POWERHOUSE PARRAMATTA
ENVIRONMENTAL IMPACT STATEMENT

APPENDIX Z
NOISE AND VIBRATION IMPACT ASSESSMENT

Arup

NSW GOVERNMENT

Infrastructure NSW

Powerhouse Precinct Parramatta

Noise and Vibration Impact Assessment

PHM-ARP-REP-AC-0004

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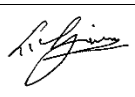
		Signature			
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1 Introduction

This report supports a State Significant Development (SSD) Development Application (DA) for the development of the Powerhouse Parramatta at 34-54 & 30B Phillip Street and 338 Church Street, Parramatta. The Powerhouse Parramatta is a museum (information and education facility) that has a capital investment value in excess of $30 million and as such the DA is submitted to the Minister for Planning pursuant to Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Infrastructure NSW is the proponent of the DA.

1.1 Background

The Powerhouse is Australia's contemporary museum for excellence and innovation in applied arts and sciences. The museum was established in 1879 in the Garden Palace which emerged from a history of 19th Century grand exhibition halls, including the Grand Palais. It currently encompasses the Powerhouse in Ultimo, Sydney Observatory in The Rocks and the Museums Discovery Centre in Castle Hill. The Powerhouse has occupied the Ultimo site since 1988.

Parramatta, in the heart of Western Sydney, is entering a period of rapid growth. It was identified in 2014's *A Plan for Growing Sydney* as the metropolis' emerging second Central Business District, with the provision of supporting social and cultural infrastructure regarded as integral to its success. The strategic importance of Parramatta as an economic and social capital for Sydney has been subsequently reinforced and further emphasised through its designation as the metropolitan centre of the Central City under the *Greater Sydney Region Plan*.

Powerhouse Parramatta will be the first State cultural institution to be located in Western Sydney – the geographical heart of Sydney. In December 2019, the Government announced the winning design, by Moreau Kusunoki and Genton, for the Powerhouse Parramatta from an international design competition.

Powerhouse Parramatta will establish a new paradigm for museums through the creation of an institution that is innately flexible. It will become a national and international destination renowned for its distinctive programs driven by original research and inspired by its expansive collections. It will be a place of collaboration, a mirror of its communities forever embedded in the contemporary identity of Greater Sydney and NSW.

1.2 Site Description

The site is located at the northern edge of the Parramatta CBD on the southern bank of the Parramatta River. It occupies an area of approximately 2.5 hectares and has extensive frontages to Phillip Street, Wilde Avenue and the Parramatta River. A small portion of the site extends along the foreshore of the Parramatta River to the west, close to the Lennox Street Bridge on Church Street. The site

boundary is identified in Figure 1 and Figure 2. The site excludes the GE Office Building at 32 Phillip Street.
The site is currently occupied by a number of buildings and structures, including:

- Riverbank Car Park – a four-level public car park
- Willow Grove – a two-storey villa of Victorian Italianate style constructed in the 1870s
- St George's Terrace – a two-storey terrace of seven houses fronting Phillip Street constructed in the 1880s
- 36 Phillip Street – a two-storey building comprising retail and business premises
- 40 Phillip Street – a two-storey building comprising retail and business premises
- 42 Phillip Street – a substation building set back from the street

The immediate context of the site comprises a range of land uses including office premises, retail premises, hotel, serviced apartments and residential apartments. To the north is the Parramatta River and open space corridor, beyond which are predominately residential uses. The Riverside Theatre is located to the north-west across the Parramatta River.

Figure 1: Aerial photograph of the site and its context Source: Mark Merton Photography

Figure 2: Site boundary, key existing features, and immediate local context Source: Ethos Urban

1.3 Overview of Proposed Development

The Powerhouse was established in 1879, and Powerhouse Parramatta will radically return to its origins through the creation of seven presentation spaces of extraordinary scale that will enable the delivery of an ambitious, constantly changing program that provides new levels of access to the Powerhouse Collection. The Powerhouse will set a new international benchmark in experiential learning through the creation of an immensely scaled 360-degree digital space, unique to Australia.

Powerhouse Parramatta will reflect the communities and cultures of one of Australia's fastest growing regions. It will hold First Nations culture at its core and set a new national benchmark in culturally diverse programming. The Powerhouse will be highly connected through multiple transport links, and integrate into the fine grain of the city.

Powerhouse Parramatta will be an active working precinct and include the Powerlab, which will enable researchers, scientists, artists and students from across regional NSW, Australia and around the world to collaborate and participate in Powerhouse programs. The Powerlab will feature digital studios to support music and screen industries alongside co-working spaces, life-long learning and community spaces. Integrated into the Powerlab will be a research kitchen and library that will support a NSW industry development program including archives and oral histories.

This application will deliver an iconic cultural institution for Parramatta in the heart of Sydney's Central City. The SSD DA seeks consent for the delivery of the Powerhouse Parramatta as a single stage, comprising:

- site preparation works, including the termination or relocation of site services and infrastructure, tree removal and the erection of site protection hoardings and fencing;
- demolition of existing buildings including the existing Riverbank Car Park, 'Willow Grove', 'St George's Terrace' and all other existing structures located on the site;
- construction of the Powerhouse Parramatta, including:
    - seven major public presentation spaces for the exhibition of Powerhouse Collection;
    - front and back-of-house spaces;
    - studio, co-working and collaboration spaces comprising the 'Powerlab', supported by 40 residences (serviced apartments) for scientists, researchers, students and artists, and 60 dormitory beds for school students;
    - education and community spaces for staff, researchers and the Powerlab residents, the community, and education and commercial hirers;
    - commercial kitchen comprising the 'Powerlab Kitchen' used for cultural food programs, research, education and events;
    - film, photography, and postproduction studios that will connect communities with industry and content that will interpret the Powerhouse Collection;
    - public facing research library and archive for community, industry, students and researchers to access materials; and
    - a mix of retail spaces including food and drink tenancies with outdoor dining.
- operation and use of the Powerhouse Parramatta including use of the public domain provided on the site to support programs and functions;
- maintenance of the existing vehicular access easement via Dirrabarri Lane, the removal of Oyster Lane and termination of George Khattar Lane, and the provision of a new vehicular access point to Wilde Avenue for loading;
- public domain within the site including new public open space areas, landscaping and tree planting across the site; and
- building identification signage.

