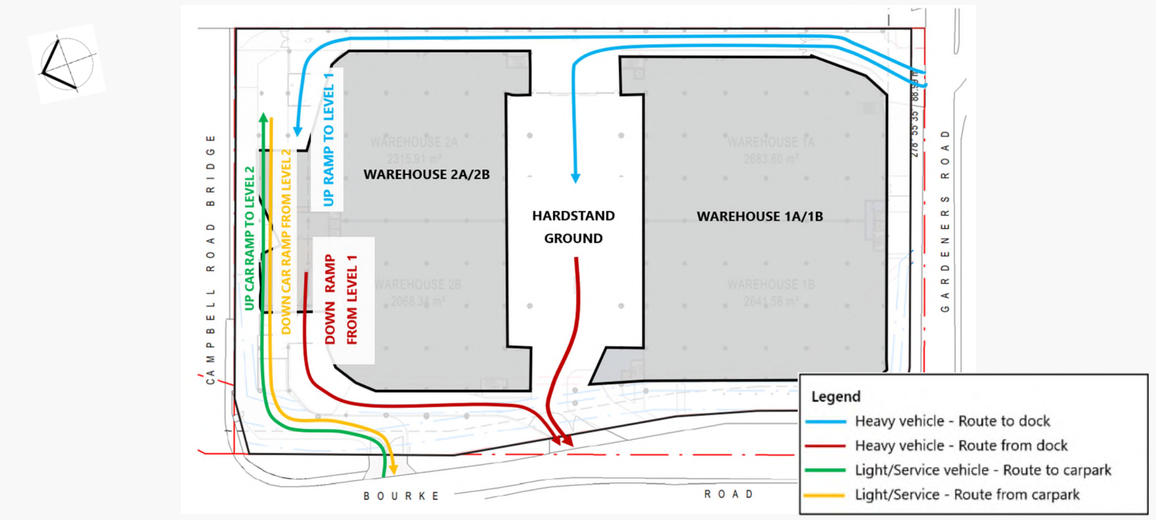
The trucks operating through the site would travel to and from the site as detailed in Section 5.1. Once these trucks enter the Proposal site they are assessed in accordance with the NPfI. While outside of the site on public roads, they are assessed using the RNP, as per Section 5.1. Trucks would arrive and enter the site via the routes shown in Figure 8 to access the Proposal.

Within the site, the truck movements through the facility generally follow two paths, depending upon if they are going to the Ground level or Level 1 warehouses and hardstand area. The approximate movements diagrams are presented in Figure 10.

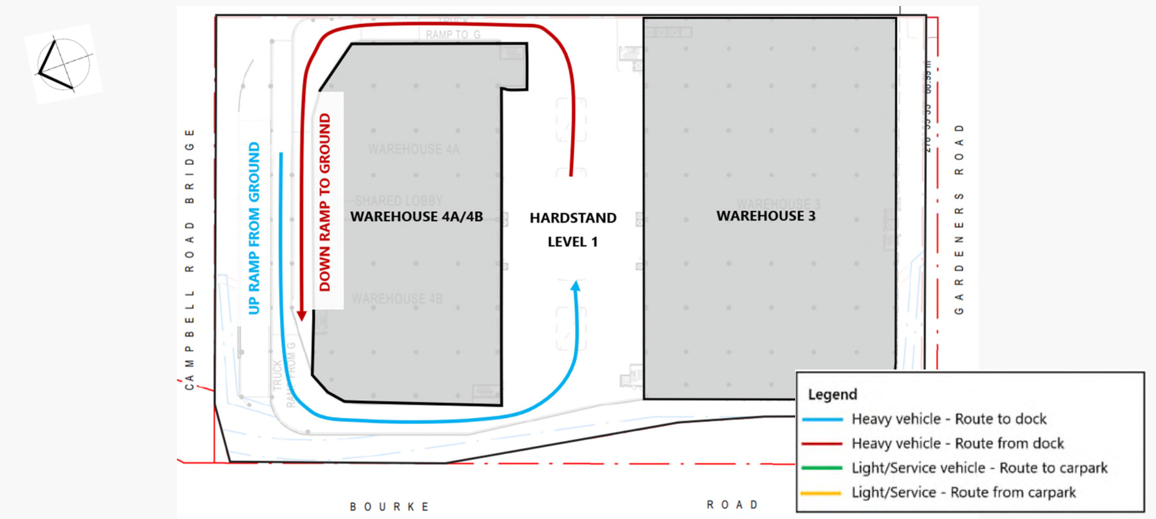
Trucks would move around the site at 10 km/h when not undertaking manoeuvres. During manoeuvres (ie. accelerating from stationary, reversing, moving up ramps), the trucks would operate at slower speeds, and different noise levels as per assumptions in APPENDIX C. Noting that an onsite speed of 10 km/h is already slow, as such it is likely that truck would move at similar speeds when moving down ramps, with moving up ramps assumed to be 5 km/h for a worst case.

Figure 10: Vehicle movement routes through the facility

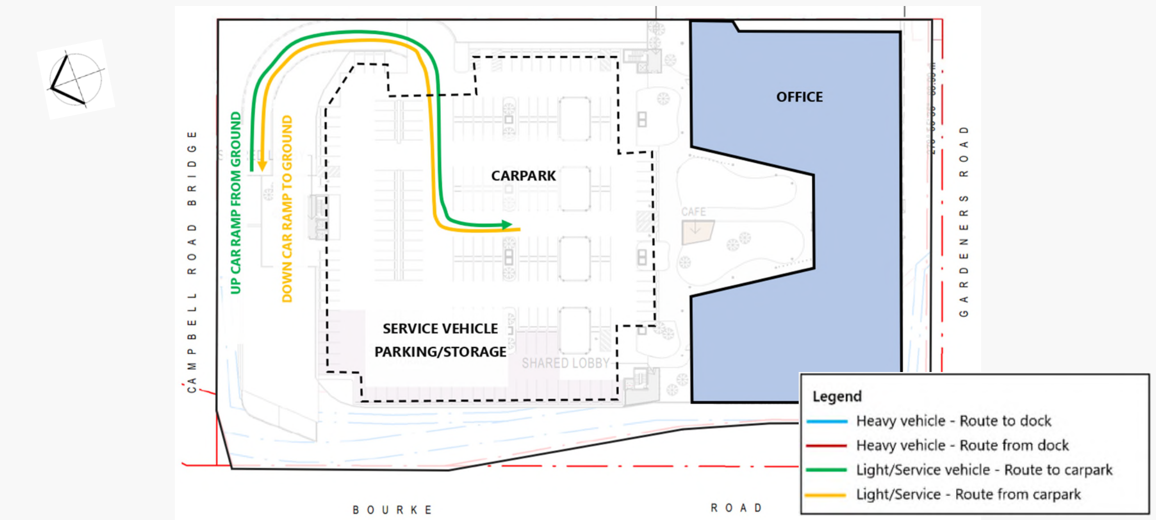
a) Ground floor



b) Level 1



c) Level 2



Based upon the above information provided by the project team, the reasonable worst case 15-minute period movement assumptions used for noise modelling are presented in Table 5-7.

Table 5-7: Reasonable worst case 15-minute period truck movements

Trucks	Day	Evening	Night	Morning shoulder
Warehouse delivery truck (inbound to Ground hardstand)	4	1	1	1
Warehouse delivery truck (inbound to Level 1 hardstand)	4	2[2]		2[2]
Warehouse delivery truck (outbound to Ground hardstand)	4	1	1	1
Warehouse delivery truck (outbound to Level 1 hardstand)	4	2[2]		2[2]
Total inbound truck movements (from entry to dock) per 15 minute period	**8**	**3**	**1**	**3**
Total outbound truck movements (from dock to exit) per 15 minute period	**8**	**3**	**1**	**3**

Notes: 1. One truck movement has been modelled moving along the associate route shown in Figure 10 to occur within a 15-minute period.

2. Modelled to Level 1, as this is the conservative assumption

Conservative assessment assumptions

These truck movements could be made up of rigid, semi-trailer and B-double heavy vehicles. For a conservative assessment, these have all been modelled as B-doubles. As the external truck movements is one of the key sources of noise emissions, where the truck types are quieter than assumed (ie. small delivery vans, small rigids with quieter engine noise etc), then noise emissions will likely be lower than presented in this assessment.

The noise levels for slow moving vehicles within the facility were based upon noise measurements undertaken at similar warehouse and distribution facilities. The modelling of truck movements within the Proposal has adopted the sound power levels presented in Table 5-8 for a conservative assessment, with the detailed modelling assumptions presented in APPENDIX C.

Warehouse and distribution type facilities can range from predominately storage type facilities with a few small truck deliveries during the daytime period and minimal other activity (eg Schindler Australia operations), through to distribution centres which are temperature-controlled facilities that are required to maintain the cold chain and operate with multiple shifts with 24/7 operations.

As the Proposal contains up to six potential warehouse tenancies that are unknown, and only one warehouse tenant known, conservative assumptions have been adopted for this assessment. Given that temperature-controlled warehouse/distribution activities are not expected or supported by the Proposal, the loud noise sources from such plant and activities have not been considered further in this assessment. However, consistent with providing a conservative assessment, all heavy vehicle movements through the facility have been assumed at the upper end of the typical expected noise source levels (ie. B-doubles). Based upon RT&A experience, Table 5-8 shows the lower and upper ranges typically expected from some of the normal warehouse/distribution vehicles that may operate through the facility, along with the source levels that have been adopted for the assessment.

This conservative approach should be considered by both the proponent and regulators before requiring or committing to the recommended mitigation measures presented in Section 5.3.2.

Table 5-8: Summary of assumed sound power levels, dB(A) – Key truck sources for Proposal

Equipment / Plant	Noise source / noise generating operation	Time characteristic at source over a 15-minute period	Individual source/activity sound power level (moving point source L_w or stationary point source L_w) (L_w re. 1pW), $L_{Aeq,t}$, dB(A)		
			Lower range	Upper range	Adopted for the assessment
Truck noise sources					
Warehouse delivery trucks	Moving onsite (10km/h)	Semi-steady	93[1]	107[2]	107
	Moving onsite (up ramp ~ 5km/h)	Semi-steady	96[1]	108[2]	108
	Moving onsite (down ramp ~ 10km/h)	Semi-steady	93	107	107
	Accelerating from stationary (ie. dock) (~ 5-10km/h) – Engine	Non-steady	100	109	109
	Accelerating from stationary (ie. dock) – Engine (L_{Amax})	Non-steady	-	≤ 110	110
	Airbrake (when stop at dock) (L_{Amax})	Isolated peak	-[5]	≤ 122	122
	Airbrake (when stop at dock; over a 15 minute period)	Isolated peak	-	90	90
	Airbrake (working brake, as part of normal slow down movement) (L_{Amax})	Isolated peak	-	111[4]	111[4]
	Truck reversing into dock activities (with reversing beeper operating during reversing)[3] (L_{Amax})	Non-steady + Repetitive peaks	105	113[6]	113
	Truck reversing into dock activities (with reversing beeper operating during reversing at 2km/h)[3]	Non-steady + Repetitive peaks	< 105	111	108[7]

Notes:
1. Small delivery van
2. B-Double trucks
3. Measurements were with a tonal reversing alarm. Broadband alarms are recommended to be incorporated across all heavy vehicles using the facility.
4. This noise event will often not occur as part of normal brake usage. It will only occur occasionally, subject to the driving technique. Source level is converted to 81 Lw dB(A) LAeq 15 minute, for the LAeq assessment.
5. Not required for all truck types
6. This captures noise events during sudden stopping as part of reversing operation
7. Based upon typical large warehouse semi-trailer/B-double

5.2.1.3 Loading dock and hardstand activities

Trucks would arrive and enter the site via the routes shown in Figure 8 to access the hardstand and loading dock areas. Loading dock activities would include trucks reversing into the warehouse loading dock and would be loaded via forklifts either via side loading or from internally via the rear, subject to the type of truck.

Typically, drivers would be required to reverse into dock, and then complete paperwork or similar. Similarly, this may be required prior to departure, before the truck then accelerates to site speed to then depart the facility. As such, these noise sources have been included in the model.

5.2.1.4 Warehouse operations

The key internal noise generating components that are typical of warehouse activities are:

- Forklift operations
- Machinery operations (ie. conveyors) or internal music

The key potential for noise breakout from these activities is through the building facade elements. These include:

- Building facade cladding
- Ventilation louvres

It is proposed that most of the facades are to be constructed typically with precast concrete panels, as such internal breakout via these is likely to be negligible. There will be air intake louvres located along the non-hardstand facades of each warehouse, which will have the potential for noise breakout from internal activities. The assumed internal noise levels are based upon measurements at similar warehouse facilities and are presented in APPENDIX C (Table 6-4).

5.2.1.5 Offices and staff vehicle movements and car parking

The Proposal is expected to generate up to 586 light vehicle trips per day (inbound and outbound movements).

The proposed carpark movement assumptions are detailed in Section 5.1.2.2, which presents a summary of the forecasted vehicles assumed for the Proposal as provided by the project team.

Noise generated by car park activities includes vehicle doors closing, vehicle engines starting, vehicles accelerating and vehicles moving. To assess this noise, the $L_{Aeq\ 15\text{-minute}}$ noise level at the nearest affected residential premises was determined for each relevant period based on the number of vehicle movements expected to occur during that period. This also includes the addition of service vehicles.

For this assessment, the proposed staff requirements for the facility have been reviewed to determine the maximum number of car movements within the carpark during each assessment period. This distribution has considered the following:

- The Proposal staff carpark has 144 spaces.
- There is provision for 47 service vehicle parking spaces.
- Cars and service vehicles are expected to move at 10 km/h within the site.

- Cars will enter and exit off Bourke Road and access the Level 2 carpark via a ramp along the northern boundary.

5.2.1.6 Key building services and mechanical plant

The specific type of building services and mechanical plant and their location on site are yet to be finalised at this early development approval stage of the project. The key known building services and mechanical plant items to be considered for the noise assessment are:

- Condensing unit plant areas
- Jet fans (to ventilate the hardstand areas)
- Warehouse ventilation
- Makeup air louvres along warehouse facades

Table 5-9 details the mechanical plant assumed as part of the modelling for this assessment and are detailed in Section 5.2.2, with noise source levels included in APPENDIX C.

Table 5-9: Assumed mechanical plant noise sources, dB(A)

Noise source	Number of units (See Section 5.2.2 for assumed operations)	Individual source/activity sound power level (L_w re. 1pW), $L_{Aeq,t}$, OR sound pressure level (L_p), dB(A)	Location	Mitigation assumptions
Warehouse/office condenser units (eastern plant area)	10	Refer to APPENDIX C	Level 2 roof, located either on eastern boundary or northern side of southern offices	Mitigation measure M4.2
Warehouse/office condenser units (western plant area)	10		Level 2 roof, located either on eastern boundary or northern side of southern offices	Mitigation measure M4.2
Hardstand jet fans	14 per floor (28 in total)		Hardstand soffit mounted	2 diameter long circular attenuator on both discharge/intake
Warehouse exhaust fans	1 per warehouse (8 in total)		Within warehouse, exhausting to hardstand area	2 diameter long circular attenuator on both discharge/intake
Intake air louvres	Minimum 20m^2 per warehouse		Along non-hardstand facade Warehouse 1A/1B/3 – South facade Warehouse 2A/2B/4A/4B – North facade	Internally lined plenum / ductwork internal to the facade louvre for the southern warehouse tenancies (1A/1B & 3)

Note: 1. Plant and equipment not listed above has not been assessed.

5.2.1.7 Emergency plant and equipment

The following noise generating plant are proposed to be included in the Proposal:

1. Sprinkler pumps, located within a dedicated plant room on the southern boundary of the Proposal site.

2. Smoke clearance fans.

Due to the infrequent and non-typical operating nature of these emergency plant and equipment items, they do not operate as part of normal reasonable worst-case operations as they are for emergency and stand-by usage only. For this reason and in the absence of any directly relevant NSW guideline or specific guidance for emergency and stand-by equipment, they do not form part of the reasonable worst case 15-minute scenario modelling.

However, feasible and reasonable mitigation and management should be implemented in accordance with the NPfI in order to minimise the potential noise impacts on nearby sensitive receivers. The project trigger levels presented in Section 3.4.2.2.3 are not directly suitable or applicable to the stand-by and emergency plant but can serve as a guide for reviewing selections and feasible and reasonable mitigation and management at detailed design.

As such, the following recommendations should be incorporated:

1. For selection and installation of the sprinkler pumps, they are to be located within an acoustically rated building, designed to minimise noise impacts at the nearest residential receivers directly south across Gardeners Road during testing and maintenance procedures.

2. Smoke clearance fans should be selected and designed to minimise noise emissions to nearby receivers during testing and maintenance procedures.

3. All emergency plant and equipment are to be tested and maintained during the daytime weekday period (7:00 am to 6:00 pm).

4. All noise mitigation and management measures should generally be selected to not substantially increase the cumulative site noise emissions during testing [ie. not increase total site noise emissions by more than 5 dB(A)].

5. The design of noise levels from emergency plant and equipment should consider the internal noise level requirements during emergencies detailed in Section 4.6 of AS/NZS 1668:2015.

5.2.2 Reasonable worst-case intrusiveness scenarios (15-minute period)

To assess noise impacts from the Proposal, 'reasonable' worst-case scenarios (15-minute period) assessment scenarios have been developed for assessing noise emissions from the facility for each assessment period (ie. day, evening, night and morning shoulder). These scenarios have been developed based upon the aforementioned operational assumptions, operational inputs from the project team including potential traffic movements and observations of activities at other similar warehouse facility operations.

Table 5-10 details the 'reasonable' worst-case scenarios (15-minute period), covering the key noise generating activities detailed in Section 5.2.1 and noise intensive periods for the main areas of noise generation across the Proposal site. The locations of these key areas are shown in Section 5.2.1.1 for reference.

The operational noise source levels, assumptions and reasonable worst-case operational assessment scenarios have been developed to capture a conservative reasonable worst case set of operations, as the potential tenant and associated operations are not confirmed at this stage.

Table 5-10: Representative 'reasonable' worst-case 15-minute noise generating assessment scenarios

Activity / Assessment period	Daytime (7:00am to 6:00pm)	Evening (6:00pm to 10:00pm)	Night (10:00pm to 7:00am)	Morning shoulder (5:00am to 7:00am)
Internal vehicle movements				
Loading dock receiving and dispatching movements	Refer to Section 5.2.1.2 for assumed numbers, and routes that the trucks would follow within the facility. All trucks assumed to be B-Doubles.	Refer to Section 5.2.1.2 for assumed numbers, and routes that the trucks would follow within the facility. All trucks assumed to be B-Doubles.	Refer to Section 5.2.1.2 for assumed numbers, and routes that the trucks would follow within the facility. All trucks assumed to be B-Doubles.	Refer to Section 5.2.1.2 for assumed numbers, and routes that the trucks would follow within the facility. All trucks assumed to be B-Doubles.
Staff vehicle movements and car parking	Refer to Section 5.1.2.2 for assumed numbers and routes that the trucks would follow within the facility. Each car then includes a car door slam and engine start noise source.	Refer to Section 5.1.2.2 for assumed numbers and routes that the trucks would follow within the facility. Each car then includes a car door slam and engine start noise source.	Refer to Section 5.1.2.2 for assumed numbers and routes that the trucks would follow within the facility. Each car then includes a car door slam and engine start noise source.	Refer to Section 5.1.2.2 for assumed numbers and routes that the trucks would follow within the facility. Each car then includes a car door slam and engine start noise source.
Service vans	4 movements either to/from the service van parking area	4 movements either to/from the service van parking area.	2 movements either to/from the service van parking area.	4 movements either to/from the service van parking area.
Hardstand and loading dock activities				
Hardstand and warehouse loading docks / roller doors activities	Across the four warehouses around each hardstand (Ground=1A/1B/2A/2B, Level 1=3A/3B/4A/4B) the following were modelled: • 4 x trucks arrive and reverse to dock with truck airbrake (trailer) release at end (one each warehouse) • 4 x trucks accelerate from dock to internal speed (one each warehouse). • 12 x trucks idle for 2 minutes either prior to departure or following arrival (3 each warehouse) • 8 x trucks being loaded via pallet loaders or similar from internal (two each warehouse). Assumed 4 loading operations could occur within 15 minutes (see Note 1).	Across the four warehouses around each hardstand (Ground=1A/1B/2A/2B, Level 1=3A/3B/4A/4B) the following were modelled: • 2 x trucks arrive and reverse to dock with truck airbrake (trailer) release at end (one for 1A/1B and one for 2A/2B) • 2 x trucks accelerate from dock to internal speed (one for 1A/1B and one for 2A/2B). • 8 x trucks idle for 2 minutes either prior to departure or following arrival (2 each warehouse) • 4 x trucks being loaded via pallet loaders or similar from internal (one each warehouse) Assumed 4 loading operations could occur within 15 minutes (see Note 1).	Across the four warehouses around each hardstand (Ground=1A/1B/2A/2B, Level 1=3A/3B/4A/4B) the following were modelled: • 1 x trucks arrive and reverse to dock with truck airbrake (trailer) release at end (western end). • 1 x trucks accelerate from dock to internal speed (western end). • 4 x trucks idle for 2 minutes either prior to departure or following arrival (1 each warehouse) • 2 x trucks being loaded via pallet loaders or similar from internal (one for 1A/1B and one for 2A/2B) Assumed 4 loading operations could occur within 15 minutes (see Note 1).	Across the four warehouses around each hardstand (Ground=1A/1B/2A/2B, Level 1=3A/3B/4A/4B) the following were modelled: • 2 x trucks arrive and reverse to dock with truck airbrake (trailer) release at end (one for 1A/1B and one for 2A/2B) • 2 x trucks accelerate from dock to internal speed (one for 1A/1B and one for 2A/2B). • 8 x trucks idle for 2 minutes either prior to departure or following arrival (2 each warehouse) • 4 x trucks being loaded via pallet loaders or similar from internal (one each warehouse) Assumed 4 loading operations could occur within 15 minutes (see Note 1).
Hardstand jet fans	Hardstand soffit mounted fans x14 along each hardstand area (ie. 14 located on Ground and 14 located on Level 1)			
Warehouse exhaust fans	One warehouse exhaust fan per warehouse, exhausting into the hardstand area			
Internal warehouse activities				
Internal warehouse activities	Internal warehouse activities [Internal noise level based upon similar warehouses such as internal forklift activities (see APPENDIX C)] All three warehouse doors per warehouse are assumed as open (ie. 12 warehouse doors open per level)			

Activity / Assessment period	Daytime (7:00am to 6:00pm)	Evening (6:00pm to 10:00pm)	Night (10:00pm to 7:00am)	Morning shoulder (5:00am to 7:00am)
Warehouse exhaust fans	One warehouse exhaust fan per warehouse, pulling from the internal warehouse space			
Mechanical plant and equipment and building services				
Condenser unit plant area – Level 2 roof (eastern boundary)	Condenser units x 10 within the plant area			
Condenser unit plant area – Level 2 roof (western boundary)	Condenser units x 10 within the plant area			

Notes: 1. As a conservative assumption, internal pallet loading activities have been modelled as the source levels are higher than side loading with forklifts.