The project does not seek consent for the carrying out of works outside of the site boundary, and in particular does not involve any alterations to the existing edge of the formed concrete edge of the Parramatta River or to the waterway itself.

1.4 Assessment requirements

The Department of Planning, Industry and Environment have issued Secretary's Environmental Assessment Requirements (SEARs) to the applicant for the preparation of an Environmental Impact Statement for the proposed development. This report has been prepared having regard to the SEARs as follows:

SEAR	Where addressed
9. Environmental Amenity The EIS shall: • include a noise and vibration assessment prepared in accordance with the relevant EPA guidelines, detailing operational noise impacts on nearby noise sensitive receivers and outline proposed noise and vibration mitigation and monitoring procedures	Section 4
17. Construction The EIS shall include a Construction Pedestrian and Traffic Management Plan addressing: • potential impacts of the construction on surrounding areas with respect to noise and vibration, air quality and odour impacts, dust and particle emissions, water quality, storm water runoff, groundwater seepage, soil pollution and construction waste	Section 3

This report also addresses the following Strategic Policy, Technical Guidelines and National Codes:

- Development near rail corridors and busy roads (Department of Planning, 2008)
- Interim Construction Noise Guidelines (DECCW, 2009)
- National Construction Code (Australian Building Codes Board, 2019)

It is noted that Development Near Rail Corridors and Busy Roads [1] is not relevant to the subject development, as it applies to the assessment of developments adjacent to rail and roads with an annual average daily traffic (AADT) volume of 20,000 vehicles per day or over. The adjacent roads, Wilde Avenue and Phillip Street, do not have an AADT greater than 20,000 (see Table 23) and there are no rail lines immediately adjacent the site.

National Construction Code acoustic design requirements, including partition ratings and internal noise levels, shall be addressed at the detailed design stage. No further assessment of National Construction Code requirements has been included in this report.

2 Existing acoustic environment

The site is located adjacent to Wilde Avenue to the east, Phillip Street to the south, both the Meriton Suites Parramatta and the Parkroyal Parramatta adjacent to the west and the Parramatta River to the north.

The main noise sources in the local environment are:

- Road traffic along Wilde Avenue, Phillip Street and other local roads
- CBD 'urban hum'
- Pedestrians
- Natural surrounds
- Temporary construction activities

The above sources generally vary in level over the day. The ambient acoustic environment has been quantified in accordance with NSW EPA policies and is outlined in this section.

2.1 Surrounding land-use

Maps showing the location of the site and the surroundings are included in Section 1.2 above. Types of land use surrounding the site is identified in Figure 3.

North of the Parramatta River lies predominantly medium density residential premises, interspersed with some non-residential premises, including commercial premises, places of worship and education institutions. Areas south of the Parramatta River, including the proposed site of the Powerhouse Parramatta, are predominantly mixed-use and commercial, also interspersed with some non-residential premises, including places of worship and education institutions.

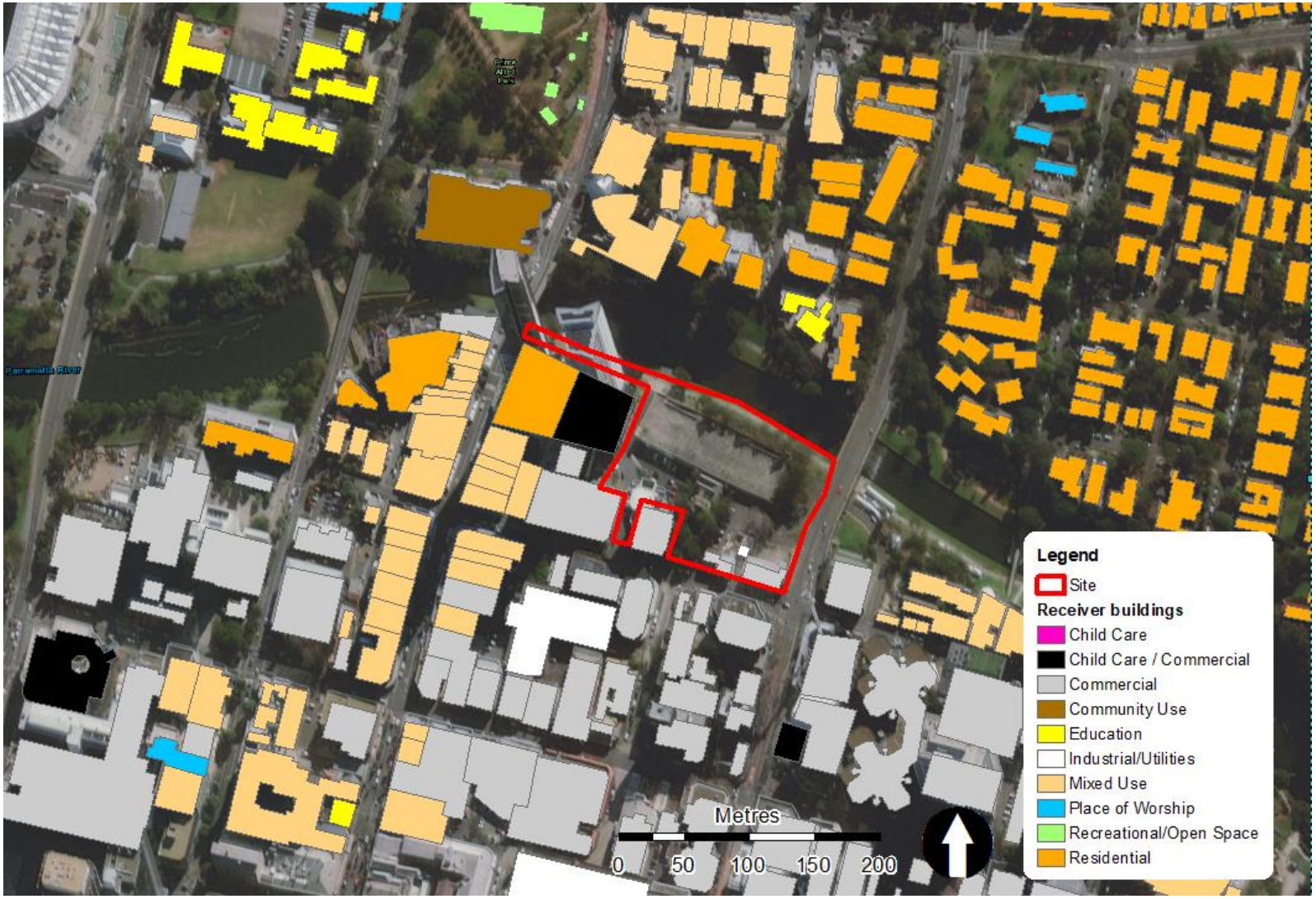


Figure 3: Surrounding noise sensitive receivers

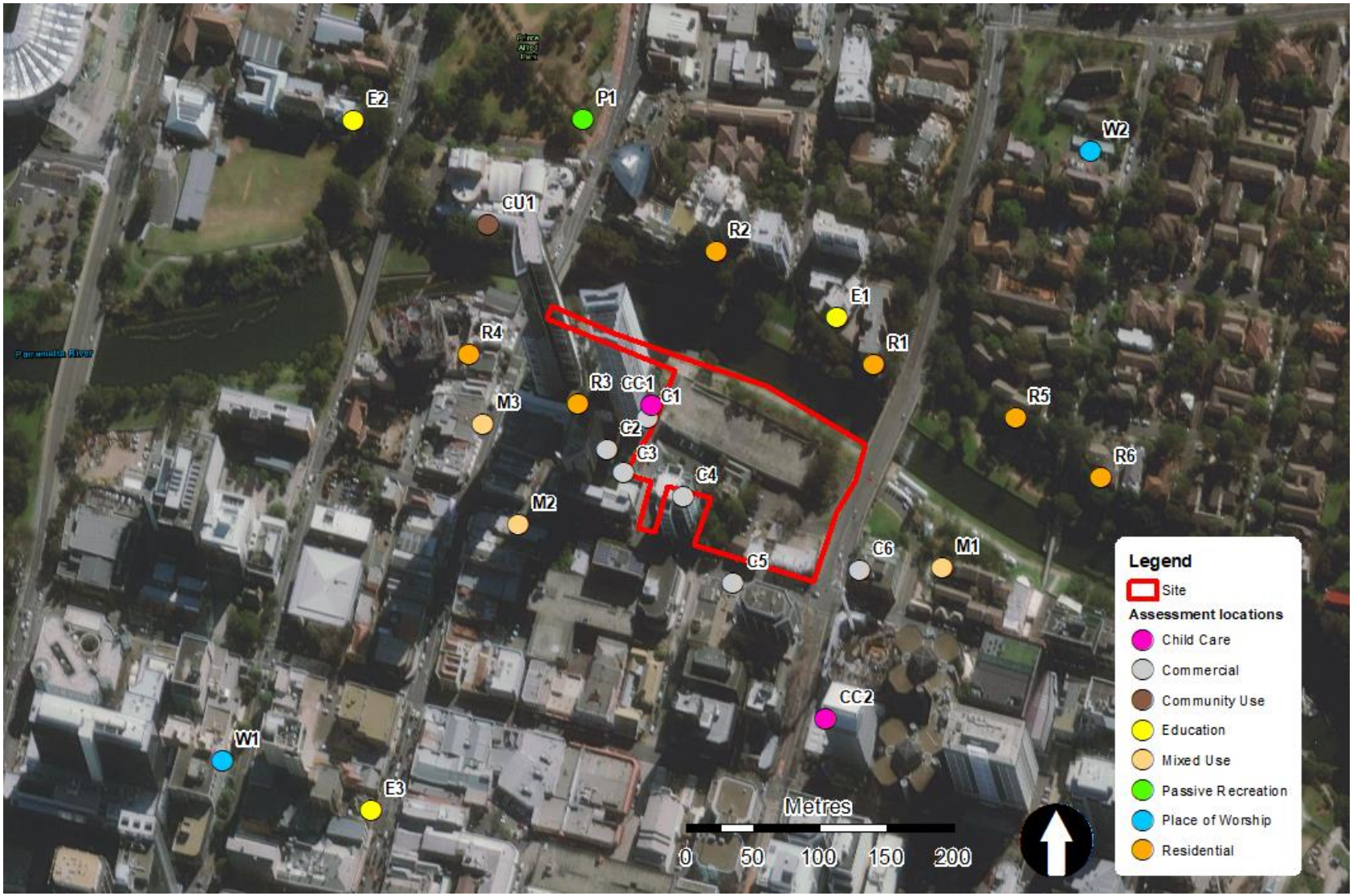


Figure 4: Assessment locations

For residential receivers, where noise targets are established from background levels, Noise Catchment Areas (NCA) have been defined. The NCA boundaries have been determined from site observations and attended measurements, which are detailed in Section 2.4.3. Classifications of NCAs as 'Urban' are based on on-site observations, and based on the NSW *Noise Policy for Industry* (NPfI) definitions, given that these areas have '*through-traffic with characteristically heavy and continuous traffic flows during peak periods'* and are *'near commercial districts or industrial districts'*.

2.2 Noise catchment areas

Receivers potentially affected by the noise and vibration associated with the Proposal have been classified into two noise catchment areas according to their noise environments.

The noise catchment areas are defined on a vertical plane, with NCA 1 representing receivers on ground floor up to Level 18 and NCA 2 representing receivers from Level 19 and above. This was based on measurements conducted on the roof of the 36 storey Meriton Suites building, with the lower half of the floors represented by ground floor measurements and the upper half represented by rooftop measurements.

The noise environment at each of the sensitive receivers within a noise catchment area is considered to be similar. One noise logger was placed within each NCA at a representative location. A description of the receivers within each NCA is described in Table 1.

Table 1: Noise Catchment Area (NCA) descriptions

NCA	Description
1	Lower floors of study area, Ground floor to Level 18
2	Upper floors of study area, Level 19 and above

2.3 Noise sensitive receivers

In accordance with the NPfI the reasonably most-affected receivers have been identified. Table 2 presents the most-potentially affected residential receivers and mixed-use receivers in each NCA, while Table 3 presents the non-residential noise sensitive receivers within the study area. Mixed-use receivers are defined as residences located in the same building as a commercial premise.

While noise predictions have been carried out to each receiver, for clarity, the assessment presented in this report is isolated to the reasonably most-affected receivers. Figure 4 shows the receivers where noise and vibration impacts were assessed within this report.