For **emergency plant and/or equipment** such as a smoke clearance fans, this would not form part of normal operations. It is assumed that is may be tested once every couple of months during the daytime period. See Section 5.2.1.7 for more information.

Across these operational areas, presented in Table 5-11 are the potential noise sources that could result in instantaneous noise events that could typically occur as part of operations that have been assumed in the sleep disturbance assessment at night. The locations of these key areas are shown in Figure 9 for reference.

Table 5-11: Instantaneous noise events assessment scenarios (night period)

Location / activity	Instantaneous noise sources (L_{Amax} event)
Internal heavy vehicle movements	
Rigids/Semi-trailers/B-Doubles	Truck acceleration
Rigids/Semi-trailers/B-Doubles - at entry or exit locations	Truck working brake release
Carpark and service vehicles	Car / service vehicle engine start Car / service vehicle door slam
Loading dock and delivery activities	
Loading dock area	1. Truck airbrake 2. Trailer loading 3. Truck accelerate 4. Reversing activities

5.3 Initial assessment and acoustic mitigation and management review

5.3.1 Initial assessment outcome

Based upon an initial assessment, it was determined that noise emissions from site operations may exceed the noise limits presented in Section 3.4.2.2.3 without further review of noise inputs assumptions and reasonable mitigation and management measures applied across the facility. Key noise sources that were contributing to the overall cumulative noise emission level at nearby receivers were:

- Hardstand activities breaking out the eastern and western access openings
- Truck movements along internal routes, in particular:
  - Ground level entrance corridor along eastern boundary
  - Level 1 western internal road movements prior to hardstand
  - Ground level movements along western boundary prior to exiting

As such, a detailed review of input assumptions across all contributing noise sources was undertaken, and feasible and reasonable mitigation and management measures that could be implemented have been identified and recommended to ensure that the site can achieve the requirements of the NPfI.

5.3.2 Recommended design mitigation and management measures

Following the initial assessment of the site noise emissions, a range of feasible and reasonable mitigation and management measures were investigated and identified in order to determine a design that would achieve the required NPfI project trigger levels detailed in Section 3.4.2.2.3 and minimise noise emissions from the site.

The mitigation and management measures presented in Table 5-12 should be further reviewed as required so that they can be reasonably incorporated into the Proposal design where feasible. These are specific recommendations required for the Proposal, and further operational noise management measures that should be considered are detailed in Section 5.5.4. For the site to achieve the requirements of the NPfI, these mitigation or management measures are required to be implemented or further investigated during design development.

The predicted noise levels presented in Section 5.5 incorporate the following operational noise mitigation and management measures presented in Table 5-12.

Table 5-12: Recommended noise mitigation and management measures

Item	Activity / noise source	Ref. Figure
	Overall and operational management	
M1.1	Broadband reversing alarms "quackers" shall be adopted across the tenant truck fleet that operates through warehouse facility centre. This should be adopted for all permanent and tenant owned/controlled vehicles. This is of particular note for vehicles that would operate in non-enclosed areas (ie. service vehicles parked on roof level). Where tenants do not have control over vehicles that operate through the facility, management of potential impacts should be reviewed further as part of the tenant operational management plan.	-
M1.2	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.	-
M1.3	Ensure that for all non-enclosed areas of the facility, and entry and exit areas (ie. Gardeners Road and Bourke Road access points) - - All pavement is smooth (ie. no speed bumps) - 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). 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, in particular where they are required to operate during the night period. These will be reviewed at detailed design to avoid competing traffic issues and traffic management at required pedestrian interfaces like footpath crossings.	Figure 11
M1.4	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.	-

Item	Activity / noise source	Ref. Figure
M1.5	Building services, mechanical plant and plantroom spaces are to be designed to not increase total site noise emissions. This will likely include selection of quiet plant/equipment, acoustic absorption, noise barriers, and the use of acoustic louvres and attenuators as part of the design. See Section 5.3.5. Section 5.2.1.6 (Table 5-9) also details some of the indicative treatments that were assumed in the modelling.	-
M1.6	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.	-
	Ground level	
M2.1	Eastern facade of the entrance corridor is to be closed from ground to the slab above. This is to extend from the Gardeners Road entrance and extend substantially passed the ground floor hardstand area opening.	Figure 11
M2.2	Acoustic absorption lining to be installed on the underside of the enclosure roof entrance corridor, and along the internal walls, to minimise truck movement and hardstand activity noise build up and breakout via the southern Gardeners Road entrance.	Figure 11
M2.3	Acoustic absorption lining to be installed on the underside of the ceiling/slab above internally.	Figure 11
M2.4	Incorporate acoustic absorptive material along the eastern building facade and the soffit of the slab above along the ground level truck exit route to minimise reflections from dock activities back to residence.	Figure 11
M2.5	Maintain the solid and non-perforated facade elements extending down from the Level 1 slab, which result in acoustic shielding to elevated residential receivers to the southern west, from ground level hardstand activities, trucks exiting the hardstand, and truck movements exiting from Level 1.	Figure 13
	Level 1	
M3.1	Level 1 eastern truck route prior to the Level 1 hardstand area is to be enclosed. This would extend from the hardstand until the northern most point along the eastern Level 1 internal access road. Acoustic absorption lining to be installed on the underside of the enclosure roof.	Figure 12
M3.2	Acoustic absorption lining to be installed on the underside of the ceiling/slab above internally.	Figure 12
M3.3	The western opening to the Level 1 hardstand area is to be enclosed. This enclosure is to extend north along the exit road substantially passed the level 1 floor hardstand area opening. Acoustic absorption lining to be installed on the underside of the enclosure roof.	Figure 12
M3.4	The concrete perimeter barrier along the internal truck road between the level 1 hardstand and the ramp to ground level is to be a minimum 2.5m high above the local ground level.	Figure 12
	Level 2 (roof level)	
M4.1	Incorporate acoustic absorptive material along the internal walls of the voids from the Level 1 hardstand to the external breakout locations on the roof level (Level 2). The configuration of the solid roof coverings over the top of the ventilation voids to the hardstand below (with sufficient open area for required ventilation) are to incorporate measures that break line-of-sight through these voids to the hardstand from the nearby elevated receiver locations. This is to reduce noise breakout from these voids. Acoustic absorptive material is also to be installed on the underside of any solid roof covering.	Figure 13

Item	Activity / noise source	Ref. Figure
M4.2	Perimeter barriers are to be installed along the western boundary of the western roof plant area, and the eastern boundary of the eastern roof plant area. They should be a minimum 2m above the top of the tallest noise generating plant item (ie. condenser unit) within the plant area and extend a minimum of 2m north of the northern most plant item. This is to be installed for both the eastern and western plant areas. Acoustic absorption installed on all internal surface of the condenser plantroom area, along the northern facade of the office building and along the above recommended perimeter wall.	Figure 13
	Ramps	
M5.1	Maintain the solid and non-perforated facade elements shielding the northern truck and car ramps from the adjacent commercial receiver, to minimise noise impacts from ramp activities.	Figure 13

Figure 11: Ground floor - Proposal indicative noise mitigation measures considered in design

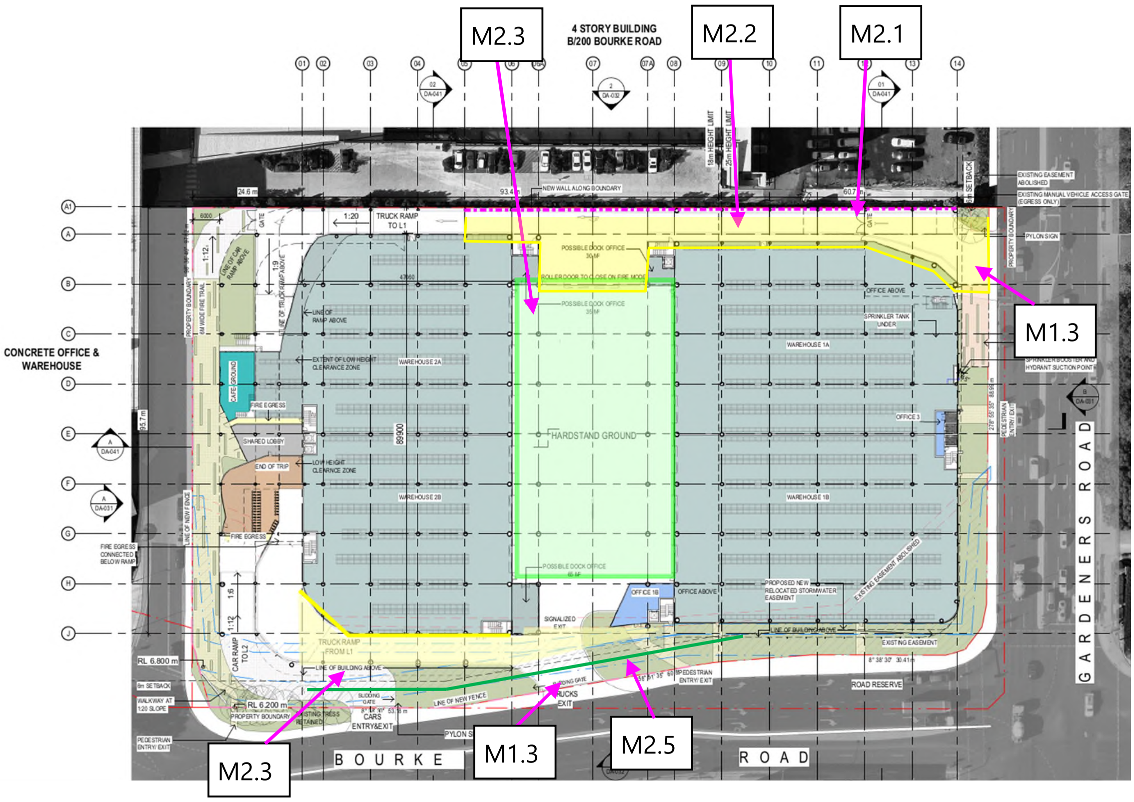


Figure 12: Level 1 - Proposal indicative noise mitigation measures considered in design

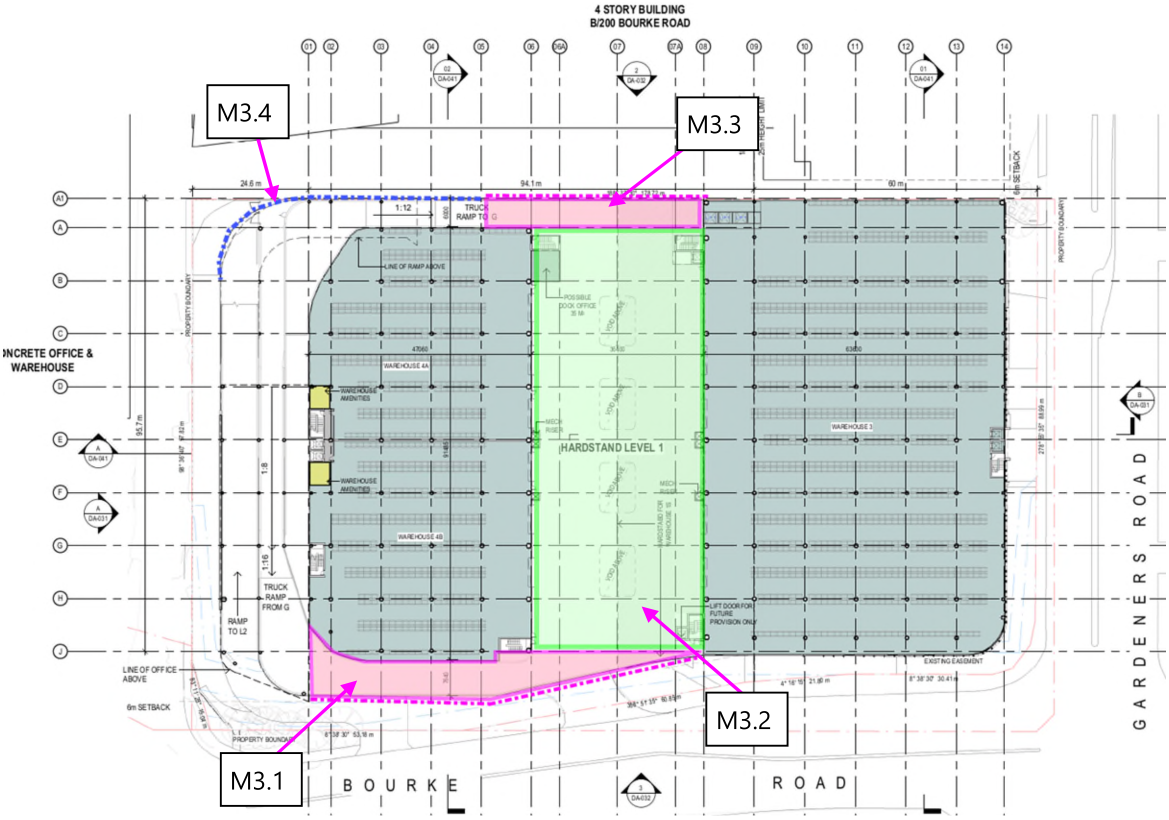


Figure 13: Level 2 - Proposal indicative noise mitigation measures considered in design

5.3.3 Noise barriers and enclosures

A range of noise barriers and enclosures are proposed as part of the noise mitigation measures incorporated into the Proposal. The extent and heights of noise barriers and areas of enclosures are indicative only at this impact assessment stage, noting that the final operations and tenants are not all known. The final extents and quantities of noise barriers, enclosures and materials required, will largely depend on the performance of the preferred materials selected by the designers and the outcomes of a design review / optimisation process. The construction of a noise barrier can 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 fence and the ground / retaining walls should be filled to ensure that the fence provides appropriate noise attenuation

5.3.4 Acoustic absorption

Elements identified for acoustic absorption lining will be reviewed and optimised during detailed design to determine the quantities and performance specifications necessary to achieve the project's noise objectives. The extents and quantities of materials required to line the building element identified for acoustic absorption lining, will largely depend on the performance of the materials selected by the designers and the outcomes of a design review / optimisation process.

Within enclosed spaces such as the hardstand area, or enclosed internal roads/corridors, materials such as glasswool or mineral wool, 50mm thick 32kg/m^3 insulation with solid non-perforated foil facing, minimum NRC 0.8 would be the typical type of material to investigate.

5.3.5 In principle building services and mechanical plant and equipment 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. At this stage of the project appropriate detail for mechanical plant is not typically available, and so indicative plant and equipment has been assumed as part of the assessment with indicative mitigation (ie. acoustic louvres, attenuation to air openings, acoustic absorption lining, etc.), as detailed in Section 5.2.1.6. Details some of the indicative treatments that were assumed in the modelling are detailed in Table 5-9.

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 noise generating items and operations as part of typical operations (ie. building services and mechanical plant cumulatively with other noise sources such as trucks and loading activities) does not exceed the applicable noise criteria. This includes the detailed specification and location of mechanical plant on site.
- Noise control treatment can affect the operation of the mechanical services system. An acoustic engineer should be consulted during the initial design phase of mechanical services system to reduce potential redesign of the mechanical system.
- 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
- Fans shall be mounted on vibration isolators and balanced in accordance with Australian Standard 2625 '*Rotating and Reciprocating Machinery – Mechanical Vibration*'.

5.3.6 Considerations of the recommended mitigation and management measures

The above recommendations provide in-principle solutions to address project acoustic requirements. This information is presented for the purpose of the consent authority approvals process and for preliminary cost planning. It shall not be used for detailed design and construction purposes without approval in writing by the acoustic consultant. Assistance of the acoustic consultant must be sought during the detailed design phase of the project to confirm all details, material quantities and performance specifications are consistent with the outcomes of this assessment.

5.4 Noise prediction methodology

5.4.1 Modelling overview

Modelling and assessment of airborne noise impacts from the Proposal were determined by modelling the noise sources, receiver locations and topographical features, and possible noise mitigation measures using a 3D noise modelling package, CadnaA (Version 2021 MR 1). Noise modelling algorithms were used to calculate the contribution of each noise source at each identified sensitive receiver location and to predict the total noise from the site for the various reasonable worst-case scenarios developed for the Proposal.

Internal and covered spaces within the facility such as the ground and level 1 hardstand and breezeways, the entrance corridor along the eastern side, and other covered ramp and internal road areas were modelled using CadnaR (Version 2021) to determine the noise levels at the openings to these spaces. These modelled noise levels were then incorporated into the overall CadnaA noise model.

The noise prediction model considers:

- Location of noise sources and sensitive receiver locations (including multi-storey buildings).
- Heights of sources and receivers referenced to digital ground contours (1 metre contour intervals) or relative to the Proposal building structure.
- Each noise-sensitive building in the project has been assessed separately, considering all facades and floors. The results in Section 5.5 only present the levels at representative receiver locations, however, all nearby and potentially impacted noise sensitive receivers have been evaluated.
- Noise source levels of individual plant and equipment.
- Internal noise levels within the facility, and the breakout of these noise levels through the facade building elements.
- Separation distances between sources and receivers.
- Ground type and reflections between sources and receivers (ground absorption value of 0 for the site, warehouse areas and roads, and 0.1 outside of this area (ie. urban land uses).
- Attenuation from barriers, buildings and structures (natural terrain and purpose built). This includes proposed buildings likely to be there, as detailed in Section 1.5.
- Atmospheric losses and meteorological conditions.
- Feasible and reasonable noise mitigation/treatments and management measures that have been determined for the Proposal.

As a large number of the nearest noise sensitive receivers are close by to the Proposal site, with many located within 100 metres, the noise prediction modelling has been undertaken using the International Standard ISO 9613-2 (1996), which incorporates moderately adverse meteorological conditions (i.e. wind and temperature inversions) implemented in accordance with ISO/TR 17534-3 (2015). This algorithm is suitable to capture noise propagation for urban areas for receivers at these distances in accordance with the NPfI.

5.4.2 Meteorological factors

In accordance with the NPfI, the noise assessment should consider the potential effects of adverse meteorological conditions such as wind and temperature inversions.

As the most affected noise sensitive receivers are within 100 metres of the Proposal area the noise prediction modelling has been undertaken using the International Standard ISO 9613-2 (1996), which incorporates moderately adverse meteorological conditions (i.e. wind and temperature inversions) implemented in accordance with ISO/TR 17534-3 (2015).

5.5 Noise predictions

5.5.1 Predicted operational noise levels

To assess operational noise emissions from the Proposal, the assessment scenarios identified in Section 5.2.2 have been evaluated to progress to the modelling and assessment stages.

As operations take place during the night period, there is also the potential for sleep disturbance noise impacts to occur from high noise events activities within the facility (ie. airbrake releases) these have also been assessed.

Each of these assessment scenarios represent the reasonable worst-case operating scenarios that would take place. However, where all the assumed activities do not occur simultaneously during the same 15-minute period, then noise levels are likely to be lower than those predicted.

The predicted noise levels presented in this section include all feasible and reasonable mitigation and management measures presented in Section 5.3, which have been recommended based upon an initial evaluation and the progressive assessment process.