Table 2: Reasonably most-affected residential receivers

Receiver ID	NCA	Address	No. of floors
R1	1	14 Lamont Street, Parramatta	6
R2	1	3 Sorrell Street, Parramatta (Solace apartments)	16
R3	1 & 2	330 Church Street, Parramatta (Meriton suites)	49
R4	1 & 2	12 Phillip Street, Parramatta (Coronation – Under construction)	41
R5	1	5 Elizabeth Street, Parramatta	4
R6	1	1 Robertson Street, Parramatta	3
M1	1	66 Phillip Street, Parramatta	4
M2	1	302 Church Street, Parramatta	2
M3	1	295 Church Street, Parramatta	2

Table 3: Non-residential receivers

Receiver ID	Name	Address	No. of floors
Commercial			
C1	Meriton Suites	330 Church Street, Parramatta	32
C2	Parkroyal (Hotel tower)	30 Phillip Street, Parramatta	10
C3	Parkroyal (Lobby/Entrance/Hotel)	30 Phillip Street, Parramatta	8
C4	GE Building	32 Phillip Street, Parramatta	14
C5	Himalayan Fusion	81 Phillip Street, Parramatta	3
C6	Rotary South Pacific & Philippines Office	60 Phillip Street, Parramatta	5
Child Care Centre			
CC1	MindChamps Early Learning Centre	330 Church Street, Parramatta	1
CC2	Reggio Emilia Early Learning Centre	100 George Street, Parramatta	2
Theatre			
CU1	Riverside Theatres	353-353 Church Street, Parramatta	5
Education			
E1	Apex Institute of Education	2 Sorrell Street, Parramatta	3
E2	Parramatta Marist High (Middle of Grounds)	3 Marist Place, Parramatta	4
E3	University of New England	211 Church Street, Parramatta	3
Passive Recreation Area			
P1	Prince Alfred Square	Prince Alfred Square	0
Place of Worship			
W1	Parramatta Mosque	150 Marsden Street, Parramatta	8

Receiver ID	Name	Address	No. of floors
W2	All Saints Anglican Church	27 Elizabeth Street, Parramatta	2

2.4 Ambient noise level measurements

Ambient noise monitoring was undertaken at seven locations throughout the study area in February 2020. This included both unattended, long-term monitoring and short-term attended measurements.

A full set of noise monitoring results, graphs and details of instrumentation are presented in Appendix B.

2.4.1 Noise measurement locations

Noise measurements are ideally carried out at the nearest or most potentially affected locations surrounding a development. An alternative, representative location should be established in the case of access restrictions or if a safe and secure location cannot be identified. Furthermore, representative locations may be established in the case of multiple receivers as it is usually impractical to carry out measurements at all locations surrounding a site.

The short-term and long-term measurement locations are outlined in Table 4 and shown in Figure 5.

Table 4: Measurement summary

ID	NCA	Measurement location	Measurement type	Comment on location suitability
Meas. 1A	1	Rear yard of Solace Apartments, 3 Sorrell St	Long and short term	Considered representative of the worst affected receivers, located along the northern bank of Parramatta River. Also used to conservatively represent residences south of the Parramatta River, which are considered to have higher background noise levels than the logger location.
Meas. 1B	1	On site on carpark roof – northern boundary towards Parramatta River	Short term	Used to determine differences in background noise level between Solace Apartment logger location and residences south of Parramatta River.
Meas. 2A	2	Rooftop of Meriton Suites, 330 Church St	Long and short term	Considered representative of upper floors of residential towers surrounding the site, which are exposed to different noise sources to lower floors, hence required determination. Balconies on towers were not accessible for long term monitoring.

ID	NCA	Measurement location	Measurement type	Comment on location suitability
Meas. 2B	2	Level 36 balcony Meriton Suites, 330 Church St	Short term	Used to determine differences in background noise level between rooftop logger location and upper floor balconies.

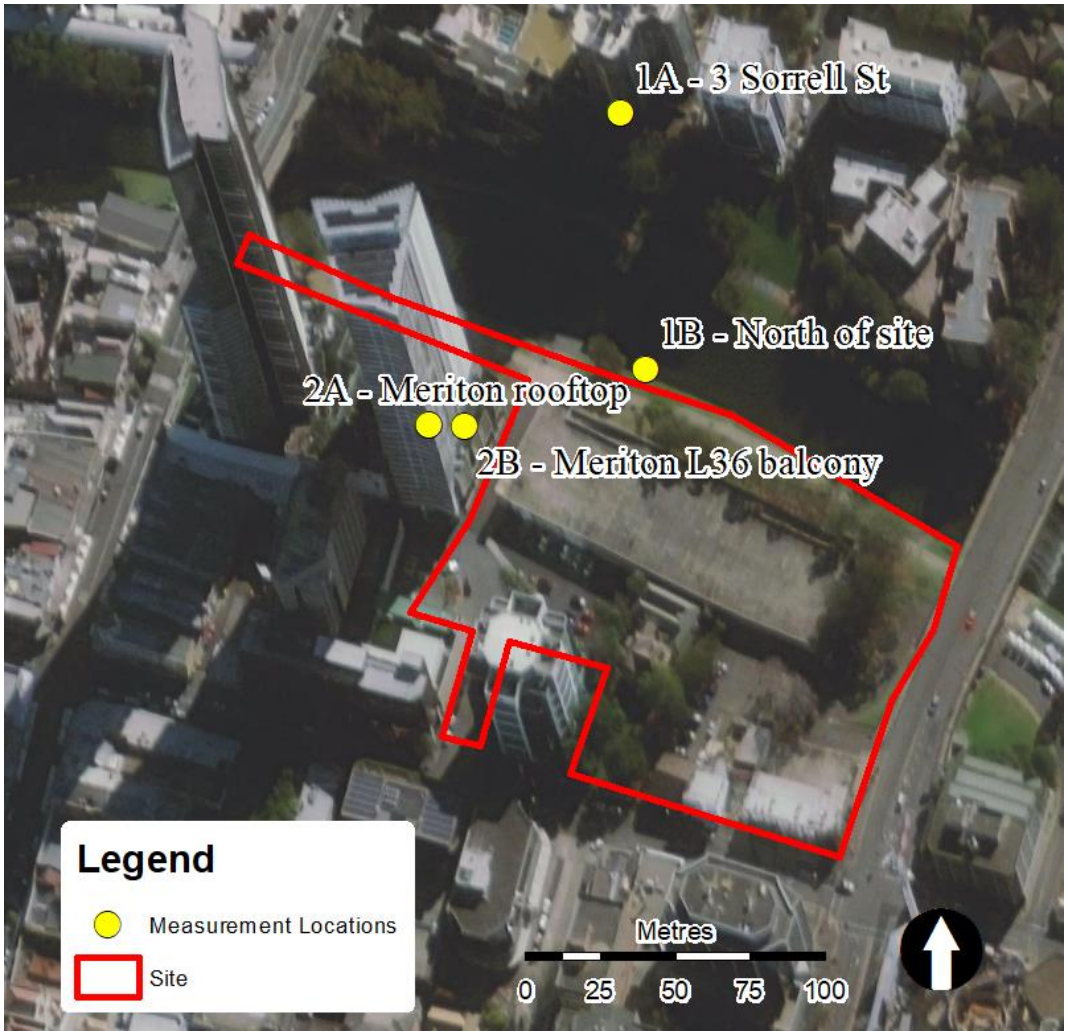


Figure 5: Measurement locations

2.4.2 Unattended noise measurements

Noise monitoring was conducted to determine existing background noise levels at sensitive receivers. Noise loggers were placed at the locations indicated in Figure 5. Noise loggers monitored noise levels continuously from 20 February 2020 until 4 March 2020.

The loggers measured the noise levels over the sample period and then determined L_{A10}, L_{A90}, L_{Amax}, and L_{Aeq} levels of the noise environment. The L_{A10} and L_{A90} noise levels are the levels exceeded for 10 percent and 90 percent of the measurement period respectively. The L_{A90} is taken as the background level. The L_{Amax} is

indicative of the maximum noise levels due to individual noise events such as the pass-by of a heavy vehicle. The L_{Aeq} level is the equivalent continuous sound level and has the same sound energy over the sample period as the actual noise environment with fluctuating sound levels.

The L_{A90} noise levels were analysed to determine a single assessment background level (ABL) for each day, evening and night period in accordance with the NSW Noise Policy for Industry (NPfI) [2], for each monitoring location. The ABL is established by determining the lowest ten-percentile level of the L_{A90} noise data acquired over each period of interest. Appendix B presents individual ABLs for each day's assessment periods.

The background noise level or rating background level (RBL) representing the day, evening and night-time assessment periods is based on the median of individual ABLs determined over the entire monitoring period, and are presented in Table 5.

Table 5: Long-term noise monitoring results

Measurement Location	**Day[1]**	**Evening[1]**	**Night[1]**
NCA1 – 3 Sorrell St, Parramatta			
Rating background level, dBL_{A90}	51	49	44
Log Average, dBL_{Aeq}	57	54	50
NCA2 – 330 Church St, Parramatta			
Rating background level, dBL_{A90}	51	49	46
Log Average, dBL_{Aeq}	55	54	51

Notes:

1. Day is defined as 7:00 am to 6:00 pm, Monday to Sunday & Public Holidays.
   Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday & Public Holidays.
   Night is defined as 10:00 pm to 7:00 am, Monday to Sunday & Public Holidays.

Appendix B also presents the existing L_{Aeq} ambient noise level selected for each day, evening and night-time period, in accordance with the NPfI [2]. An overall representative L_{Aeq} noise level is determined by logarithmically averaging each assessment period for the defined monitoring periods.

A full set of monitored results along with graphical noise logging results are presented in Appendix B and periods where data has been omitted are indicated.

2.4.3 Attended noise monitoring

Attended monitoring was conducted at the two unattended monitoring locations, along with an additional five locations on 20 and 27 of February, and 4 March 2020. Each measurement was conducted over a 15-minute period. Skies were generally clear with scattered clouds and conditions were calm with a slight breeze on the days of monitoring.

A summary of attended measurement results is presented in Table 6.

Table 6: Attended measurement results

ID	NCA	Measurement location	Date / time	Description of noise environment	Attended measurement results, dB(A)	
					$L_{eq,15\ min}$	$L_{90,15\ min}$
Meas. 1A	1	Rear yard of Solace Apartments, 3 Sorrell St	20/02/2020 12:23	Included general city hum, including distant traffic and natural surrounds. Aircraft, some construction noted	55	52
Meas. 1B	1	On site on carpark roof – northern boundary towards Parramatta River	04/03/2020 17:23	Included general city hum, including distant traffic and natural surrounds. Some construction noise noted. Some passing foot traffic and local conversational noise.	56	52
Meas. 2A	2	Rooftop of Meriton Suites, 330 Church St	20/02/2020 13:14	General city hum controlled by traffic, construction noted	55	52
Meas. 2B	2	Level 36 balcony Meriton Suites, 330 Church St	20/02/2020 13:51	General city hum controlled by traffic, construction noted	55	53

Results show measured L_{A90} levels at all locations are within 1 dB of each other, demonstrating that unattended monitoring results at locations 1A and 2A are considered representative of locations 1B and 2B.

3 Construction

This Section addresses the noise and vibration associated with construction of the Powerhouse Parramatta.

3.1 Hours of work

General construction works will be undertaken within the hours outlined in Table 7, in accordance with ICNG standard hours of construction with quieter works proposed outside of standard hours from 1:00 pm till 5:00 pm on Saturday, outlined in Section 3.5.1.

The extension of works outside of standard hours is proposed in order to:

- Maximise productivity on Saturdays to offset losses in productivity due to COVID-19 impacts, WH&S and social distancing requirements; and
- Take advantage of reduced road traffic on Saturdays for truck routes and deliveries, etc.

Table 7: Proposed Hours of Construction

Day	Standard construction hours	Proposed construction hours
Monday to Friday	7.00 am to 6:00 pm	7.00 am to 6:00 pm
Saturdays	8.00 am to 1:00 pm	8.00 am to 5:00 pm
Sundays or Public Holidays	No construction	No construction

In some additional cases, after-hours permits may be sought from the relevant authorities where special requirements exist, for example oversized deliveries.

3.2 Construction noise criteria

The ICNG provides recommended noise levels for airborne construction noise at sensitive land uses. The ICNG provides construction management noise levels above which all ‘feasible and reasonable’ work practices should be applied to minimise the construction noise impact. The ICNG works on the principle of a ‘screening’ criterion – if predicted or measured construction noise exceeds the ICNG levels then the construction activity must implement all ‘feasible and reasonable’ work practices to reduce noise levels.