Predicted noise levels have been assessed to the nearby representative receivers, and a summary of these results are presented in Table 5-13. As many receivers are multi-storey residences, representative floor levels have been used to show the results for the various receiver floor locations. These multiple floors have been identified with the suffix "A", "B", etc. For example, R1A is the first representative floor location for representative receiver R1.

Noise contour maps at 1.5 metres above the local ground level for each of the scenarios assessed are presented in APPENDIX D.

Table 5-13: Predicted operational noise levels – $L_{Aeq,15minute}$, dB(A)

Assessment scenario				Daytime (7:00am to 6:00pm)			Evening (6:00pm to 10:00pm)			Night (10:00pm to 5:00am)			Morning shoulder (5:00am to 7:00am)		
Receiver	Floor	Receiver type	NCA	PNTL	Predicted noise level, $L_{Aeq\ 15min}$, dB(A)	Exceedance	PNTL	Predicted noise level, $L_{Aeq\ 15min}$, dB(A)	Exceedance	PNTL	Predicted noise level, $L_{Aeq\ 15min}$, dB(A)	Exceedance	PNTL	Predicted noise level, $L_{Aeq\ 15min}$, dB(A)	Exceedance
R1A 671 Gardeners Road	Level 3	Residential	NCA1A	58	41	-	53	38	-	51	35	-	52	38	-
R1B 671 Gardeners Road	Level 8	Residential	NCA1B	58	41	-	48	39	-	44	36	-	54	39	-
R1C 671 Gardeners Road	Level 14	Residential	NCA1B	58	44	-	48	41	-	44	39	-	54	41	-
R2A 659 Gardeners Road (north tower)	Level 2	Residential	NCA1A	58	46	-	53	43	-	51	40	-	52	43	-
R2B 659 Gardeners Road (north tower)	Level 6	Residential	NCA1B	58	46	-	48	43	-	44	40	-	54	43	-
R2C 659 Gardeners Road (north tower)	Level 12	Residential	NCA1B	58	48	-	48	45	-	44	42	-	54	45	-
R3A 653 Gardeners Road	Level 2	Residential	NCA1A	58	50	-	53	47	-	51	43	-	52	47	-
R3B 653 Gardeners Road	Level 6	Residential	NCA1B	58	50	-	48	47	-	44	44	-	54	47	-
R3C 653 Gardeners Road	Level 12	Residential	NCA1B	58	50	-	48	47	-	44	44	-	54	47	-
R3A 653 Gardeners Road	Level 2	Residential	NCA2	58	49	-	48	45	-	44	41	-	50	45	-
R3B 653 Gardeners Road	Level 6	Residential	NCA2	58	49	-	48	45	-	44	41	-	50	45	-
R3C 653 Gardeners Road	Level 12	Residential	NCA2	58	48	-	48	45	-	44	41	-	50	45	-
R4 659 Gardeners Road (south tower)	Level 8	Residential	NCA2	58	31	-	48	29	-	44	27	-	50	29	-
R5A 635 Gardeners Road (north facade)	Level 2	Residential	NCA3	58	54	-	52	50	-	49	46	-	54	50	-
R5B 635 Gardeners Road (north facade)	Level 4	Residential	NCA3	58	54	-	52	50	-	49	46	-	54	50	-
R6A 629 Gardeners Road (north facade)	Level 2	Residential	NCA3	58	47	-	52	44	-	49	39	-	54	44	-
R6B 629 Gardeners Road (north facade)	Level 5	Residential	NCA3	58	48	-	52	44	-	49	39	-	54	44	-
R5A 635 Gardeners Road (west facade)	Level 2	Residential	NCA4	58	53	-	49	49	-	46	44	-	53	49	-
R5B 635 Gardeners Road (west facade)	Level 4	Residential	NCA4	58	53	-	49	49	-	46	45	-	53	49	-
R7 635 Gardeners Road (west facade)	Level 3	Residential	NCA4	58	48	-	49	44	-	46	40	-	53	44	-
R8 635 Gardeners Road	Level 3	Residential	NCA4	58	48	-	49	44	-	46	40	-	53	44	-
R9 639 Gardeners Road	Level 1	Commercial	-	63	54	-	63	50	-	63	46	-	63	50	-
R10 506-518 Gardeners Road	Level 6	Commercial	-	63	63	-	63	61	-	63	58	-	63	61	-
R11 200 Bourke Road, Alexandria	Level 2	Commercial	-	63	59	-	63	56	-	63	53	-	63	56	-
R12 79 Bourke Road, Alexandria	Level 2	Commercial	-	63	57	-	63	54	-	63	51	-	63	54	-
R13 83 Bourke Road, Alexandria	Level 3	Industrial	-	68	59	-	68	56	-	68	52	-	68	56	-
R14 85 Bourke Road, Alexandria	Level 3	Industrial	-	68	57	-	68	53	-	68	50	-	68	53	-
R15 532-536 Gardeners Road	Ground	Commercial	-	63	47	-	63	43	-	63	40	-	63	43	-
R16 538 Gardeners Road	Level 2	Commercial	-	63	45	-	63	42	-	63	38	-	63	42	-

Notes: 1. Project specific noise limits only applicable when in use
2. Receiver locations shown in Figure 2.

From the above tables, the predicted operational noise levels indicate with the recommended mitigation and management measures presented in Section 5.3, noise emissions can achieve the project noise trigger levels presented in Section 3.4.2.2.3 at all nearby assessment receivers for all assessment periods.

5.5.2 Annoying noise characteristics adjustments

Where the character of the industrial noise is assessed as particularly annoying at a receiver location (ie. if the resulting noise level at a receiver location is tonal, low frequency or is intermittent at night), then an adjustment would be added to penalise the predicted noise for its potential increase in annoyance. The Fact Sheet C of the NPfI provides definitive procedures for determining whether a modifying factor should be applied which is assessed as part of the Proposal. The corrections are to be added to the predicted noise levels at the receiver before comparison with the project noise trigger levels.

The noise sources used for modelling were based upon measurements of the noise sources at similar warehouse and distribution facilities, and these measurements sufficiently captured the duration of the total activity noise level (ie. incoming manoeuvre, idle, departure manoeuvre etc), and all recorded the relevant statistical measurement parameters (L_{Amax}, $L_{A1,T}$, $L_{A10,T}$, $L_{A90,T,}$ L_{Amin}) in accordance with AS1055:2018.

5.5.2.1 Tonality

One noise source was identified as tonal at source and as such was further assessed to see if it is potentially tonal at the nearby receivers. The source being the reversing alarms on heavy vehicles. The noise contribution from this source was compared to the noise from typical operations at the nearby residential receivers and it was also compared to the background noise level at nearby receivers, and it was determined that this noise source is unlikely to exceed the tonality test of the NPfI, and so the predicted noise levels from the operations do not require an annoyance penalty to be applied.

Furthermore, mitigation measure M1.1 in Table 5-12 recommends that broadband reversing alarms are adopted throughout the facility instead of tonal alarms, which assists in reducing the risk of tonal noise.

5.5.2.2 Low frequency

The proposed operations do not support or expect to have any sources that could result in low-frequency noise levels at nearby receivers, therefore noise emissions do not require a low-frequency noise penalty as identified in the NPfI.

5.5.2.3 Intermittent noise

The NPfI details that the test for intermittent noise that applies during the night period to be *"The source noise heard at the receiver varies by more than 5 dB(A) and the intermittent nature of the noise is clearly audible."* and *"…where the level suddenly drops/increases several times during the assessment* *period…"*. During the environmental assessment stage it is not possible to listen and subjectively assess the noise at the receiver as required by the guideline. However, only where all of the following tests are met shall a penalty be applicable to the predicted noise level at the relevant receiver:

- the noise level fluctuates / cycles by more than 5 dB(A);
- this difference relates to a 'sudden' drop/increase in the activity noise level;
- this activity may occur multiple times during a 15-minute assessment period; and
- the predicted noise level from the subject source at a receiver is clearly audible over the ambient noise environment.

The only noise source which potentially exhibits intermittent characteristics, such as cycling on and off, would be the reversing alarms fitted to the heavy vehicles that operate throughout the facility. Noting that mitigation measure M1.1 in Table 5-12 recommends that broadband reversing alarms are adopted throughout the facility, and there are minimum night period truck movements likely, a screening test was undertaken to determine the likely instantaneous noise level from that source from broadband reversing alarms at the typical locations that they would operate within the hardstands of the facility. The screening test determined that considering the noise environment at the receivers when the project is operational the instantaneous noise events from the broadband reversing alarms are unlikely to change noise levels at nearby receivers by more than 5 dB(A). As these truck reversing operations at night would typically only occur within the covered/enclosed hardstand areas, which all have substantial shielding to the nearest residential receivers by the warehouse building, the noise level from this source was assessed as unlikely to be clearly audible at the nearby receivers. As such, the screening test determined that the noise emissions during the night time period are unlikely to require an intermittent penalty as identified in the NPfI.

5.5.3 Sleep disturbance assessment

This section assesses the potential for sleep disturbance impacts, specifically looking at the maximum noise levels (L_{AFmax}). Refer to Section 5.5.1 for the $L_{Aeq15\ minute}$ predicted noise levels. The EPA NPfI $L_{Aeq15\ minute}$ sleep disturbance assessment levels are presented in Table 3-15, with the lowest assessment trigger levels across all NCAs being 47 dB(A) $L_{Aeq15\ minute}$ during the night period and 50 dB(A) $L_{Aeq15\ minute}$ during the morning shoulder period. Across all NCAs the highest predicted night period noise level is 46 dB(A) $L_{Aeq15\ minute}$ and morning shoulder period noise level is 49 dB(A) $L_{Aeq15\ minute,}$ which is at a residential receiver in NCA3. As such, these levels achieve the EPA NPfI $L_{Aeq15\ minute}$ sleep disturbance assessment level.

Potentially loud instantaneous noise events that could occur across the Proposal operations with the potential to disturb sleep are detailed in Table 5-11. Activities such as truck loading activities, truck manoeuvring, when trucks stop and release airbrakes or intermittent manufacturing activities and operations (ie. compressed air releases) exhibit non-steady noise characteristics with loud instantaneous noise events. Table 5-11 details the various locations where they may typically occur and accordingly modelled. As such, these maximum noise levels have been assessed for the potential to disturb sleep, in accordance with the NPfI.

In regard to the WHO 2018 sleep disturbance project assessment noise level of 48 dB(A) $L_{Aeq15\ minute}$ [equivalent to 45 dB(A) $L_{night\ (outside)}$ see Section 3.4.2.5.2], the highest predicted night period noise level is 46 dB(A) $L_{Aeq15\ minute}$ and morning shoulder period noise level is 49 dB(A) $L_{Aeq15\ minute}$ at a residential receiver in NCA3. Noting that the existing morning shoulder background noise levels is 49 dB(A) $L_{Aeq15\ minute}$ and ambient noise level is 65 dB(A) $L_{Aeq15\ minute}$, this level of noise from the facility is substantially below the existing noise levels and would not result in a substantial change to the existing noise environment and associated potential impacts on sleep from average noise emissions levels from the facility.

Predicted noise levels for the Proposal operations at nearby representative receivers during the night period are presented in Table 5-14. Noise contour maps at 1.5 metres above the local ground level for each of the existing scenarios assessed are presented in APPENDIX D.

Table 5-14: Sleep disturbance assessment; L_{Amax}, dB(A)

NCA	Representative receiver	Floor	Screening level			Night (10:00pm to 5:00am)			Morning shoulder (5:00am to 7:00am)		
							Exceedance			Exceedance	
			Night (10pm - 5am)	Morning shoulder (5am - 7am)	Awakening reaction	Predicted noise level, L_{AFmax}, dB(A)	Screening level	Awakening reaction	Predicted noise level, L_{AFmax}, dB(A)	Screening level	Awakening reaction
NCA1A	R1A	3	62	62	65	52	-	-	52	-	-
NCA1B	R1B	8	62	64	65	49	-	-	49	-	-
	R1C	14	62	64	65	50	-	-	50	-	-
NCA1A	R2A	2	62	64	65	56	-	-	56	-	-
NCA1B	R2B	6	62	64	65	56	-	-	56	-	-
	R2C	12	62	64	65	56	-	-	56	-	-
NCA1A	R3A (north)	2	62	62	65	61	-	-	61	-	-
NCA1B	R3B (north)	6	62	62	65	60	-	-	60	-	-
	R3C (north)	12	62	62	65	60	-	-	60	-	-
NCA2	R3A (south)	2	57	60	65	59	2	-	59	-	-
	R3B (south)	6	57	60	65	58	1	-	58	-	-
	R3C (south)	12	57	60	65	57	-	-	57	-	-
	R4	8	57	60	65	31	-	-	31	-	-
NCA3	R5A (north)	2	60	64	65	70	10	5	70	6	5
	R5B (north)	4	60	64	65	69	9	4	69	5	4
	R6A	2	60	64	65	62	2	-	62	-	-
	R6B	5	60	64	65	62	2	-	62	-	-
NCA4	R5A (west)	2	60	63	65	68	8	3	68	5	3
	R5B (west)	4	60	63	65	68	8	3	68	5	3
	R7	3	60	63	66	63	3	-	63	-	-
	R8	8	60	63	67	64	4	-	64	1	-

The maximum noise level events associated with on-site truck activities, loading dock and hardstand activities have been reviewed to determine their potential to cause sleep disturbance at nearby residential receivers both within the hardstand areas and from trucks moving around the facility. However, it should be noted that the key sources of instantaneous noise events (ie. airbrake releases) will occur within the hardstand areas, which are both covered by the facility-built structure, and block line-of-sight to the majority of receiver locations.

Considering the recommended mitigation measures in Section 5.3.2, which includes enclosing several internal truck routes and the openings to the warehouse hardstands in order to mitigate the overall $L_{Aeq15minute}$ noise levels, these measures substantially mitigate noise emissions from these noise sources.

Similarly, the main source that results in the exceedance of the sleep disturbance assessment level and the awakening reaction level in Table 5-14 at receiver R5 (635 Gardeners Road), is if vehicles have to stop or have brake air releases or minor noise events from jolting, or unnecessary accelerating of the truck. Considering the recommended mitigation measure M1.3 in Section 5.3.2, the potential for this event can be minimised, and as such could be removed or the number of occurrences reduced.

With the exception of R3 and R5, Table 5-14 shows that the predicted noise levels from these noise sources are below the sleep disturbance screening levels at the nearby residences because the site mitigation measures effectively reduce noise emissions from these events. As such, the L_{Amax} noise levels associated with these events are predicted to generally be below the sleep disturbance assessment trigger levels.

For R3 and R5, both receivers front Gardeners Road and are also close to the intersection with Bourke Road. The attended measurements presented in Appendix B.2 along with site observations, found that due to the presence of the intersection, there are many existing high noise events that are between 70 to 80 dB(A) L_{Amax} as shown in the unattended monitoring results presented in APPENDIX B. These are typically due to sources such as loud vehicle pass-bys (ie. concrete agitators, crane trucks, etc) or noise events from other vehicles which were identified during the night period attended monitoring (see Appendix B.2 for more details). Considering the proposed likely number of movements presented in Section 5.1.2.2, it is unlikely that even with these events occurring, that there would be a noticeable change in the number of noise events above the sleep disturbance assessment trigger levels.

Nonetheless, these activities will be mitigated and managed where feasible and reasonable by minimising the requirement for trucks to stop or jolt when entering the site as detailed in mitigation measures M1.3, in order to minimise maximum noise level events that have the potential to disturb sleep from occurring when trucks enter and exit the facility and move around within it.

5.5.4 Operational noise management

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 / arrival / departure times during sensitive time periods (ie. night).
- Minimising concurrent use of mobile plant near hardstand openings (ie. ground floor exit) and/or limiting their use to the less sensitive daytime and evening periods.
- Minimising use of reversing alarms by providing forward manoeuvring where practicable.
- 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).

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).

The above recommendations provide in-principle solutions to address project acoustic requirements. This information is presented for the purpose of the consent authority approvals process and for preliminary cost planning. It shall not be used for detailed design and construction purposes without approval in writing by the acoustic consultant. Assistance of the acoustic consultant must be sought during the detailed design phase of the project to confirm all details, material quantities and performance specifications.

6 Conclusion

Renzo Tonin & Associates (RT&A) has been engaged by Charter Hall Holdings Pty Ltd (Charter Hall) to undertake an operational and construction noise and vibration impact assessment (NVIA) to accompany the State Significant Development (SSD) 32489140 for the proposed Ascent Logistics Centre at the 520 Gardeners Road, Alexandria (the Proposal).

This report assesses noise and vibration impacts during the construction and operational phases for the Proposal. It proposes mitigation and management measures to reduce potential noise emissions and resulting noise impacts during the construction and operation phases of the Proposal. The report has been prepared to address the requirements of the Secretary of the Department of Planning, Industry and Environment (DPIE) ('the Secretary's environmental assessment requirements') (SEARs).

6.1 Operational noise assessment

Operational noise impacts from the proposed warehouse facility have been assessed, potential noise impacts identified and a range of feasible and reasonable mitigation measures recommended and/or incorporated into the Proposal design to minimise noise emissions and potential impacts on sensitive receivers nearby to the Proposal site.

Potential sources of noise within the warehouse development were truck movements within the warehouse facility, including receiving and dispatching trucks, passenger vehicle movements and car parking, warehouse loading dock receiving and dispatching activities, internal warehouse activities and office related activities.

At this stage, the final operations of the warehouse facility are not clearly understood (except for one tenant being Schindler Australia) as the final tenants of the facility 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. Warehouse and distribution type facilities can range from predominately storage type facilities with a few small truck deliveries during the daytime period and minimal other activity, through to distribution centres with noise intensive operations, multiple shifts and 24/7 operations. As the Proposal contains six potential tenancies which are unknown, with only one warehouse tenant currently known, this assessment has aimed to review potential operations in a conservative manner, to allow the necessary flexibility of the potential future tenants.

Current project estimates are that over the entire day period there would be potentially 771 vehicle movements (to or from the Proposal site), with 586 light vehicle movements and 185 heavy vehicle movements. This equates to 90-100 truck movements through the facility each day. Most of the heavy vehicle movements are expected to occur during the daytime period, with reduced numbers during the morning shoulder and evening periods. Minimal truck movements are typically expected during the night period.

The assessment has reviewed the existing noise environment and established the noise emission objectives in accordance with the NSW Noise Policy for Industry (NPfI) (EPA 2017).

The assessment then undertook a review of the potential noise generating activities that will likely take place as part of operations of the facility, based upon information provided by the project team and the types of activities observed by RT&A at similar warehouse facilities.

The assessment has predicted the potential noise impacts from the reasonable worst case site operations. Following the initial assessment of the site noise emissions it was determined that noise emissions from site operations may exceed the project noise limits without further reasonable mitigation and management being investigated and applied across the facility.

The assessment then reviewed and recommended a range of mitigation and management measures to be further considered and implemented across the facility where feasible and reasonable. Following this the assessment demonstrated that the predicted noise emissions from the facility can comply with the requirements of the NPfI at all potentially impacted receivers that surround the Proposal site.

Potential increases in road traffic noise by heavy vehicles generated by the Proposal on public roads has been reviewed. 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 requirements.

The Proposal site is located within the Sydney Airport ANEF 2039 chart 20 to 25 contours. As such, the Proposal has been assessed in accordance with AS2021:2015 and determined as acceptable and so no further assessment was required.

6.2 Construction noise and vibration assessment

An assessment of construction noise impact from the Proposal 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 are currently proposed to take place between early 2022 and mid-2023. 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 the utility and services phases of work, may potentially exceed the NMLs at the nearby surrounding residential, commercial and industrial receivers. 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.

There are a number of potential construction projects nearby to the Proposal that may be taking place concurrently, and so cumulative impacts should be considered during further design development.

Construction related road traffic noise is expected to achieve the requirements of the NSW Road Noise Policy and is not expected to cause any adverse impacts at nearby receivers.

The expected construction noise levels have been predicted and presented in Section 4.5.1. Noise mitigation and management measures have been presented in Section 4.5.6 to aid in providing additional noise reduction benefits where exceedance of the objectives occurs.

A number of vibration intensive construction activities are likely to be required such a piling and possibly use of hydraulic hammers. Due to the close proximity of both data centres and the Sydney trains T8 Airport & South line tunnel further review of potential vibration impacts would be required during further design development phases to ensure that potential vibration impacts are adequately mitigated and managed.

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3. NSW Department of Environment and Climate Change (2009), *Interim Construction Noise Guideline* (ICNG)
4. NSW Environment Protection Authority (2017), *Noise Policy for Industry* (NPfI)
5. NSW Environment Protection Authority (2015*), Draft Industrial Noise Guideline Technical Background Paper*
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7. Standards Australia (2016), *Guide to Noise Control on Construction, Demolition and Maintenance Sites*, AS 2436:2010 (R2016)
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9. UK Department of Transport 1988, *Calculation of Road Traffic Noise* (CORTN)
10. World Health Organisation (2009), *Night Noise Guidelines for Europe*
11. World Health Organisation (2018), *Environmental Noise Guidelines for the European Region: A systematic Review on Environmental Noise and Effects on Sleep*

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 $\mathbf{L_w}$, while **sound pressure level** is represented by **SPL** or $\mathbf{L_p}$, 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 motorway and ventilation 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. Each policy/guideline is discussed in detail in the body of this report:

- Section 3.5 details the NSW Road Noise Policy
- Section 3.4.2 details the Noise Policy for Industry
- Section 3.1 details the EPA's Interim Construction Noise Guideline.

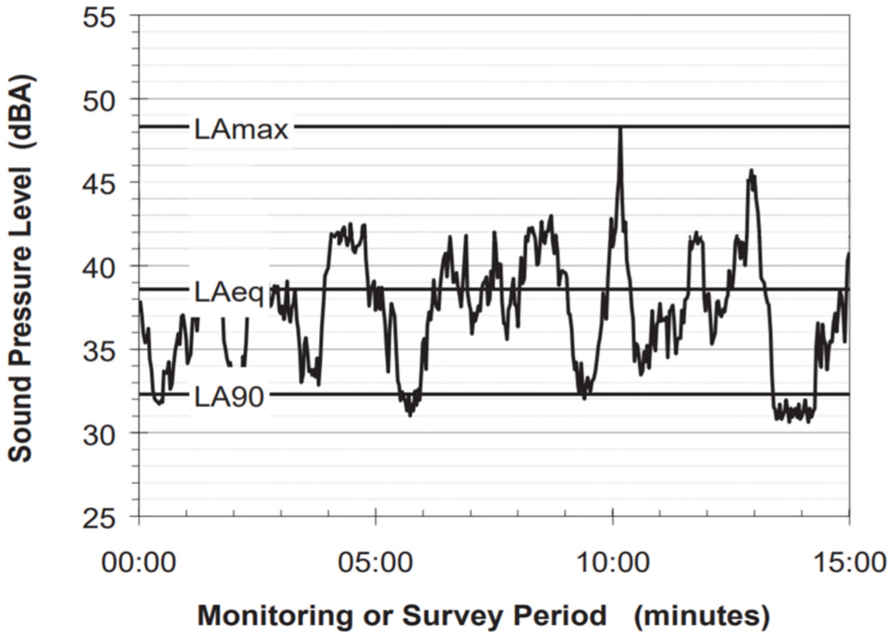
L_{Aeq} - To protect against long-term repeated noise exposure, the indicator for assessing the cumulative noise exposure level over a specific time interval is the equivalent sound pressure level, denoted as L_{Aeq}. The L_{Aeq} indicator accounts for the total energy content from all sources of sound 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.

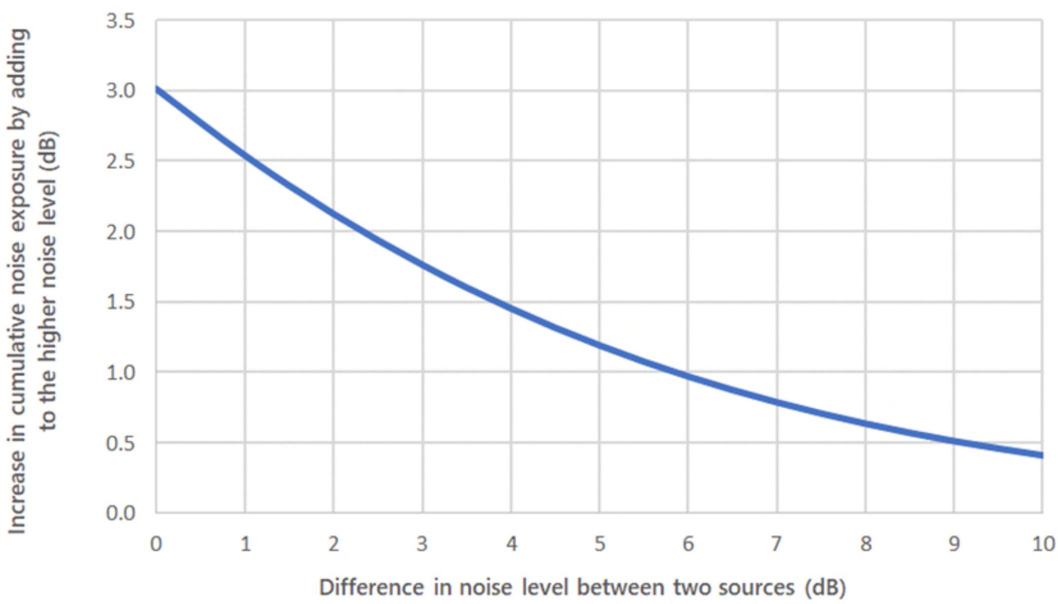
Figure A-1: Environmental noise assessment indicators



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 Existing acoustic environement

B.1 Unattended monitoring

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Acoustics
Vibration
Structural Dynamics

sydney@renzotonin.com.au
www.renzotonin.com.au

Monitoring ID: L1

Address: 671 Gardeners Road, Mascot

Description: Level 4 podium, north façade, overlooking Gardeners Road

Background & Ambient Noise Monitoring Results

	L_{A90} Background Noise Levels				L_{Aeq} Ambient Noise Levels			
	Day[1]	Evening[2]	Night[3]	Shoulder[4,6]	Day[1]	Evening[2]	Night[3]	Shoulder[4]
Representative Week[5]	59	53	47	47	68	65	63	66

Notes:

1. Day: 7.00am to 6.00pm Monday to Saturday and 8.00am to 6.00pm Sundays & Public Holidays
2. Evening: 6.00pm to 10.00pm Monday to Sunday & Public Holidays
3. Night: 10.00pm to 5.00am Monday to Sunday & Public Holidays
4. Shoulder period: 5:00am to 7:00am
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}
6. Shoulder period RBL levels determined as per NPfI Fact Sheet A3

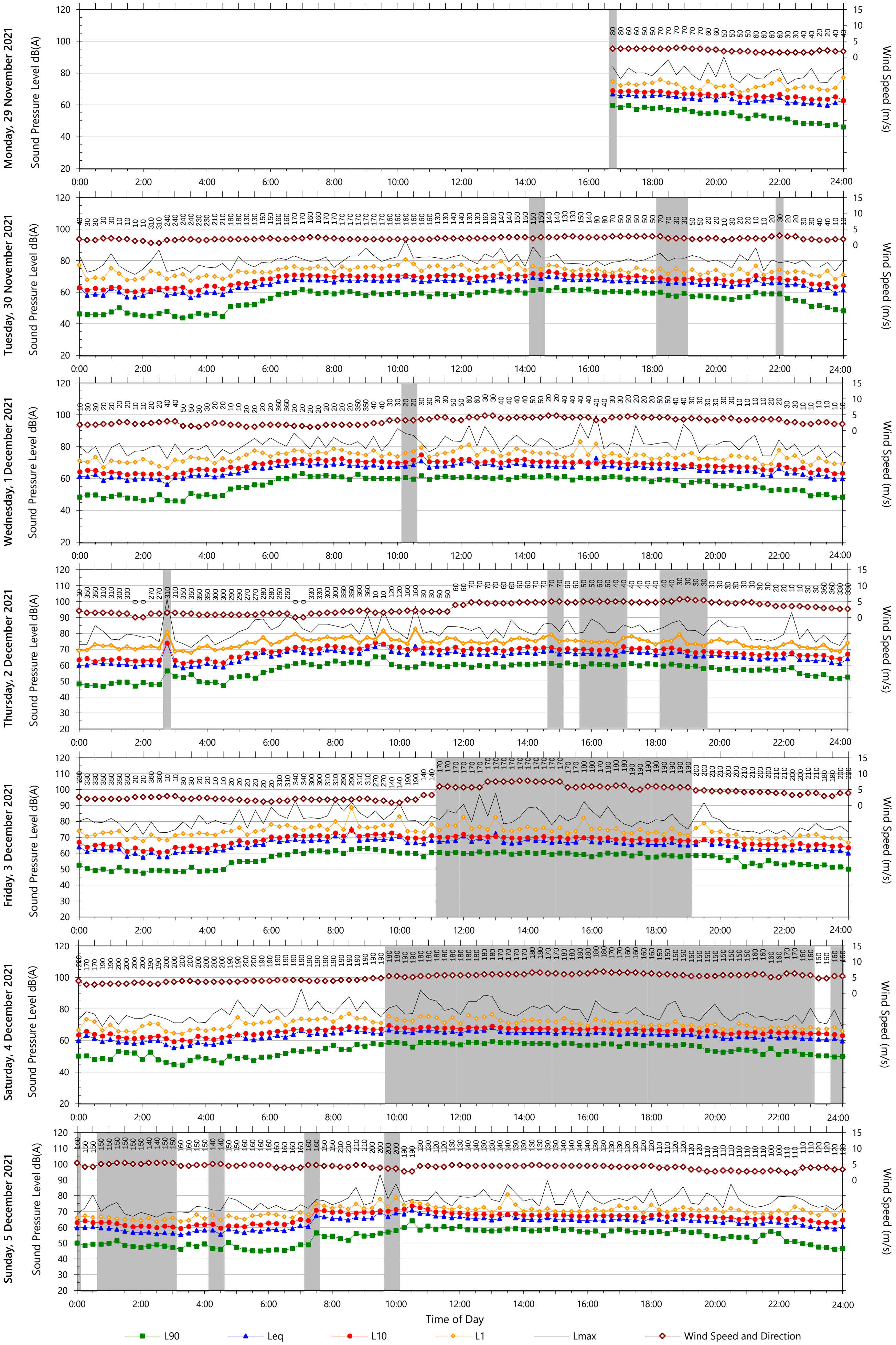
Road Monitoring Results (at one metre from façade[4])

	L_{Aeq} Noise Levels[4]	
	Day[1]	Night[2]
Representative Week[3]	70	65

Notes:

1. Day is 7:00am to 10:00pm
2. Night is 10:00pm to 7:00am
3. Median of daily L_{Aeq}
4. Values are calculated at the facade. 2.5dB is added to results if logger is placed in the free field

Logger location photograph	Logger location map
	



Data File: 2021-11-29_SLM_001_123_Rpt_Report.txt

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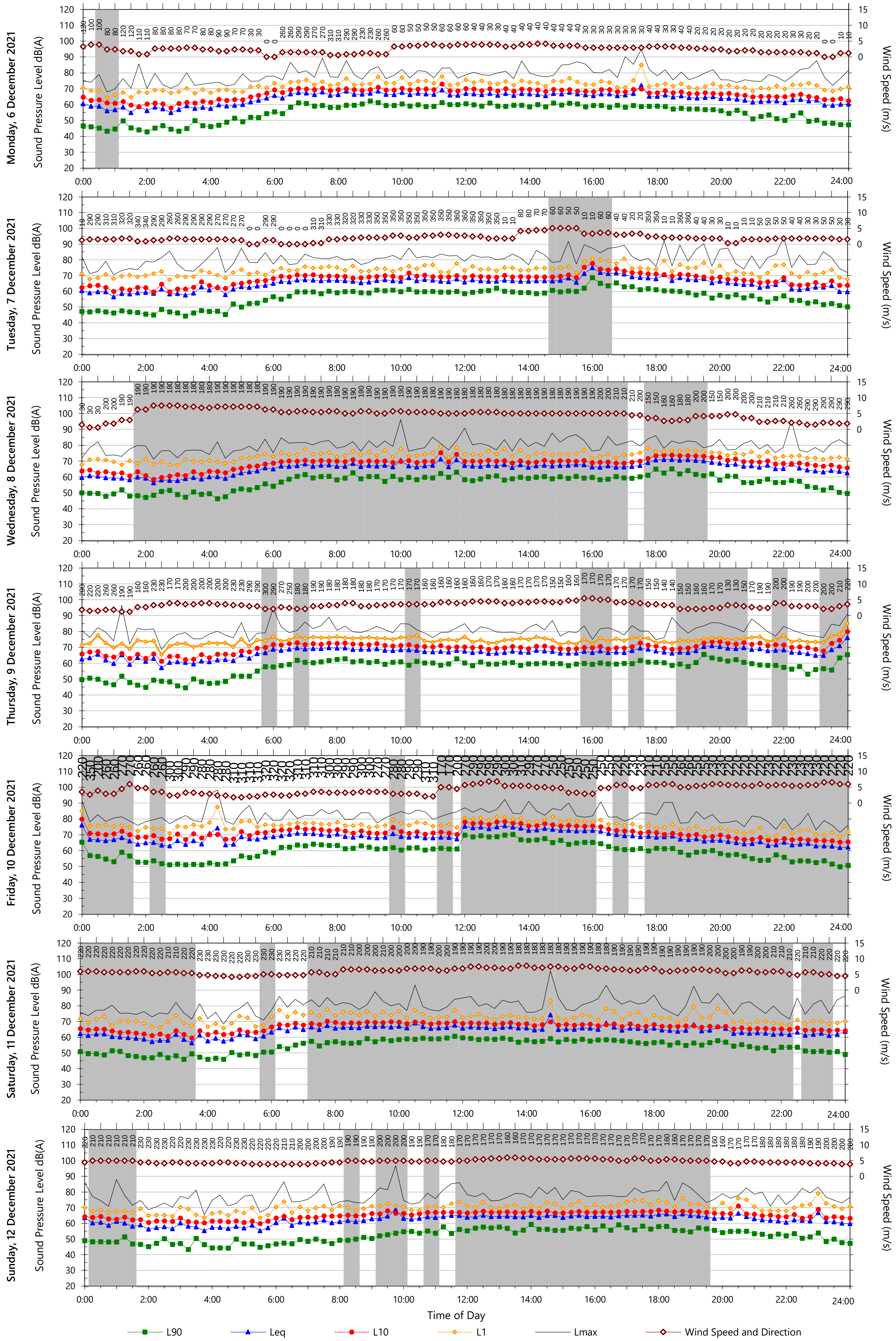
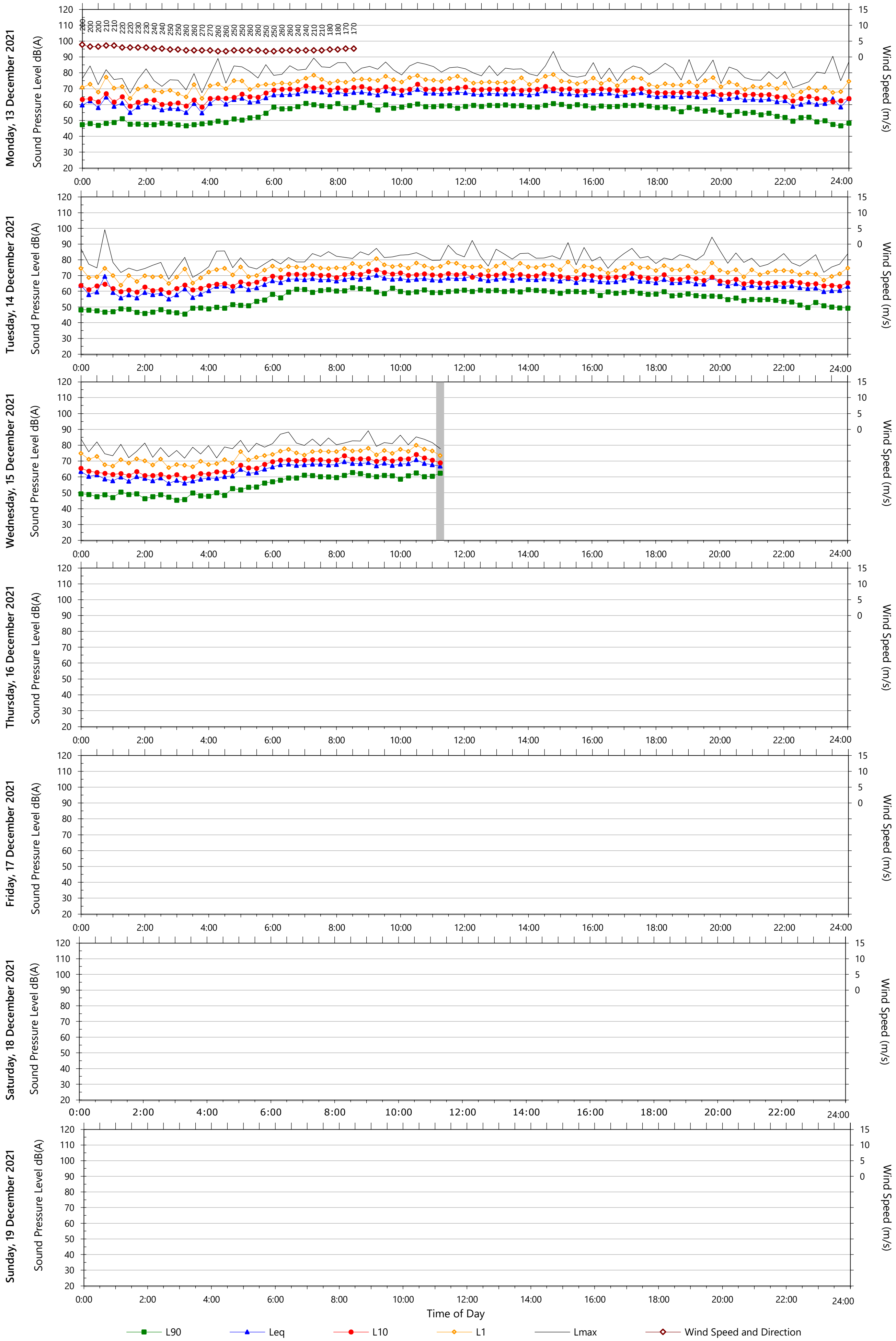


Data File: 2021-11-29_SLM_001_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r38)

Unattended Monitoring Results **Location: Level 4 podium, north façade, overlooking Gardeners Road**



Data File: 2021-11-29_SLM_001_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r38)

Acoustics
Vibration
Structural Dynamics

sydney@renzotonin.com.au
www.renzotonin.com.au

Monitoring ID: L2

Address: Level 12, rooftop terrace, 659 Gardeners Road, Mascot

Description: Level 12, rooftop terrace, northern façade overlooking Gardeners Road

Background & Ambient Noise Monitoring Results

	L_{A90} Background Noise Levels				L_{Aeq} Ambient Noise Levels			
	Day[1]	Evening[2]	Night[3]	Shoulder[4,6]	Day[1]	Evening[2]	Night[3]	Shoulder[4]
Representative Week[5]	56	51	47	49	63	60	56	59

Notes:

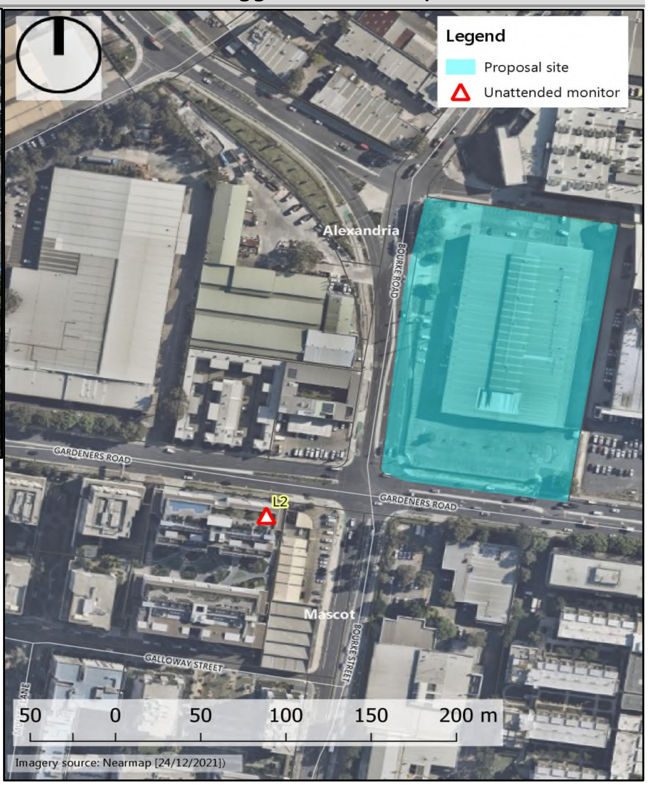
1. Day: 7.00am to 6.00pm Monday to Saturday and 8.00am to 6.00pm Sundays & Public Holidays
2. Evening: 6.00pm to 10.00pm Monday to Sunday & Public Holidays
3. Night: 10.00pm to 5.00am Monday to Sunday & Public Holidays
4. Shoulder period: 5:00am to 7:00am
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}
6. Shoulder period RBL levels determined as per NPfI Fact Sheet A3

Road Monitoring Results (at one metre from façade[4])