The ICNG sets out management levels for noise at noise sensitive receivers, and how they are to be applied. The determination of management noise levels for residential receivers is outlined in Table 8 with the project specific levels summarised in Table 9. Noise management levels for other sensitive receivers are presented in Table 10.

Table 8: Construction noise management levels at residential receivers

Time of day	**Management level** [1] **$L_{Aeq\ (15\ min)}$**	**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 + 10dB	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.
	Highly noise affected 75dBA	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: times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours[2]	Noise affected RBL + 5dB	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 5dBA above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

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

2 – See Table for definition of outside standard hours definitions

Table 9: Noise Management Levels at residential receivers

NCA	Highly noise affected	Noise Management Level $dBL_{Aeq(15\ min)}$[1]	
		Standard construction hours[2]	Outside of standard hours – day[2]
All residences and mixed use premises[1]	75	61	56

Note:

1. RBLs and therefore NMLs are equivalent in both catchment areas

2. Proposed outside of standard hours works are 1:00 pm – 5:00 pm on Saturdays. Standard and proposed construction hours presented in Table 7.

Table 10: Noise Management Levels at other noise sensitive land uses

Land use	Where objective applies	Noise Management level $dBL_{Aeq(15\ min)}$[1]
Passive recreation areas	External noise level	60
Educational institutions	Internal noise level	45
Place of worship	Internal noise level	45
Community use	Internal noise level	30[2]
Commercial premises	External noise level	70

1 - Noise management levels apply when properties are in use.

2 - Based on AS/NZS2107:2016 max design level for Drama theatre

3.2.1 Project construction noise targets

Construction noise criteria are set based on noise catchment areas relative to proposed construction works. These catchment areas are defined for the project in Section 2.2.

Measured noise data obtained at the logger location most representative of each noise catchment area has been used to derive appropriate noise management levels for the project. These are summarised in Table 9.

Noise Management Levels for non-residential receivers are presented in Table 11 and Table 12.

Table 11: Residential Noise Management Levels during intended working hours

Rec. ID	Name	Assess. location	External NML, $dBL_{Aeq\ 15minute}$		
			Standard hours	Out of standard hours	Highly noise affected
Residential					
R1	14 Lamont St	External	61	56	75
R2	Solace Apartments, 3 Sorrell St	External	61	56	75
R3	Meriton Suites (Apartment)	External	61	56	75
R4	Coronation (Under Construction)	External	61	56	75

Rec. ID	Name	Assess. location	External NML, $dBL_{Aeq\ 15minute}$		
			Standard hours	Out of standard hours	Highly noise affected
Residential					
R5	5 Elizabeth St (Apartment)	External	61	56	75
R6	1 Robertson St (Apartment)	External	61	56	75
M1	66 Phillip St	External	61	56	75
M2	Coco Cubano	External	61	56	75
M3	Mad Mex	External	61	56	75

Table 12: Non-residential Noise Management Levels during intended working hours

Rec. ID	Name	Time period	Assess. location	External NML, $dBL_{Aeq\ 15minute}$
Commercial				
C1	Meriton Suites	When in use	External	70
C2	Parkroyal (Hotel tower)	When in use	External	70
C3	Parkroyal (Lobby/Entrance/Hotel)	When in use	External	70
C4	GE Building	When in use	External	70
C5	Himalayan Fusion	When in use	External	70
C6	Rotary South Pacific & Philippines Office	When in use	External	70
Child Care				
CC1	MindChamps Early Learning Center	When in use	External	65[2]
CC2	Reggio Emilia	When in use	External	55[1]
Educational institution				
E1	Apex Institute of Education	When in use	Internal	55[1]
E2	Parramatta Marist High (Middle of Grounds)	When in use	Internal	55[1]
E3	University of New England	When in use	Internal	55[1]
Passive recreation area				
P1	Prince Alfred Square	When in use	External	60
Community Use				
CU1	Riverside Theatres	When in use	External	60[3]
Place of worship				
W1	Parramatta Mosque	When in use	Internal	55[1]
W2	All Saints Anglican Church	When in use	Internal	55[1]

Rec. ID	Name	Time period	Assess. location	External NML, dBL$_{Aeq\ 15minute}$

Note:

1. External noise levels have been determined by assuming a 10dB reduction through an open window.

2. MindChamps Early Learning Center does have doors on the eastern façade facing the construction area, however these doors are only used to access the outdoor play area. During sensitive times, such as rest times, these doors are closed. A 20dB reduction has been assumed through a closed door.

3. AS2107 recommends an internal noise level for a drama theatre of 25-30 dBA. A loss of 30dB through the building fabric into the theatre has been applied, based on the assumption a theatre building would require reasonably high performing building envelope.

3.3 Construction traffic criteria

Increased traffic generated on the surrounding road network due to either construction activities or by the operation of the Powerhouse Parramatta is assessed in accordance with the RNP. Table 3 of the NSW *Road Noise Policy* (RNP) which sets out the assessment criteria for particular types of project, road category and land use, shown in Table 31 below.

Table 13: Road traffic criteria for traffic generating development - residential receivers

Road category	Type of project / land use	Assessment criteria – dB(A)	
		Day (7:00am-10:00pm)	Night (10:00pm-7:00am)
Freeway/arterial/ sub-arterial roads Wilde Avenue	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)

Notes: These criteria are for assessment against façade corrected noise levels when measured in front of a building façade.

Regarding the application of the assessment, the RNP states:

> *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.*

3.4 Construction vibration criteria

Vibration criteria for construction works are established in the following sections. Vibration management measures have been recommended in Section 3.9.

3.4.1 Human comfort

The NSW EPA's *Assessing Vibration – A Technical Guideline* [3] provides vibration criteria for maintaining human comfort within different space uses. The guideline recommends 'preferred' and 'maximum' weighted vibration levels for both continuous vibration sources, such as steady road traffic and continuous

construction activity, and for impulsive vibration sources. The weighting curves are obtained from BS 6472-1:2008 [4].

For intermittent sources (e.g. passing heavy vehicles, impact pile driving, intermittent construction), the guideline uses the vibration dose value (VDV) metric to assess human comfort effects of vibration. VDV considers both the magnitude of vibration events and the number of instances of the vibration event. Intermittent events that occur less than 3 times in an assessment period (either day, 7 am to 10 pm, or night, 10 pm to 7 am) are counted as 'impulsive' sources for the purposes of assessment.