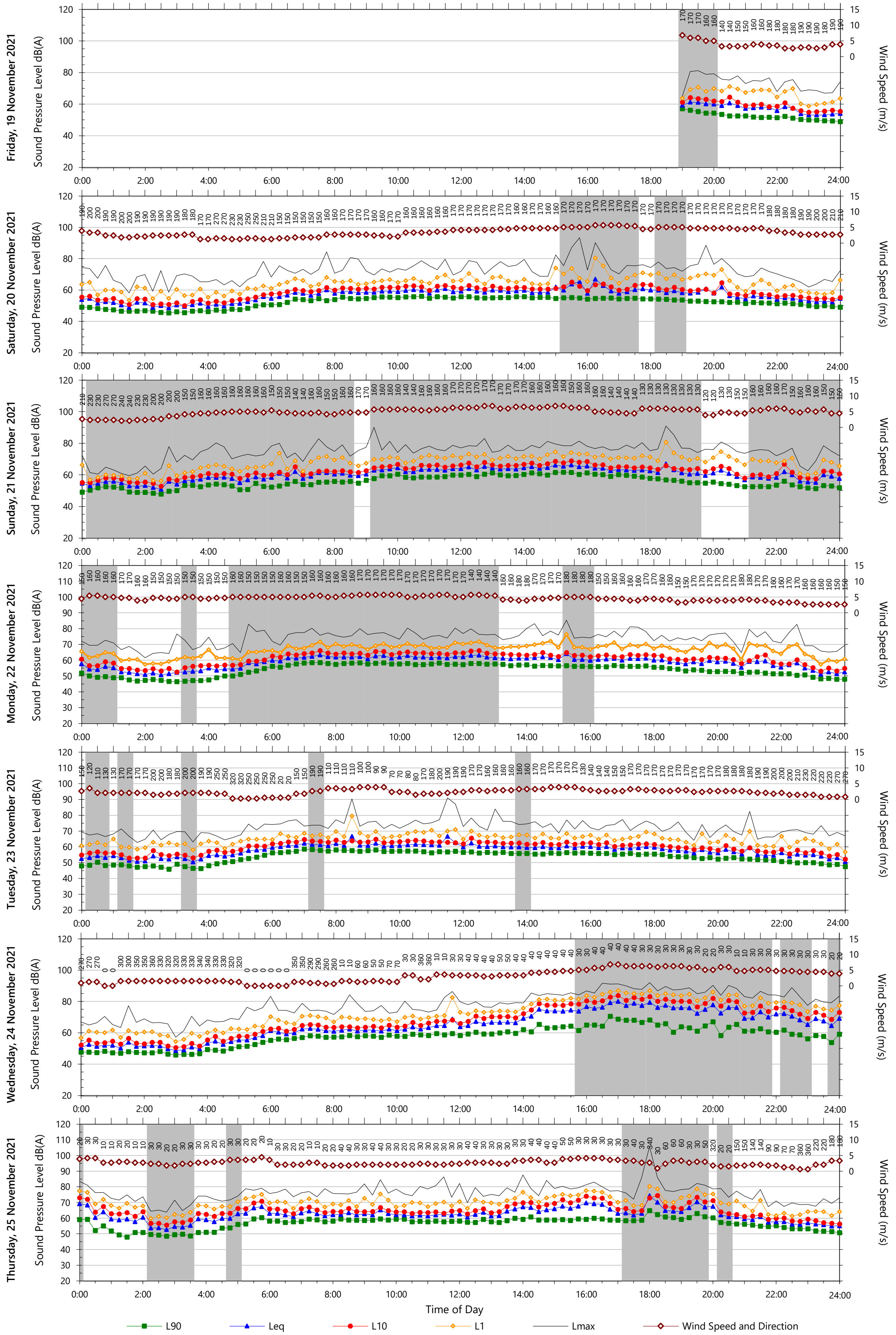
	L_{Aeq} Noise Levels[4]	
	Day[1]	Night[2]
Representative Week[3]	64	58

Notes:

1. Day is 7:00am to 10:00pm
2. Night is 10:00pm to 7:00am
3. Median of daily L_{Aeq}
4. Values are calculated at the facade. 2.5dB is added to results if logger is placed in the free field

Logger location photograph	Logger location map
	

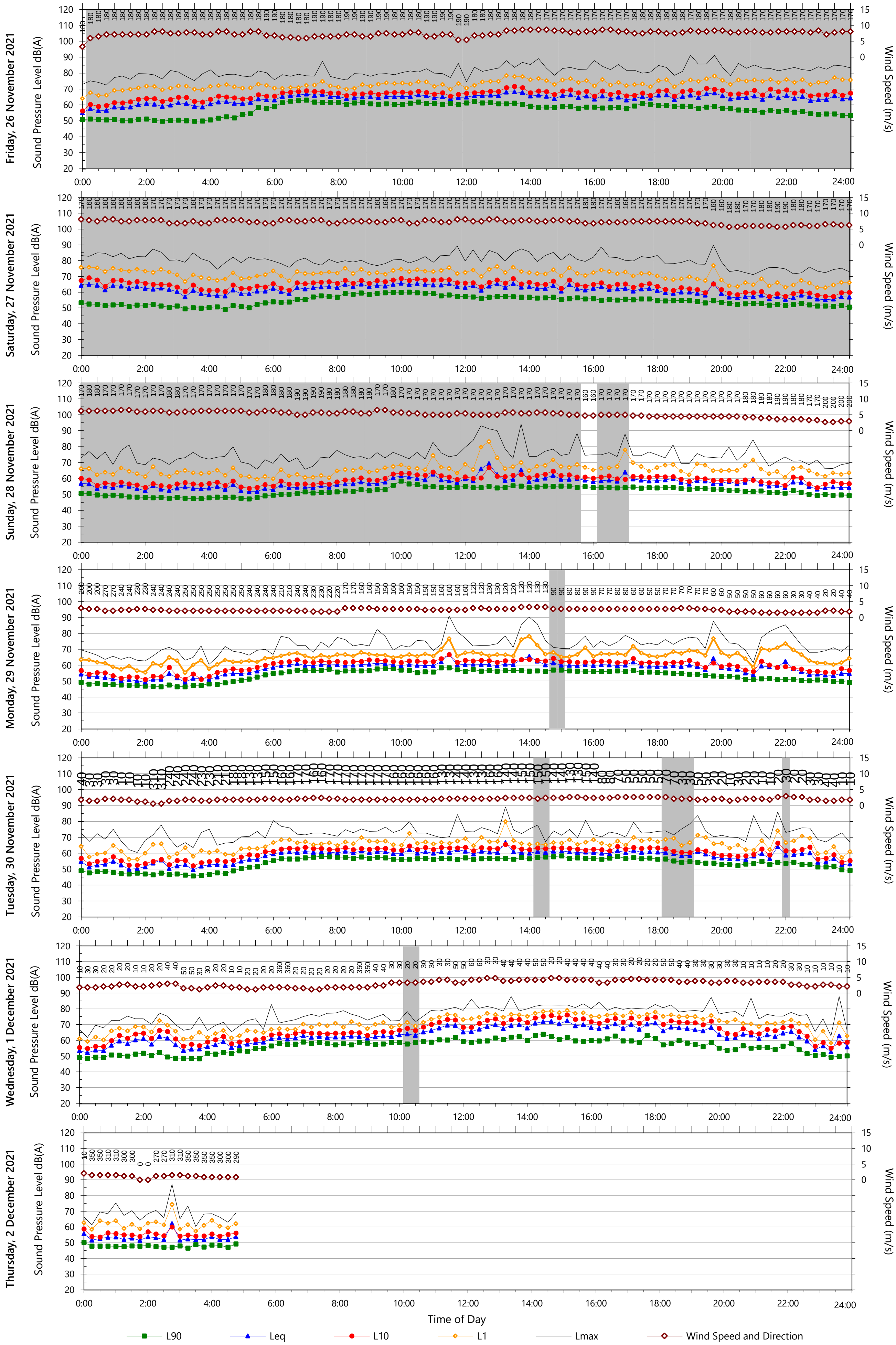
Unattended Monitoring Results **Location: Level 12, rooftop terrace, northern façade overlooking Gardeners Road**



Data File: 2021-11-19_SLM_000_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r38)

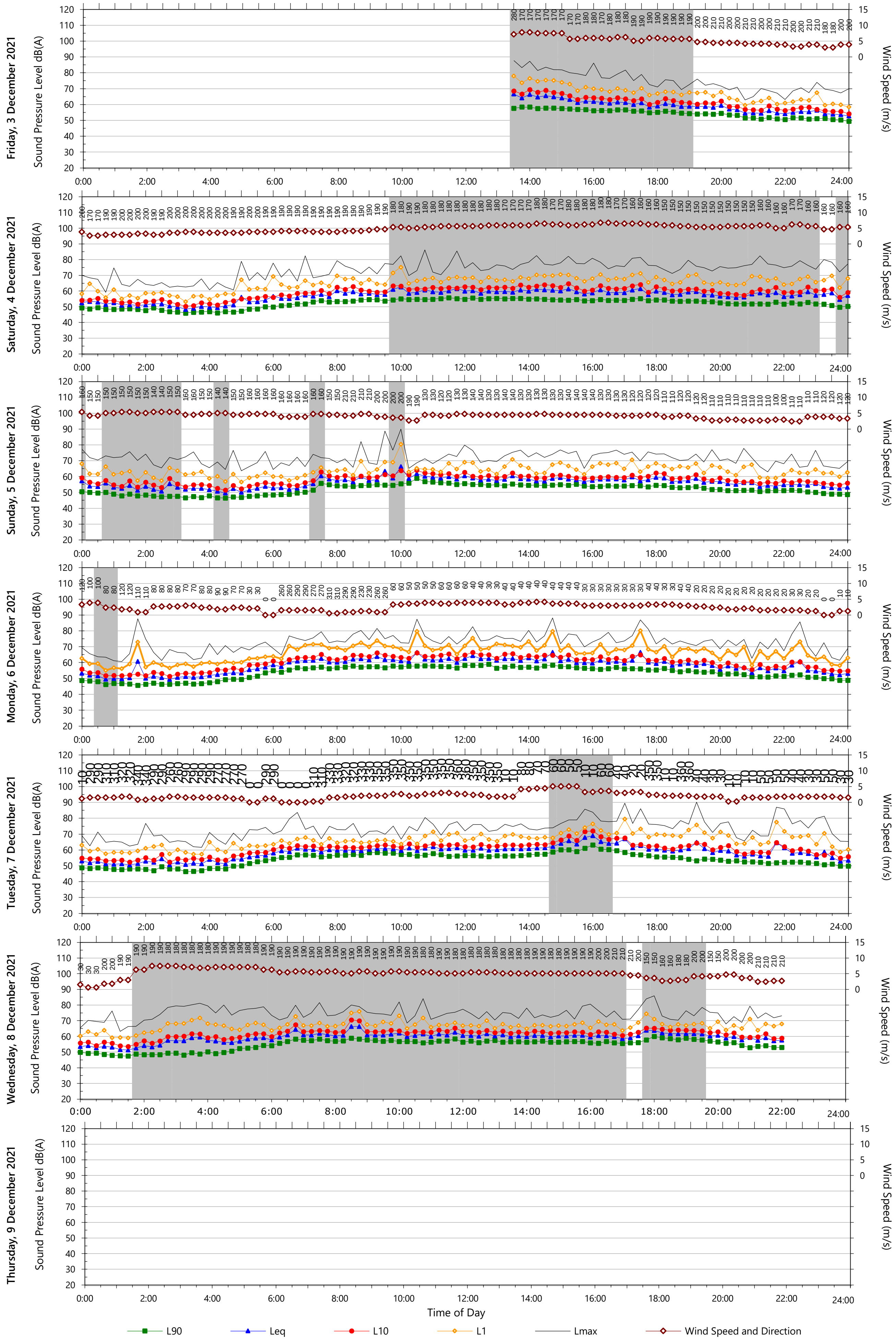
Unattended Monitoring Results **Location: Level 12, rooftop terrace, northern façade overlooking Gardeners Road**



Data File: 2021-11-19_SLM_000_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r38)

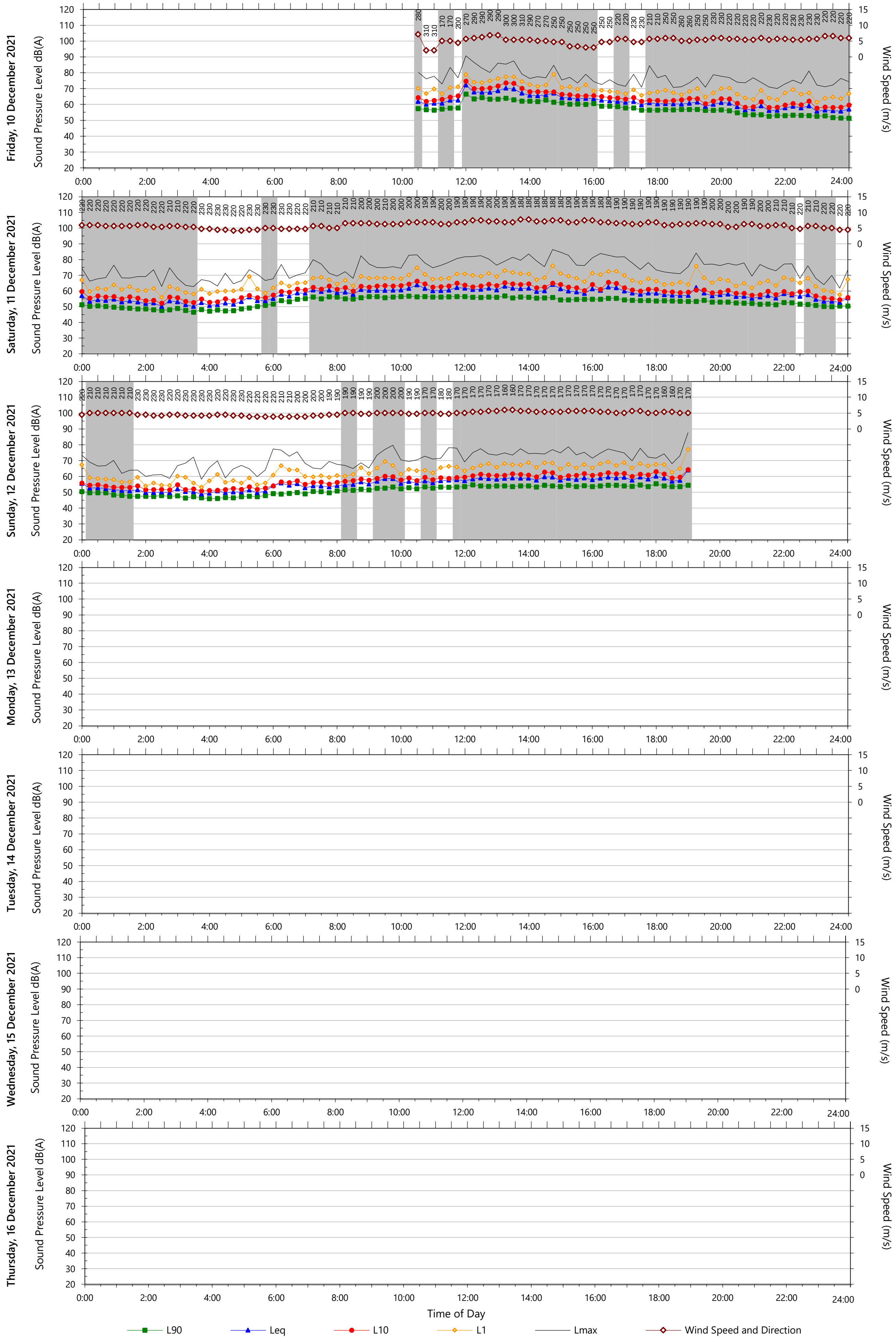
Unattended Monitoring Results **Location: Level 12, rooftop terrace, northern façade overlooking Gardeners Road**



Data File: 2021-11-19_SLM_000_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r38)

Unattended Monitoring Results **Location: Level 12, rooftop terrace, northern façade overlooking Gardeners Road**



Data File: 2021-11-19_SLM_000_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r38)

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Acoustics
Vibration
Structural Dynamics

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Monitoring ID: L3
Address: 659 Gardeners Road, Mascot
Description: Level 2 podium, eastern boundary, overlooking Bourke Road

Background & Ambient Noise Monitoring Results								
	L_{A90} Background Noise Levels				L_{Aeq} Ambient Noise Levels			
	Day[1]	Evening[2]	Night[3]	Shoulder[4,6]	Day[1]	Evening[2]	Night[3]	Shoulder[4]
Representative Week[5]	53	49	42	45	61	59	56	59

Notes:
1. Day: 7.00am to 6.00pm Monday to Saturday and 8.00am to 6.00pm Sundays & Public Holidays
2. Evening: 6.00pm to 10.00pm Monday to Sunday & Public Holidays
3. Night: 10.00pm to 5.00am Monday to Sunday & Public Holidays
4. Shoulder period: 5:00am to 7:00am
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}
6. Shoulder period RBL levels determined as per NPfI Fact Sheet A3

Road Monitoring Results (at one metre from façade[4])		
	L_{Aeq} Noise Levels[4]	
	Day[1]	Night[2]
Representative Week[3]	63	58

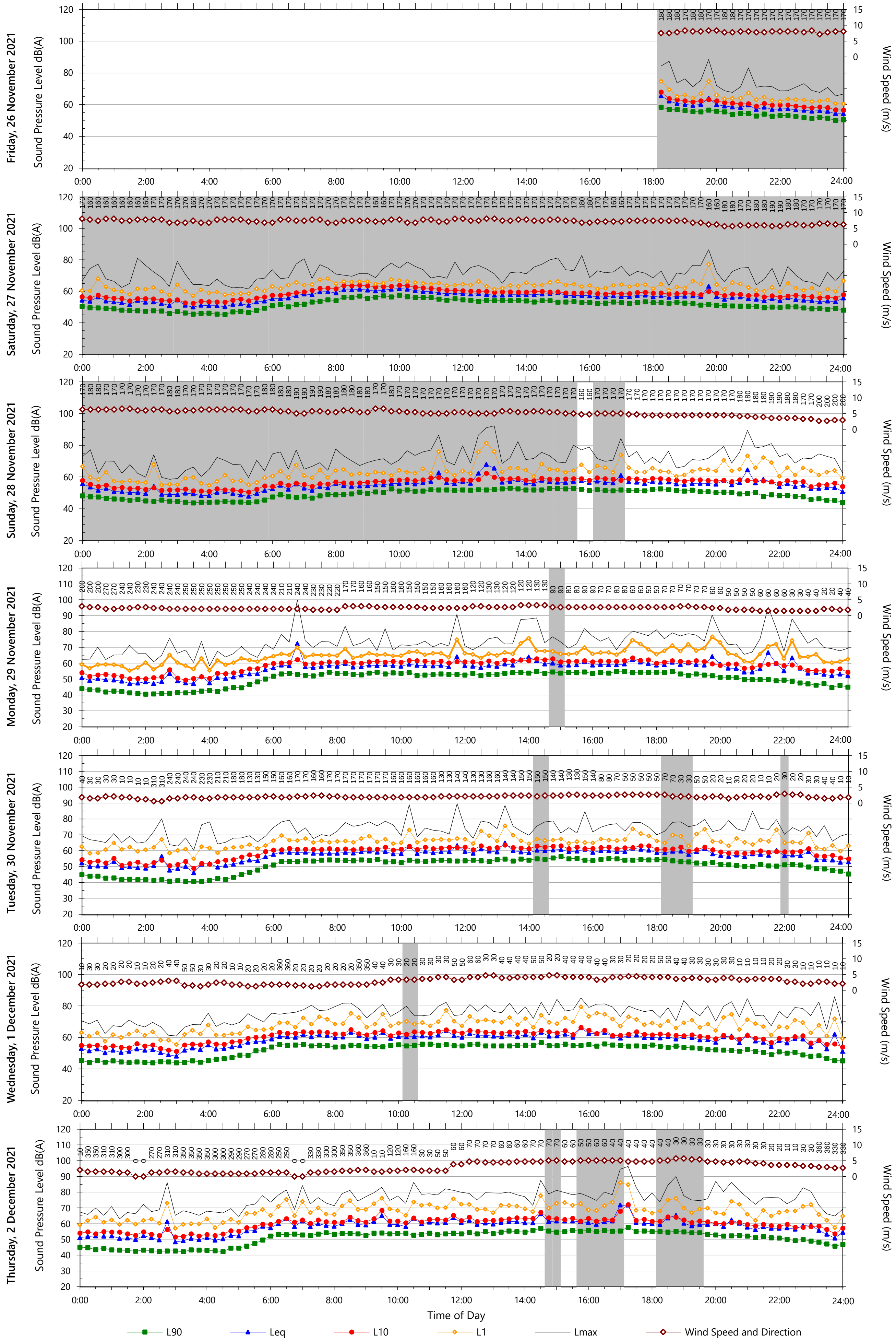
Notes:
1. Day is 7:00am to 10:00pm 2. Night is 10:00pm to 7:00am 3. Median of daily L_{Aeq}
4. Values are calculated at the facade. 2.5dB is added to results if logger is placed in the free field

Logger location photograph

Logger location map

Unattended Monitoring Results

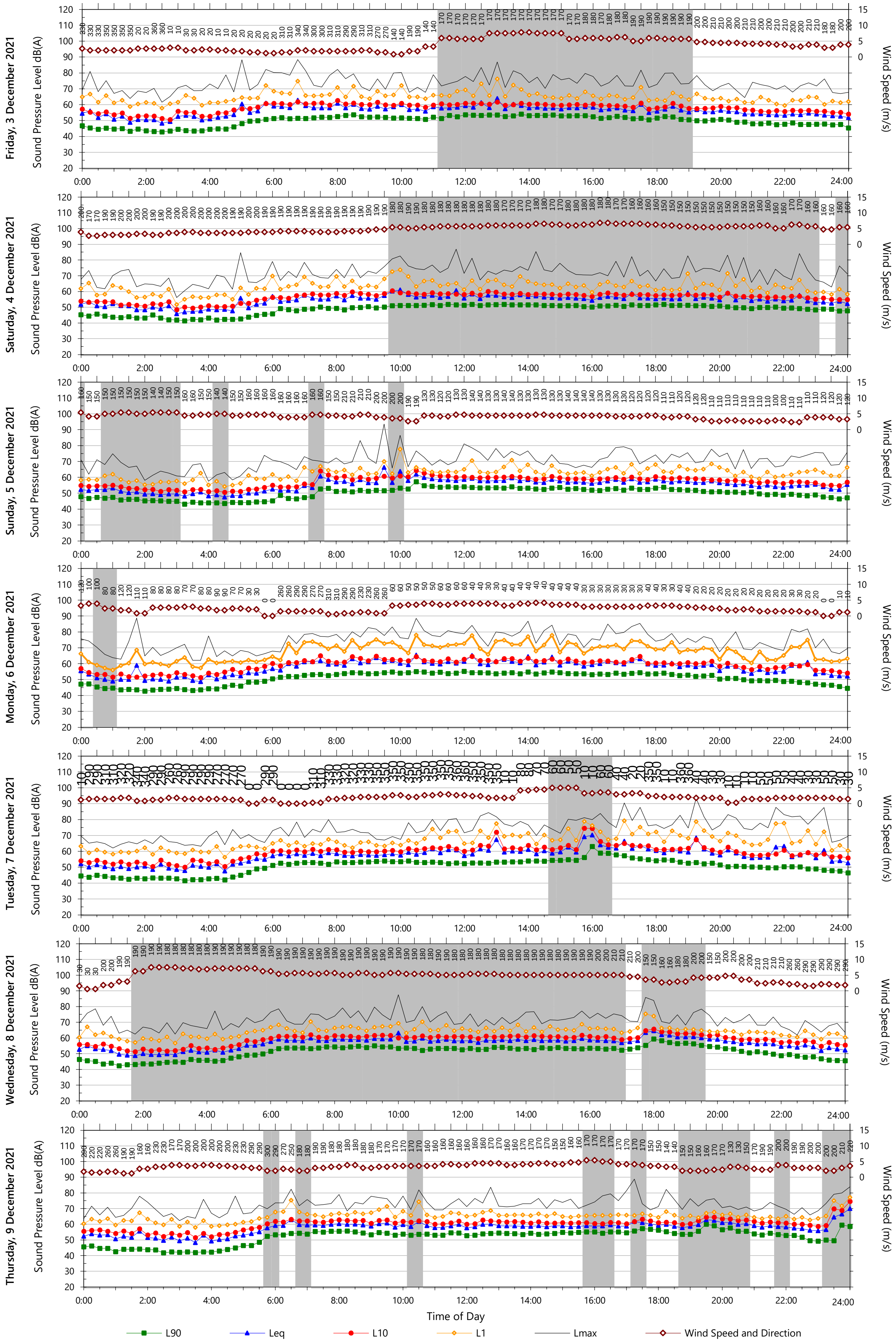
Location: Level 2 podium, eastern boundary, overlooking Bourke Road



Data File: 2021-11-26_SLM_000_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r38)

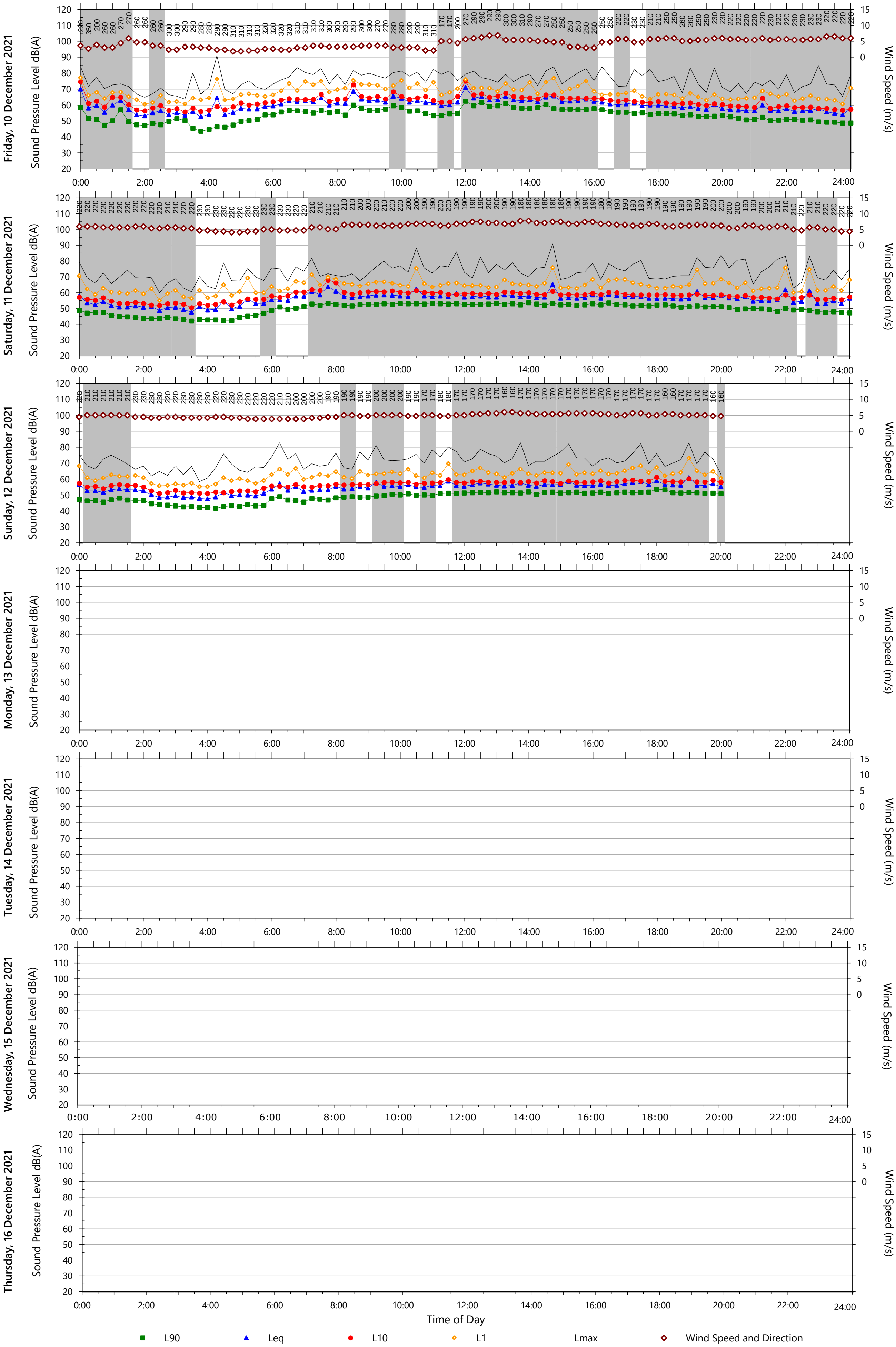
Unattended Monitoring Results | **Location: Level 2 podium, eastern boundary, overlooking Bourke Road**



Data File: 2021-11-26_SLM_000_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r38)

Unattended Monitoring Results Location: Level 2 podium, eastern boundary, overlooking Bourke Road



Data File: 2021-11-26_SLM_000_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r38)

Acoustics
Vibration
Structural Dynamics

sydney@renzotonin.com.au
www.renzotonin.com.au

Monitoring ID: L4
Address: Apartment 47, 635 Gardeners Road, Mascot
Description: Apartment 47, Level 4 balcony, north facade

Background & Ambient Noise Monitoring Results

	L_{A90} Background Noise Levels				L_{Aeq} Ambient Noise Levels			
	Day[1]	Evening[2]	Night[3]	Shoulder[4,6]	Day[1]	Evening[2]	Night[3]	Shoulder[4]
Representative Week[5]	57	53	45	49	66	64	61	65

Notes:
1. Day: 7.00am to 6.00pm Monday to Saturday and 8.00am to 6.00pm Sundays & Public Holidays
2. Evening: 6.00pm to 10.00pm Monday to Sunday & Public Holidays
3. Night: 10.00pm to 5.00am Monday to Sunday & Public Holidays
4. Shoulder period: 5:00am to 7:00am
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}
6. Shoulder period RBL levels determined as per NPfI Fact Sheet A3

Road Monitoring Results (at one metre from façade[4])

	L_{Aeq} Noise Levels[4]	
	Day[1]	Night[2]
Representative Week[3]	68	64

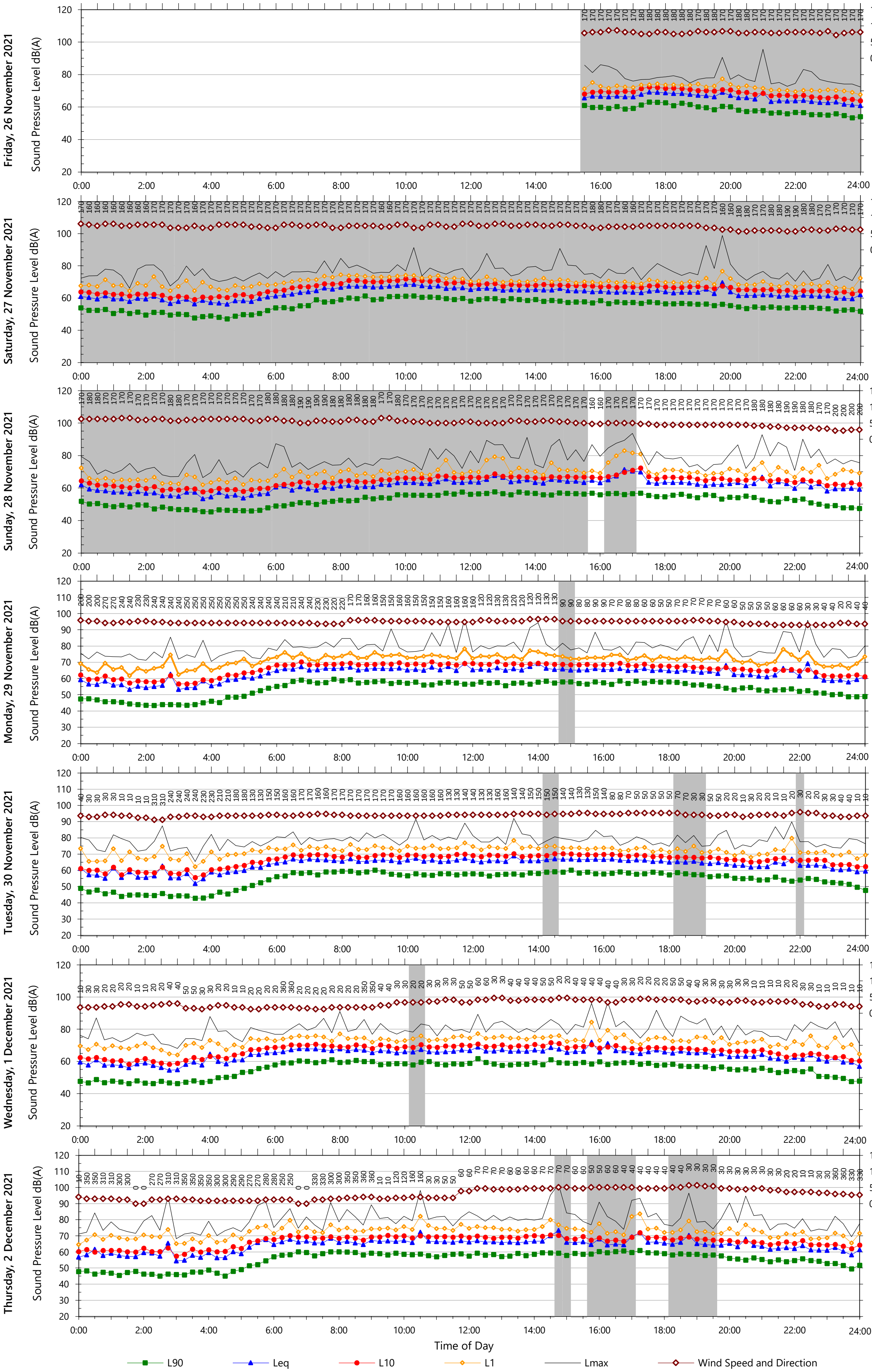
Notes:
1. Day is 7:00am to 10:00pm
2. Night is 10:00pm to 7:00am
3. Median of daily L_{Aeq}
4. Values are calculated at the facade. 2.5dB is added to results if logger is placed in the free field

Logger location photograph

Logger location map

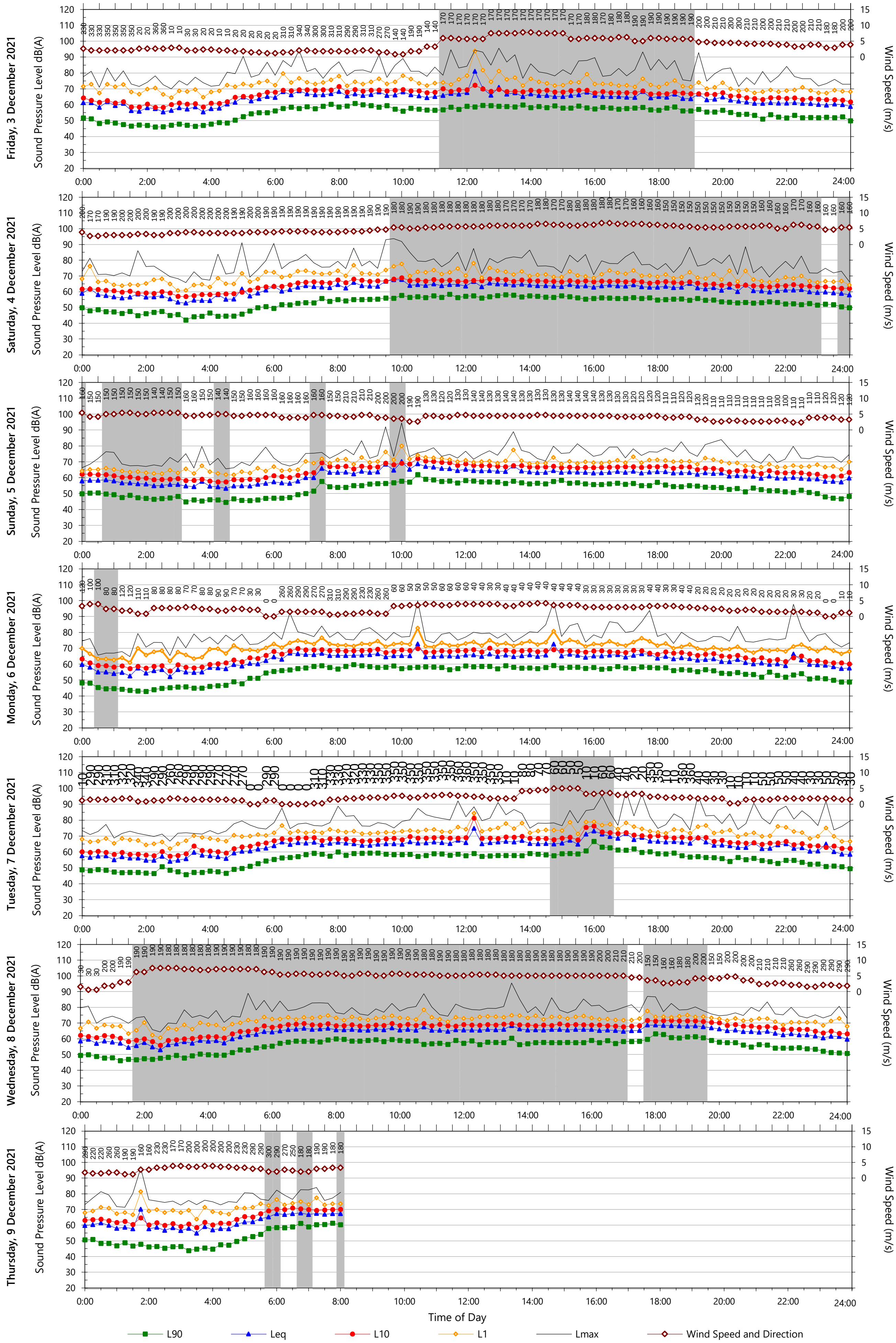
Unattended Monitoring Results

Location: Apartment 47, Level 4 balcony, north facade



Data File: 2021-11-26_SLM_000_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r38)



Data File: 2021-11-26_SLM_000_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r38)

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Monitoring ID: L5
Address: Apartment 22, 635 Gardeners Road, Mascot
Description: Apartment 22 balcony (west facing)

Background & Ambient Noise Monitoring Results

	L_{A90} Background Noise Levels				L_{Aeq} Ambient Noise Levels			
	Day[1]	Evening[2]	Night[3]	Shoulder[4,6]	Day[1]	Evening[2]	Night[3]	Shoulder[4]
Representative Week[5]	55	50	45	48	63	61	58	61

Notes:
1. Day: 7.00am to 6.00pm Monday to Saturday and 8.00am to 6.00pm Sundays & Public Holidays
2. Evening: 6.00pm to 10.00pm Monday to Sunday & Public Holidays
3. Night: 10.00pm to 5.00am Monday to Sunday & Public Holidays
4. Shoulder period: 5:00am to 7:00am
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}
6. Shoulder period RBL levels determined as per NPfI Fact Sheet A3

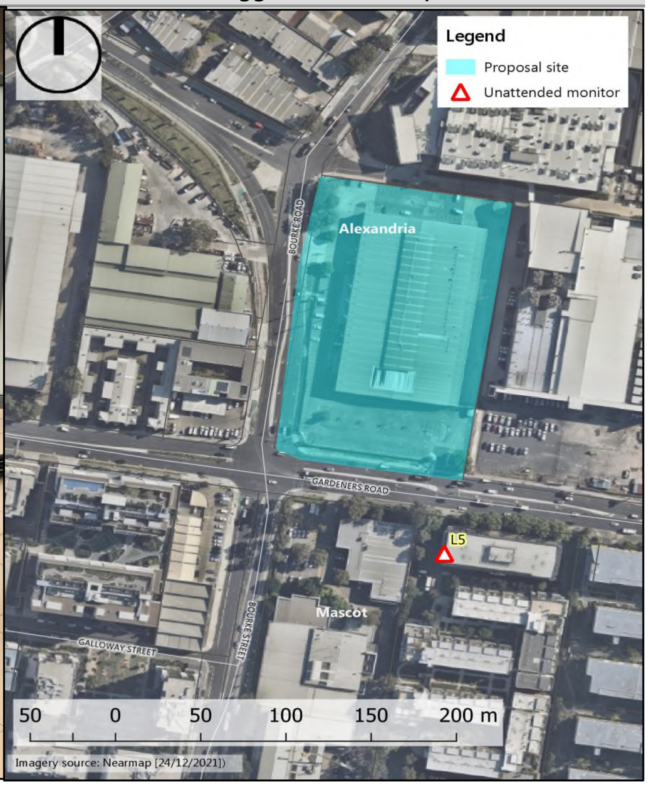
Road Monitoring Results (at one metre from façade[4])

	L_{Aeq} Noise Levels[4]	
	Day[1]	Night[2]
Representative Week[3]	66	60

Notes:
1. Day is 7:00am to 10:00pm 2. Night is 10:00pm to 7:00am 3. Median of daily L_{Aeq}
4. Values are calculated at the facade. 2.5dB is added to results if logger is placed in the free field