As noted in the Guideline, situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances, such as a construction or excavation projects. Notwithstanding, the recommended vibration limits for maintaining human comfort in residences and other relevant receiver types are given for continuous/impulsive and intermittent vibration in Table X and Table X respectively.

Table 14: Preferred and maximum weighted root-mean-square (rms) values for continuous and impulsive vibration acceleration (m/s^2) 1-80 Hz

Location	**Period**	**Preferred Values**		**Maximum Values**	
		z-axis	**x- and y-axes**	**z-axis**	**x- and y-axes**
Continuous Vibration					
Critical areas[1]	Day- or Night-time	0.005	0.0036	0.01	0.0072
Residences	Daytime 0700-2200h	0.010	0.0071	0.020	0.014
	Night-time 2200-0700h	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or Night-time	0.020	0.014	0.040	0.028
Impulsive Vibration					
Critical areas[1]	Day- or Night-time	0.005	0.0036	0.01	0.0072
Residences	Daytime 0700-2200h	0.30	0.21	0.60	0.42
	Night-time 2200-0700h	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or Night-time	0.64	0.46	1.28	0.92

1. Criteria for sensitive areas are only indicative, and have been provided as guidance to acceptable vibration levels for the use of sensitive equipment.

Table 15: Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	**Daytime 0700-2200 h**		**Night-time 2200-0700 h**	
	Preferred Value	**Maximum Value**	**Preferred Value**	**Maximum Value**
Critical areas[1]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26

Location	Daytime 0700-2200 h		Night-time 2200-0700 h	
	Preferred Value	**Maximum Value**	**Preferred Value**	**Maximum Value**
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80

1. Criteria for sensitive areas are only indicative, and there may be a need to assess intermittent vibration against impulsive or continuous criteria.

3.4.2 Building damage

Potential structural or cosmetic damage to buildings as a result of vibration is typically assessed in accordance with British Standard 7385 Part 2-1993 and/or German Standard DIN4150-3. British Standard 7385 Part 1: 1990, defines different levels of structural damage as:

- *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.*

Table 1 of BS7385-2 sets limits for the protection against cosmetic damage, however the following guidance on 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* **[not reproduced]**. *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 effect of vibration that reduces the serviceability of a structure or one of its components*" (p.2). The Standard also outlines:

"that for structures as in lines 2 and 3 of Table 1, the serviceability is considered to have been reduced if

- *cracks form in plastered surfaces of walls;*
- *existing cracks in the building are enlarged;*
- *partitions become detached from loadbearing walls or floors.*

These effects are deemed 'minor damage." (DIN4150.3, 1990, p.3)

While the DIN Standard defines the above damage as 'minor', the description aligns with BS7385 cosmetic damage, rather than referring to structural failures.

British Standard BS7835-2

BS7385-2 [5] is based on peak particle velocity and specifies damage criteria for frequencies within the range 4–250 Hz, and a maximum displacement value below 4 Hz is recommended. Table 16 sets out the BS7385 criteria for cosmetic, minor and major damage. Regarding heritage buildings, British Standard 7385 Part 2 (1993, p.5) notes that "*a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive*".

Table 16: BS 7385-2 structural damage criteria

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

Notes

1 - 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.

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

All levels relate to transient vibrations in low-rise buildings. Continuous vibration can give rise to dynamic magnifications that may require levels to be reduced by up to 50%.

3.4.3 Buried services

DIN 4150-2:1999 [6] sets out guideline values for vibration effects on buried pipework and reproduced in Table 17 below.

Table 17: Guideline values for short-term vibration impacts on buried pipework

Pipe material	Guideline values for vibration velocity measured on the pipe, mm/s
Steel (including welded pipes)	100
Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
Masonry, plastic	50

Note:

For gas and water supply pipes within 2m of buildings, these limits should be applied. Consideration must also be given to pipe junctions with the building structure as potential significant changes in mechanical loads on the pipe must be considered.

In addition, specific limits for vibration affecting high-pressure gas pipelines is provided in the UK National Grid's Specification for Safe Working in the Vicinity of National Grid High Pressure Gas Pipelines and Associated Installations – Requirements for Third Parties (report T/SP/SSW/22, UK National Grid, Rev 10/06, October 2006). This specification states that no piling is allowed within 15 m of a pipeline without an assessment of the vibration levels at the pipeline. The PPV at the pipeline is limited to a maximum level of 75 mm/s, and where PPV is predicted to exceed 50 mm/sec the ground vibration is required to be monitored.

Other services that may be encountered include electrical cables and telecommunication services such as fibre optic cables. While these may sustain vibration velocity levels from between 50 mm/s and 100 mm/s, the connected services such as transformers and switchgear may not. Where encountered, site specific vibration assessment in consultation with the utility provider should be carried out.

3.4.4 Heritage structures

Heritage structures which have been identified in the vicinity of the Powerhouse Parramatta are presented in Figure 6.

Items I737 and I738 are to be demolished as part of the development proposal. The nearest heritage listed item which would remain are located further than 70 metres from the construction site boundary, which include:

- I739 approximately 70 metres to the east
- 00218 approximately 80 metres to the south
- I677 approximately 110 metres to the west
- 00750 adjacent to the north-west

As these buildings are not considered to be structurally unsound, these heritage structures are not considered to be more vibration sensitive than other surrounding structures, therefore the relevant Group criteria in BS7385-2 [5] would apply.

Figure 6: Heritage listed properties in the vicinity of the Powerhouse Parramatta site.
Source: Advisian heritage

3.5 Construction noise assessment

3.5.1 Activities

The construction phases proposed as part of the Powerhouse Parramatta development are outlined in Table 18.

Table 18: Construction phases

Construction phase	Duration
Site Establishment & demolition	2-3 months
Bulk/Detailed Excavation/Piling	4 months
Archaeological investigations	TBC during Construction
Construction	24 months

Assumed construction equipment to be used for redevelopment works are provided in Table 19.

Equipment sound power levels have been determined by reference to AS2436 [7], BS5228 [8], and Arup's measurement database. The equipment below has been assumed to operate concurrently however equipment sound power levels have been adjusted according to its usage in a worst case 15-minute period, and penalty corrections for impulsive noise characteristics.