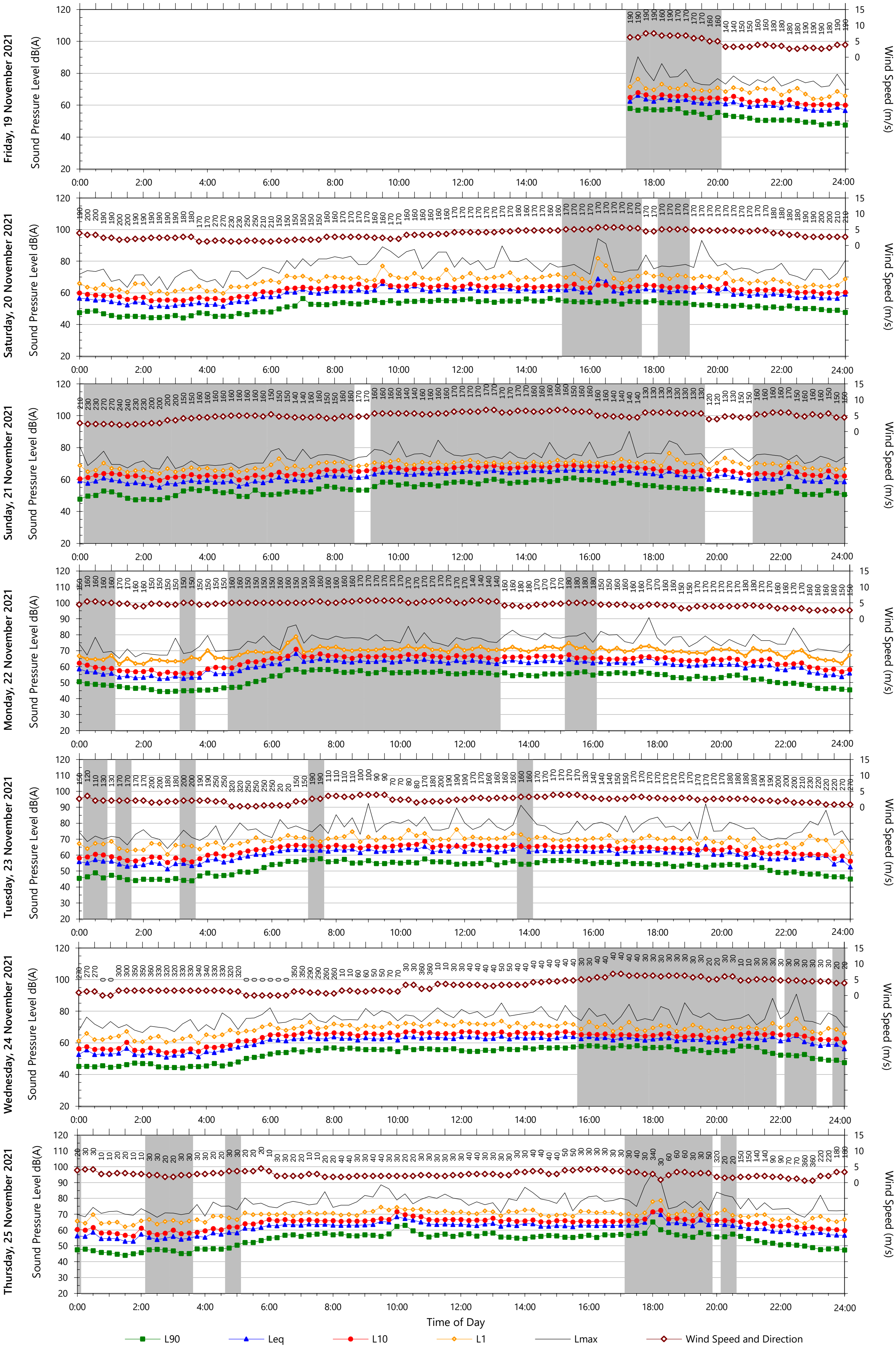
Logger location photograph

Logger location map



Unattended Monitoring Results

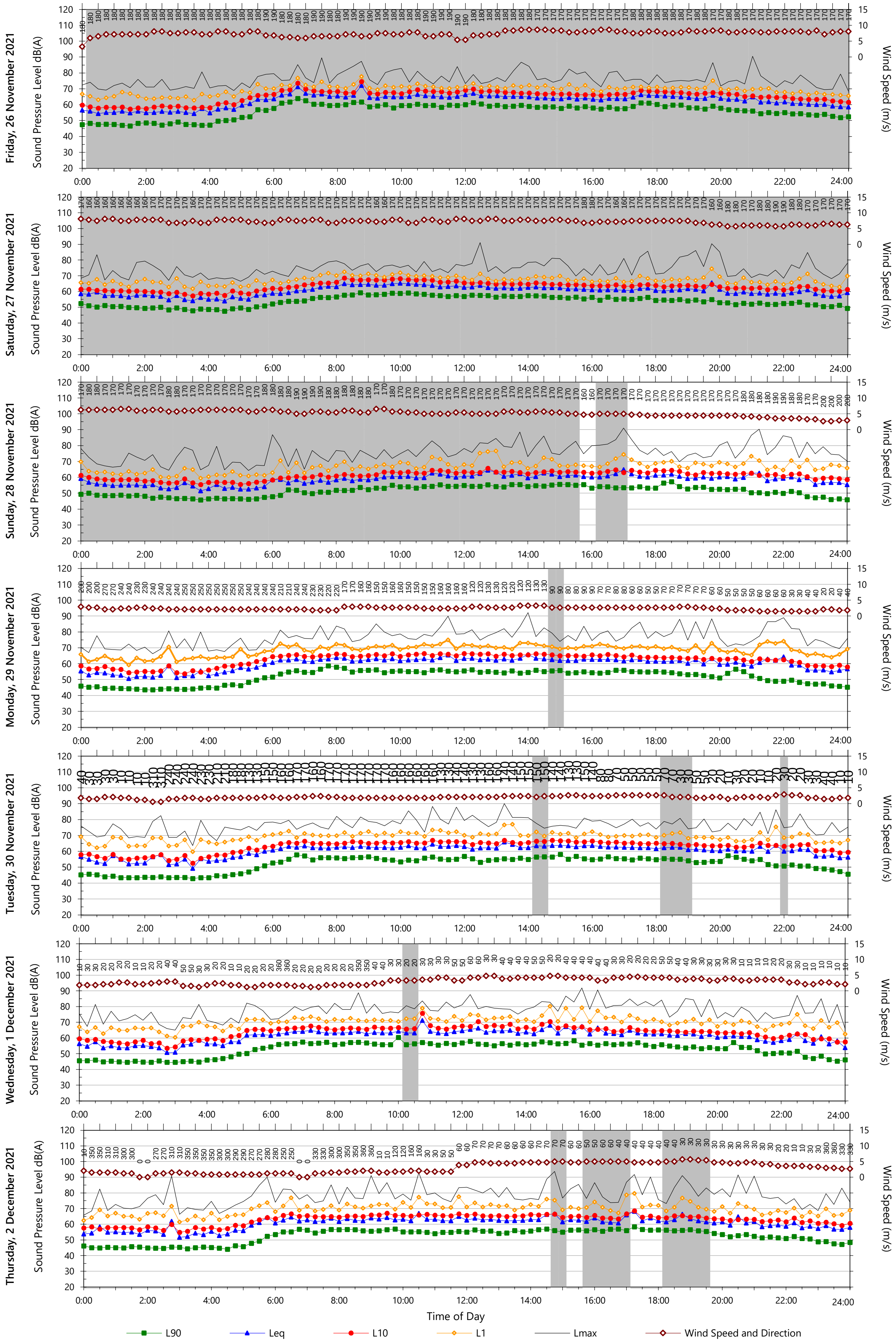
Location: Apartment 22 balcony (west facing)



Data File: 2021-11-19_SLM_002_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r38)

Unattended Monitoring Results **Location: Apartment 22 balcony (west facing)**

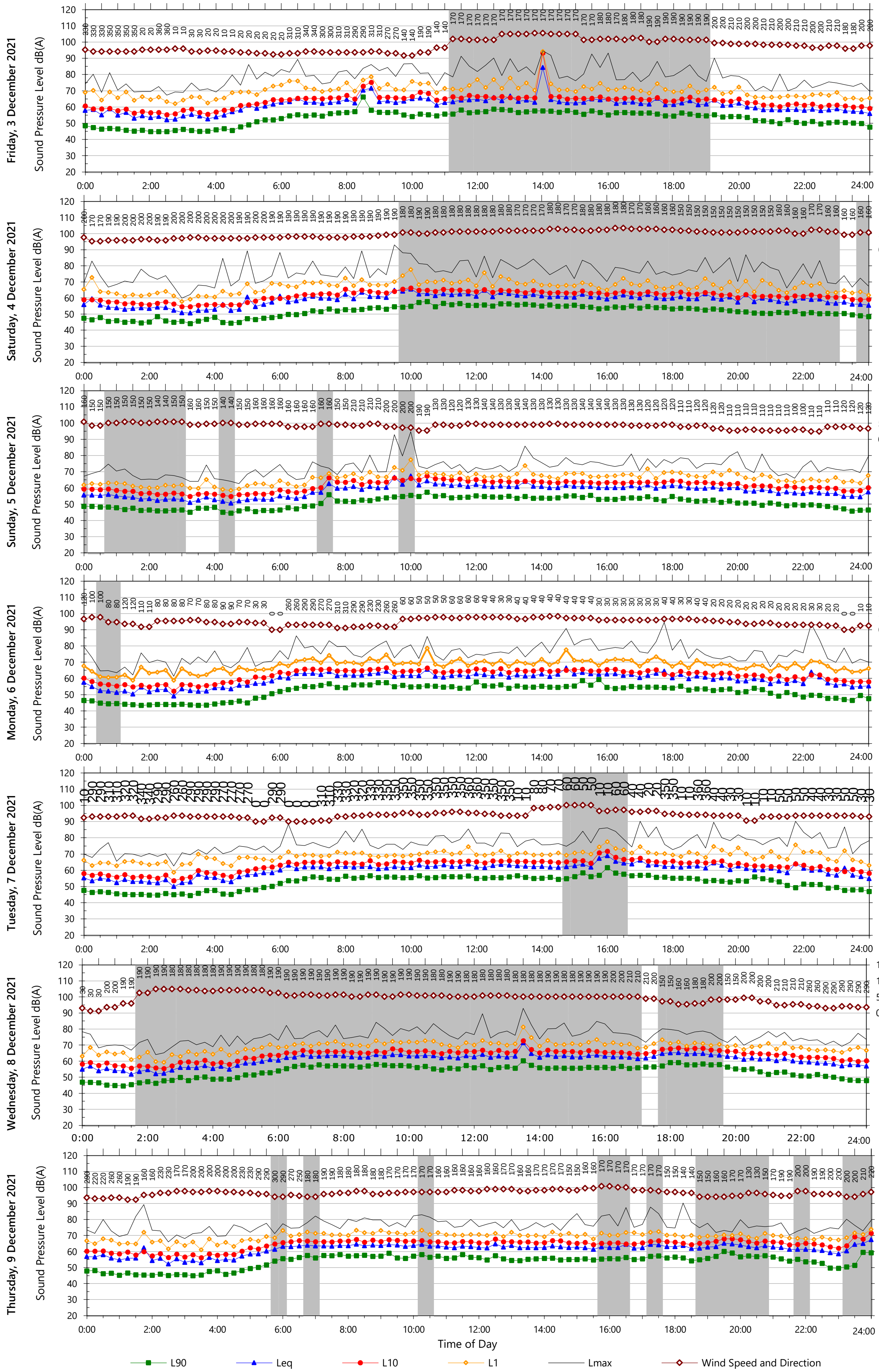


Data File: 2021-11-19_SLM_002_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r38)

Unattended Monitoring Results

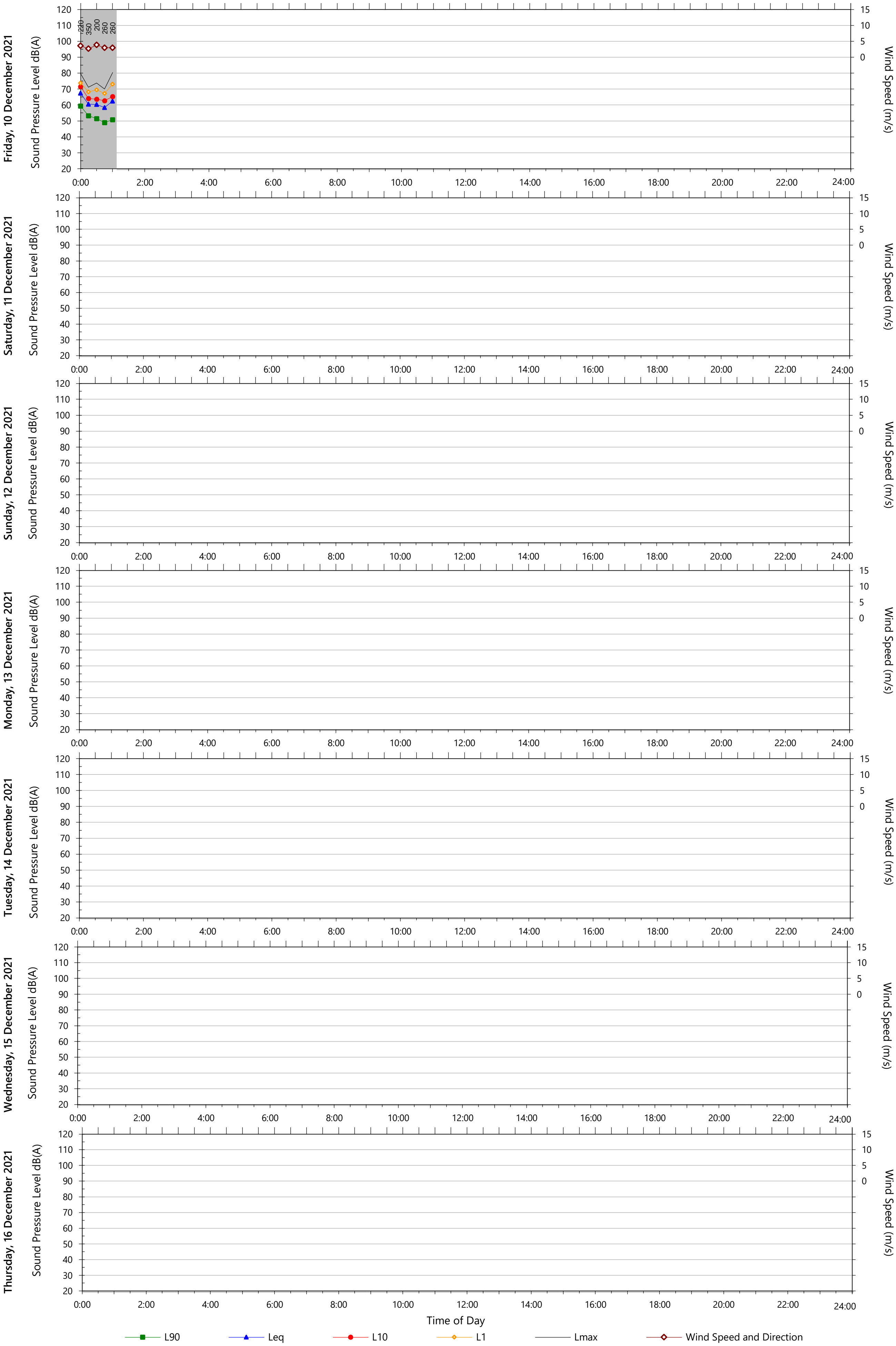
Location: Apartment 22 balcony (west facing)



Data File: 2021-11-19_SLM_002_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r38)

Unattended Monitoring Results **Location: Apartment 22 balcony (west facing)**



Data File: 2021-11-19_SLM_002_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r38)

B.2 Attended monitoring

Table 6-1: Receiver short-term attended noise monitoring results (monitoring locations shown in Figure 4.)

	Location / Time	Measured noise level, dB(A)						Comments on measured noise levels
		L_{Amax}	L_{A1}	L_{A10}	L_{Aeq}	L_{A90}	L_{Amin}	
M1	635 Gardeners Road (Ground level under Apartment 22) 1:27am – 1:42am 14 December 2021[2]	67	63	54	51	40[2]	39	The background L_{A90} was controlled by natural noise sources (i.e. insects) and just audible mechanical plant hum at 250-20 deg from 637 Gardeners Road ~ 40-41 dB(A). The ambient L_{Aeq} noise level was contributed to by road traffic on Gardeners Road, natural noise sources (i.e. insects) and distant traffic movements at the intersection of Gardeners Road and Bourke Road (~50 dB(A)). Road traffic noise – intermittent traffic on Gardeners Road was the main source with a mix of light and heavy vehicles (~56 dB(A)). High noise events were from loud vehicle passbys along Gardeners Road.
M2	635 Gardeners Road (in line with facade facing Gardeners Road) 1:48am – 2:03am 14 December 2021[2]	85	70	60	59	41[2]	39	The background L_{A90} was controlled by natural noise sources (i.e. insects) and barely audible mechanical plant hum at 232 deg from 637 Gardeners Road ~ 40-41 dB(A). The ambient L_{Aeq} noise level was contributed to by road traffic on Gardeners Road, natural noise sources (i.e. insects) and distant traffic movements (including truck engine noise and compression brake squeal) at the intersection of Gardeners Road and Bourke Road (~ 67 dB(A)). Road traffic noise – intermittent traffic on Gardeners Road was the main source with a mix of light and heavy vehicles. High noise events were from loud vehicle passbys along Gardeners Road.
M3	Level 2, 659 Gardeners Road (In garden bed) 3:11am – 3:30am 14 December 2021	62	58	51	47	41	39	The background L_{A90} was controlled by natural noise sources (i.e. insects) and barely audible mechanical plant hum at 129 deg from 637 Gardeners Road ~ 40 dB(A). The ambient L_{Aeq} noise level was contributed to by road traffic on Gardeners Road and Bourke Road, natural noise sources (i.e. insects) and distant traffic movements along Bourke Road (~55 dB(A)). Road traffic noise – intermittent traffic on Gardeners Road and Bourke Road was the main source with a mix of light and heavy vehicles. During lulls in traffic and when the traffic lights at Bourke Road were red, vehicle idle noise was up to 54 dB(A) at 113 deg. High noise events were from loud vehicle passbys along Gardeners Road.
M4	671 Gardeners Road (footpath) 4:47am – 5:02am 14 December 2021	92	77	69	67	53	51	The background L_{A90} was controlled by mechanical plant servicing ground level commercial premises from 673 Gardeners Road ~ 53 dB(A). The ambient L_{Aeq} noise level was contributed to by road traffic on Gardeners Road and vehicle activity within the Gardeners Distribution Centre (~ 72 dB(A)). Road traffic noise – intermittent traffic on Gardeners Road and vehicles exiting the distribution centre was the main noise source with a mix of light and heavy vehicles. High noise events were from loud vehicle passbys along Gardeners Road.
M5	Level 12, 659 Gardeners Road 2:45am – 3:00am 14 December 2021	*Measurement saving issue, however observations were made of the noise environment*						The background L_{A90} was controlled by natural noise sources (i.e. wind gusts), distant road traffic noise from Gardeners Road and Campbell Road and Industrial activity from Gardeners Distribution Centre at 312 deg from 546-548 Gardeners Road ~ 49 dB(A). The ambient L_{Aeq} noise level was contributed to by road traffic on Gardeners Road and distant traffic movements from Campbell Road to the intersection of Gardeners Road and Bourke Road (~ 56 dB(A)). Vehicle activity from the distribution centre contributed to the ambient noise levels. Road traffic noise – intermittent traffic on Gardeners Road and the intersection of Gardeners Road and Bourke Road was the main source with a mix of light and heavy vehicles. High noise events were from loud vehicle passbys along Gardeners Road.

	Location / Time	Measured noise level, dB(A)						Comments on measured noise levels
		L_{Amax}	L_{A1}	L_{A10}	L_{Aeq}	L_{A90}	L_{Amin}	
M6	Level 4, 671 Gardeners Road (overlooking Gardeners Road) 4:10am – 4:25am 14 December 2021	80	70	61	59	47	44	The background L_{A90} was controlled by road traffic noise from Gardeners Road, natural noise sources (i.e. insects) and Industrial activity from Gardeners Distribution Centre at 335 deg from 546-548 Gardeners Road ~ 47 dB(A). The ambient L_{Aeq} noise level was contributed to by road traffic on Gardeners Road at 12 deg ~ 67 dB(A)). Industrial activity such as alarms as well as vehicle activity and reversing alarms from vehicles within the distribution centre contributed to the ambient noise levels (~ 70 dB(A)). Road traffic noise – intermittent traffic on Gardeners Road and heavy vehicles leaving the distribution centre were the main sources with a mix of light and heavy vehicles. High noise events were from loud vehicle passbys along Gardeners Road.
M7	659 Gardeners Road (footpath) 5:08am – 5:23am 14 December 2021	84	78	71	66	50	45	The background L_{A90} was controlled by road traffic noise from Gardeners Road and Bourke Road and Industrial activity from Gardeners Distribution Centre from 546-548 Gardeners Road ~ 47 dB(A). The ambient L_{Aeq} noise level was contributed to by road traffic on Gardeners Road and the intersection with Bourke Road including heavy vehicle braking and engine noise (~ 76 dB(A)). Road traffic noise – intermittent traffic on Gardeners Road and heavy vehicles leaving the distribution centre were the main sources with a mix of light and heavy vehicles. Heavy vehicles slowing at the Gardeners Road intersection were up to 68 dB(A). High noise events were from loud vehicle passbys along Gardeners Road.

Notes:
1. All bearings are with reference to magnetic north
2. All residential receivers are elevated above ground level, with residence from Level 1 upwards. Ground floor is commercial receivers only. Access to upper levels was not possible during the night period measurements.

APPENDIX C Noise source assumptions

Points sources/stationary source levels used for the project are as follows:

Table 6-2: Noise sources - Point source levels/ stationary sources

Noise generating operation/activity	Plant/ equipment item	Individual source/ activity $L_{Aeq,t}$				Individual source/ activity $L_{Amax,t}$	
		Sound power $L_{Aeq,t}$[1], dB(A)	Duration[2]	Sound power $L_{Aeq,15\ min}$, dB(A)	Modelled source height, metres	Sound power $L_{Amax,t}$,[1] dB(A)	Modelled source height(above local ground), metres
Loading dock and hardstand activities (see Section 5.2.1.3)							
Delivery truck (idling)	B-Double (all trucks assumed at this level)	97	15 min	97	2	100	2
Airbrake full release (when parking)	B-Double (all trucks assumed at this level)	116	3 sec	90	1	122	1
Airbrake working release (general driving)	B-Double (all trucks assumed at this level)	111	1 sec	81	1	111	1
Office and carparking activities							
Typical warehouse/office condenser unit operation	Condenser unit	89	15 min	89	1.5[3]	89	1.5[3]
Carparking activities	Car engine starts	92	1 sec	63	1	97	1
Carparking activities	Car door slams	86	1 sec	56	1	96	1
Building services and mechanical plant							
Hardstand jet fans	Fitted with 2x diameter long attenuator	78	15 min	78	Hardstand soffit	78	Hardstand soffit
Warehouse exhaust fans	Fitted with 2x diameter long attenuator	74	15 min	74	Hardstand soffit	74	Hardstand soffit

Notes:
1. Sound power level L_w re. 1pW, dB(A)
2. Duration of this level within 15-minutes (minutes)
3. Relative to mountain location (ie. roof level)

Line sources / moving sources used for the project are as follows:

Table 6-3: Noise sources - Line sources / moving sources

Noise generating operation/activity	Plant/equipment item	Individual source/ activity $L_{Aeq,t}$			Individual source / activity $L_{Amax,t}$	
		Sound power, dB(A)	Modelled source height, metres	Speed (km/h)[2]	Sound power $L_{Amax,t}$, dB(A)	Modelled source height (above local ground), metres
Vehicle movements	**(see Section 5.2.1.2)**					
Moving onsite (flat)	B-Double (all trucks assumed at this level)	107	2	10	111[4]	2
Pass-by (moving up ramp ~ 5km/h))	B-Double (all trucks assumed at this level)	108	2	5	111[4]	2
Pass-by (moving down ramp ~ 10km/h))	B-Double (all trucks assumed at this level)	107	2	10	111[4]	2
Reversing operations (including tonal reversing beeper)	B-Double (all trucks assumed at this level)	108	2	2	113[3]	2
Accelerating from stationary (ie. dock)	B-Double (all trucks assumed at this level)	110	2	Up to 10	112	2
Moving onsite (flat)	Service van	93	2	10	96	2
Pass-by (moving up ramp ~ 10km/h))	Service van	96	2	10	98	2
Pass-by (moving down ramp ~ 10km/h))	Service van	93	2	10	96	2
Moving in carpark, internal roads (flat)	Car	79	1	10	90	1
Moving up/down ramps	Car	83	1	10	90	1

Notes:
1. Sound power level L_w re. 1pW, dB(A)
2. Continuous = Where a source will operate continuously along a line throughout a 15-minute period over a defined line, which will be covered in a 15-minute period, use the word 'continuous', to represent the energy is distributed along that line.
3. This captures noise events during sudden stopping as part of reversing operation
4. During non-steady movement events

Area source sources / distributed sources / internal noise level sources used for the project are as follows:

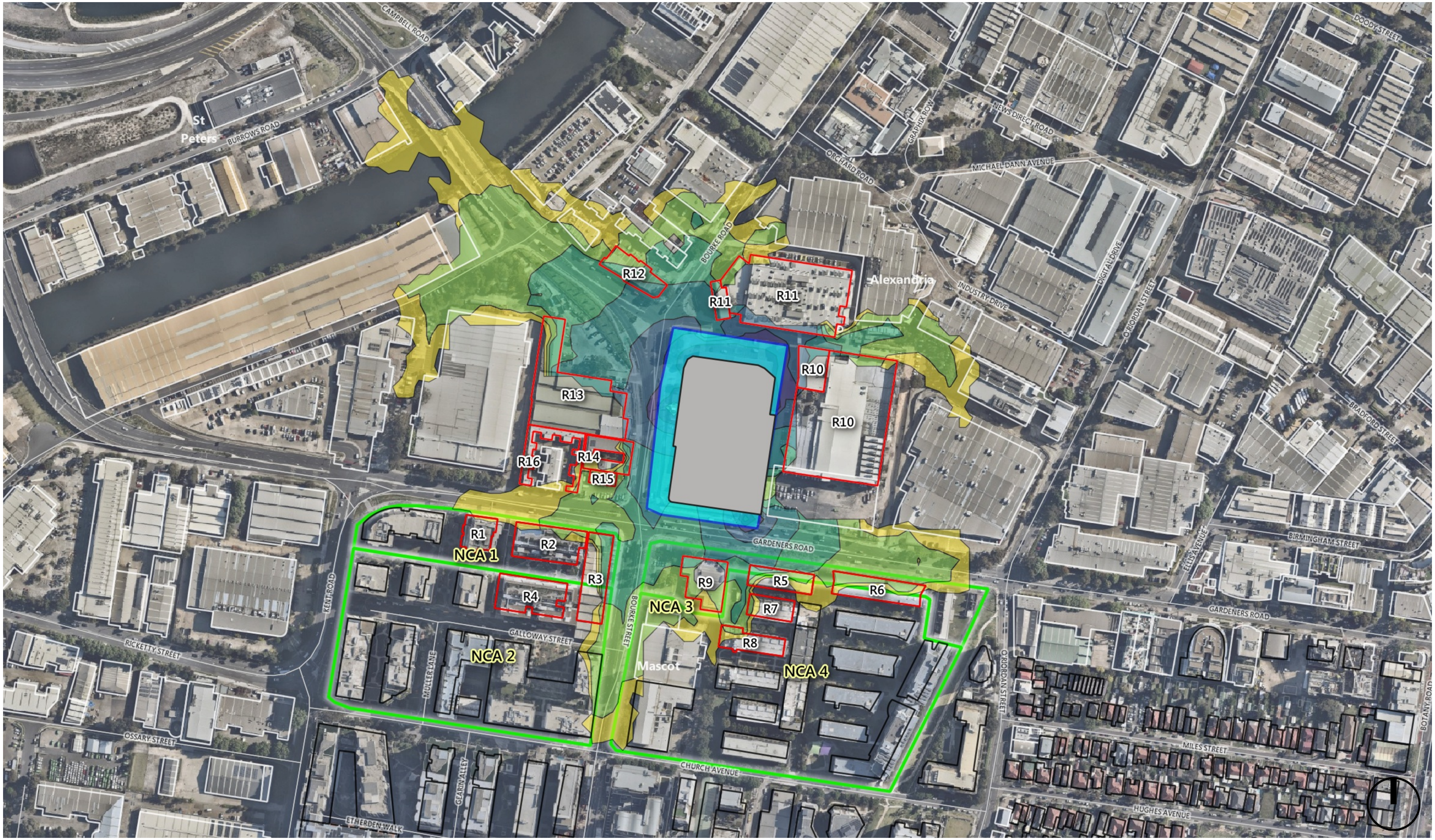
Table 6-4: Noise sources - Area source sources / distributed sources / internal noise levels

Noise generating operation/activity	Plant/ equipment item	Individual source/ activity $L_{Aeq,t}$					Individual source / activity $L_{Amax,t}$	
		$L_{Aeq,t}$, dB(A)	Duration[3]	$L_{Aeq,15 min}$, dB(A)	Modelled source height, metres	Size / area (m^2)	$L_{Amax,t}$, dB(A)	Modelled source height (above local ground), metres
External noise sources		**Sound power level, L_w[1]**						
Delivery and loading dock activities (see Section 5.2.1.3)								
Truck loading activity from rear[7]	Pallet loader	105	24 sec activity	90	2.4[6]	13	115	2.4[6]
Roof void breakout (x4)		These internal spaces were modelled in detail using the source levels in this Appendix. The breakout via the openings to these spaces were then modelled based upon the resulting predicted levels at these openings.						
Ground level hardstand								
Level 1 hardstand								
Internal movement corridors (ie. eastern entry corridor)								
Internal levels / Noise breakout		**Sound pressure level, L_p[2]**						
Warehouse activities (see Section 5.2.1.4)								
Intake air louvres	Internally lined plenum / ductwork internal	74	15 min	74	*Individual warehouse space roof level*	80	74	*Individual warehouse space roof level*
Warehouse open roller door breakout to hardstand	Forklift/ internal activities	70	15 min	70	5m x 6m[6]	30	86	-[6]

Notes:
1. Sound power level L_w re. 1pW, dB(A)
2. Sound pressure level Lp re. 20µPa, dB(A)
3. Duration of this level within 15-minutes (minutes)
4. For vertical area source heights can be referenced against the geometric centre, with dimensions referenced in the notes.
5. Modelled for all facades and roof
6. Vertical area source
7. As a conservative assumption, internal pallet loading activities have been modelled as the source levels are higher than side loading with forklifts.

APPENDIX D Predicted operational noise contours

D.1 Predicted operational noise levels, $L_{Aeq,15minute}$



Legend

- NCA boundary
- Proposal site
- Proposal built outline
- Representative receiver

Receiver type

- Industrial / Commercial
- Residential (including mixed use)
- Non-receiver

Predicted noise level, LAeq 15min, dB(A)

- 40-45
- 45-50
- 50-55
- 55-60
- 60-65
- 65-70
- >75

Client:
Charter Hall Holdings Pty Ltd

Project:
PROPOSED WAREHOUSE DEVELOPMENT, 520 GARDENERS ROAD, ALEXANDRIA

Description:
Operational noise contour (1.5m NPfI assessment height)
Daytime - LAeq 15minute

Notes
1. Imagery source: Nearmap (October2021)
2. Landuse classification based upon a desktop review only, subject to further review and detailed design.

For information only and not for construction.
Do not scale from this figure.

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Figure No:	TM455-01 1 2 003-1	Rev:	R0
Date:	23/12/2021	Sheet:	A3
Created by:	ALe	Scale:	1:3500
Co-ordinate system:	GDA 2020 MGA Zone 56		

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Plot Date: 23/12/21 - 21:26
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Layout: TM455 NOISE CONTOURS (r0)
Plot Date: 23/12/21 - 21:26
GIS File: R:\AssocSydProjects\TM451-TM500\TM455 ale 520 Gardeners Road, Alexandria\6 Figures & CAD Out\02 GIS\TM455_AL.qgz

50 0 50 100 150 200 m

Legend

- NCA boundary
- Proposal site
- Proposal built outline
- Representative receiver

Receiver type

- Industrial / Commercial
- Residential (including mixed use)
- Non-receiver

Predicted noise level, LAeq 15min, dB(A)

- 40-45
- 45-50
- 50-55
- 55-60
- 60-65
- 65-70
- >75

Client:
Charter Hall Holdings Pty Ltd

Project:
PROPOSED WAREHOUSE DEVELOPMENT,
520 GARDENERS ROAD, ALEXANDRIA

Description:
Operational noise contour (1.5m NPfI assessment height)
Evening and morning shoulder (5:00am to 7:00am) - LAeq 15minute

Notes
1. Imagery source: Nearmap (October2021)
2. Landuse classification based upon a desktop review only, subject to further review and detailed design.

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Figure No: TM455-01 1 2 003-2
Date: 23/12/2021
Created by: ALe
Co-ordinate system: GDA 2020 MGA Zone 56
Rev: R0
Sheet: A3
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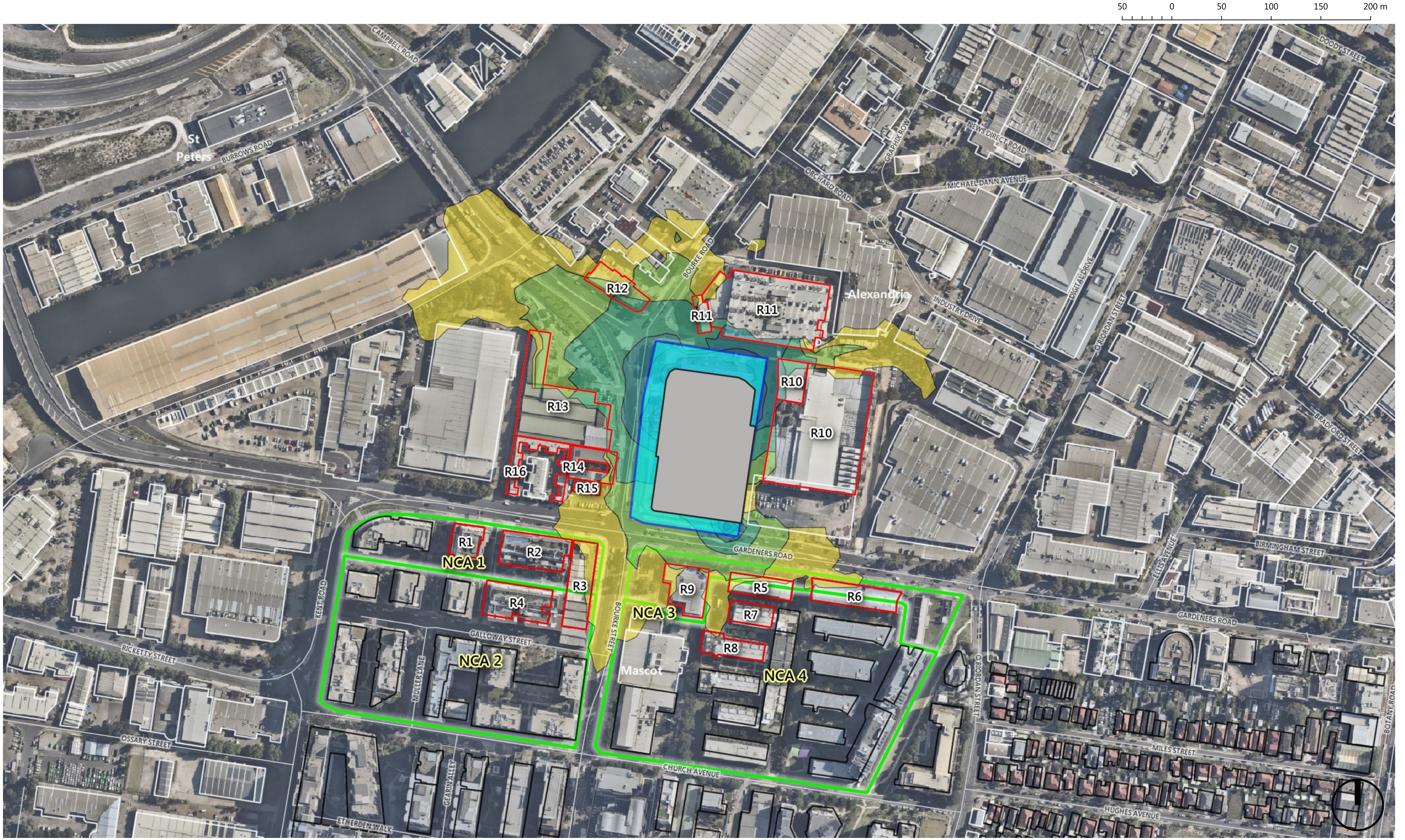

Legend

- NCA boundary
- Proposal site
- Proposal built outline
- Representative receiver

Receiver type

- Industrial / Commercial
- Residential (including mixed use)
- Non-receiver

Predicted noise level, LAeq 15min, dB(A)

- 40-45
- 45-50
- 50-55
- 55-60
- 60-65
- 65-70
- >75

Client:
Charter Hall Holdings Pty Ltd

Project:
PROPOSED WAREHOUSE DEVELOPMENT, 520 GARDENERS ROAD, ALEXANDRIA

Description:
Operational noise contour (1.5m NPfI assessment height)
Night - LAeq 15minute

Notes
1. Imagery source: Nearmap (October2021)
2. Landuse classification based upon a desktop review only, subject to further review and detailed design.

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Figure No: TM455-01 1 2 003-3
Date: 23/12/2021
Created by: ALe
Co-ordinate system: GDA 2020 MGA Zone 56
Rev: R0
Sheet: A3
Scale: 1:3500

D.2 Predicted operational noise levels – Sleep disturbance, L_{Amax}

Plot Date: 23/12/21 - 21:27 Layout: TM455 NOISE CONTOURS (r0)
GIS File: R:\AssocSydProjects\TM451-TM500\TM455 ale 520 Gardeners Road, Alexandria\6 Figures & CAD Out\02 GIS\TM455_AL.qgz

Legend

- NCA boundary
- Proposal site
- Proposal built outline
- Representative receiver

Receiver type

- Industrial / Commercial
- Residential (including mixed use)
- Non-receiver

Predicted noise level, LAmax, dB(A)

- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75-80
- > 80

Client:
Charter Hall Holdings Pty Ltd

Project:
PROPOSED WAREHOUSE DEVELOPMENT, 520 GARDENERS ROAD, ALEXANDRIA

Description:
Operational noise contour (1.5m NPfI assessment height)
Sleep disturbance assessment - Night / Morning shoulder (5:00am to 7:00am) - LAmax

Notes
1. Imagery source: Nearmap (October2021)
2. Landuse classification based upon a desktop review only, subject to further review and detailed design.

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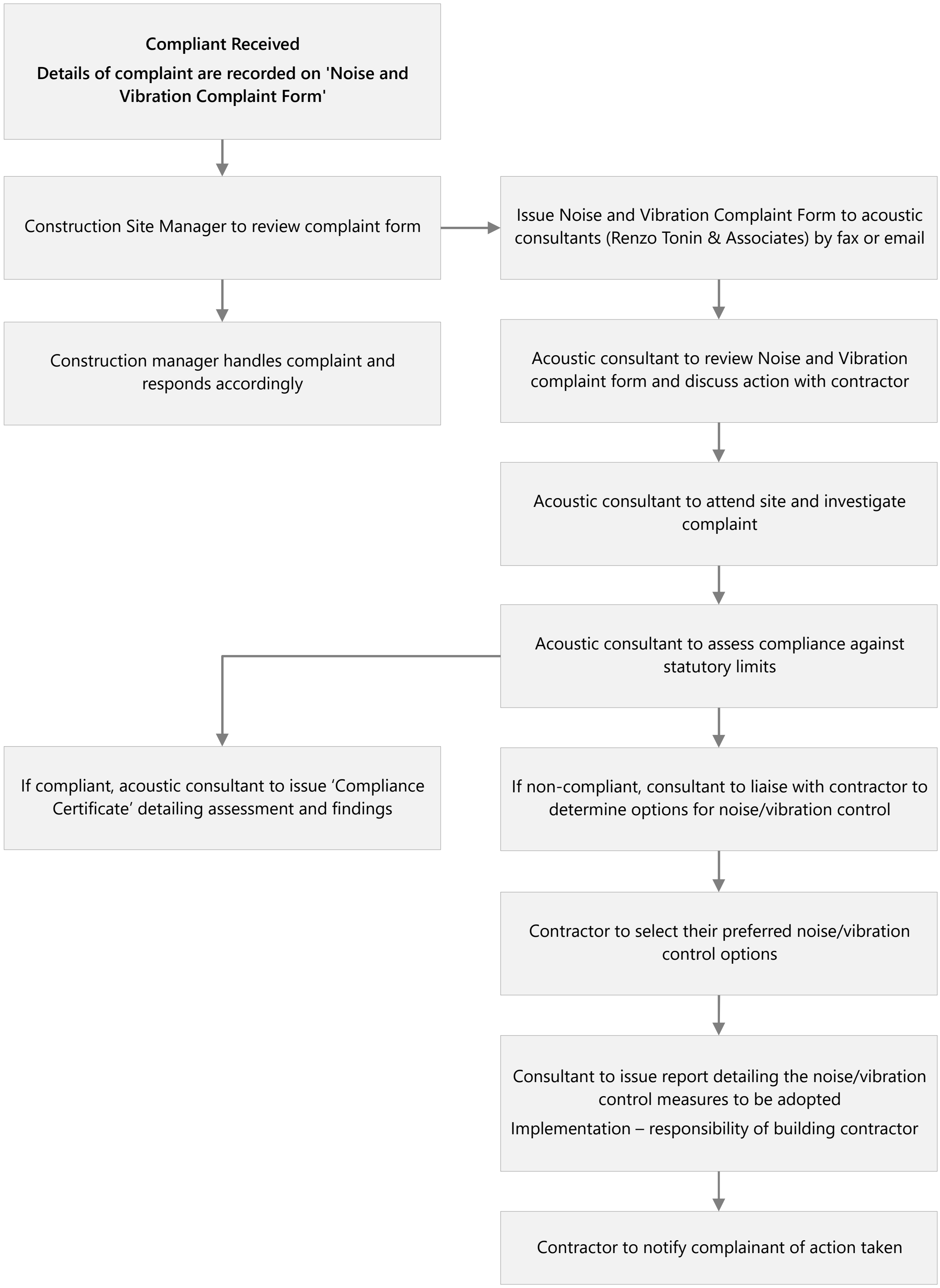
Figure No:	TM455-01 1 2 003-4	Rev:	R0
Date:	23/12/2021	Sheet:	A3
Created by:	ALe	Scale:	1:3500

Co-ordinate system: GDA 2020 MGA Zone 56

APPENDIX E 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:

Investigation

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

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