The locations of equipment have been based on the locations of the construction works around the precinct.

Table 19: Construction equipment usage and associated sound power levels (L_w)

Plant item	Sound power level - L_w, dB(A)	Penalty[1], dB	% of use in worst case 15 mins	Standard construction hours			Saturday 1pm – 5pm		
				Site Establishment & Demo.	Bulk /Detailed Excavation	Construction	Site Establishment & Demo.	Bulk /Detailed Excavation	Construction
				Number of plant items to be used in worst 15 min period.					
Excavator	117	0	100	2	2		Not used outside of standard hours		
Truck	107	0	100	1	1		1	1	
Pulveriser (mounted on Excavator)	108	0	100	2			2		
Crane (Tower)	105	0	100			3			3
Crane (Mobile)	113	0	100			1			1
Generator (Diesel)	113	0	100	1	1		1	1	
Concrete Pump	106	0	100			1			1
Skidsteer Loader (Bob-cat)	110	0	100	1	1		1	1	
Road Lorry	111	0	100	3	1		3	1	
Piling rig (Impact)	129	5	20			Piling method dependent on ground conditions, yet to be determined, impact piling assumed.	Not used outside of standard hours		
Piling rig (Bored)	111	0	100						
Concrete Saw	122	0	50	1	1		Not used outside of standard hours		

Note:

1. 5dB penalty applied for impulsive nature of noise.

3.5.2 Assessment methodology

Noise emissions from construction activities associated with the Powerhouse Parramatta have been assessed to criteria outlined in Section 3.2.

Noise emissions have been modelled using SoundPlan 8 in accordance with ISO9613-2 algorithms. The model included:

- Construction noise sources listed in Section Table 19;
- Surrounding buildings;
- Receivers listed in Section 2.2; and
- Ground terrain and absorption.

Noise emissions have been modelled on the following assumptions:

- Equipment, staging and durations are based on information provided by Aver. A review of predicted emissions should be conducted when final construction details are available as part of the development of the Construction Noise and Vibration Management Plan.
- The location of equipment will be spread evenly across the site.

3.5.3 Noise prediction results

Predicted construction noise levels at surrounding residential receivers along with the relevant NML for the intended working hours are presented in Table 20.

Graphical representations of construction noise emission are presented in Appendix C.

Table 20: Predicted construction noise levels – Residential receivers, $dBL_{Aeq\ (15\ min)}$

Receiver	NML	Construction phase		
		Site Establishment & Demo.	Bulk /Detailed Excavation	Construction
Standard construction hours				
R1 - 14 Lamont Street	**61**	71	71	74
R2 - 3 Sorrell Street	**61**	74	74	77
R3(Upper) - 330 Church Street	**61**	66	66	69
R3(Lower) - 330 Church Street	**61**	65	65	68
R4(Upper) - 12 Phillip Street	**61**	54	54	57
R4(Lower) - 12 Phillip Street	**61**	51	51	54
R5 - 5 Elizabeth Street	**61**	67	67	70
R6 - 1 Robertson Street	**61**	65	65	68
M1 - 66 Phillip Street	**61**	69	69	72
M2 - 302 Church Street	**61**	56	56	59
M3 - 295 Church Street	**61**	48	48	51

Receiver	NML	Construction phase		
		Site Establishment & Demo.	Bulk /Detailed Excavation	Construction
Saturday 1pm - 5pm				
R1 - 14 Lamont Street	**56**	66	64	62
R2 - 3 Sorrell Street	**56**	69	67	65
R3(Upper) - 330 Church Street	**56**	61	59	57
R3(Lower) - 330 Church Street	**56**	60	58	56
R4(Upper) - 12 Phillip Street	**56**	49	47	45
R4(Lower) - 12 Phillip Street	**56**	46	44	42
R5 - 5 Elizabeth Street	**56**	62	60	58
R6 - 1 Robertson Street	**56**	60	58	56
M1 - 66 Phillip Street	**56**	64	62	60
M2 - 302 Church Street	**56**	51	49	47
M3 - 295 Church Street	**56**	43	41	39

Notes:

- Levels shaded in grey indicate a notional exceedance of NMLs based on the worst-case assumptions noted above.
- Levels in **BOLD RED** represent 'highly affected' noise levels of 75dBA or above.

Results indicate that the largest exceedances are predicted at the residences along the north of the Parramatta River, opposite the site (R1 – 14 Lamont Street, R2 – 3 Sorrell Street), with exceedances of up to 16 dB predicted during standard construction hours and 13 dB on Saturdays 1 pm till 5 pm.

Noise levels at M2 - 14 Lamont Street are predicted to reach 'highly affected' levels of 75 $dBL_{Aeq(15minute)}$ or above which applies to residential receivers.

The residential Meriton Suites on Church Street (R1 - 330 Church Street) are located to the west of the Meriton serviced apartments (C1 - 330 Church Street, assessed in Table 21), therefore are shielded from the highest construction noise impacts.

Predicted noise levels at non-residential receivers are presented in Table 21.

Table 21: Predicted construction noise levels – Non-residential receivers, $dBL_{Aeq\ (15\ min)}$

Receiver	NML	Construction phase		
		Site Establishment & Demo.	Bulk /Detailed Excavation	Construction
Commercial and Hotel receivers				
C1(Lower) – Meriton Suites, 330 Church Street	**70**	82	83	82
C1(Upper) - Meriton Suites, 330 Church Street	**70**	79	80	79

Receiver	NML	Construction phase		
		Site Establishment & Demo.	Bulk /Detailed Excavation	Construction
C2 – Parkroyal Lobby 30 Phillip Street	**70**	77	78	77
C3 - Parkroyal Tower 30 Phillip Street	**70**	78	79	78
C4 - 32 Phillip Street	**70**	82	83	82
C5 - 81 Phillip Street	**70**	82	83	82
C6 - 60 Phillip Street	**70**	80	81	80
Places of Worship				
W1 - 150 Marsden Street	**55**	49	50	49
W2 - 27 Elizabeth Street	**55**	49	50	49
Childcare Facilities				
CC1 - 330 Church Street	**65**	82	83	82
CC2 - 100 George Street	**55**	59	60	59
Educational Facilities				
E1 - 2 Sorrell Street	**55**	74	75	74
E2 - 3 Marist Place	**55**	51	52	51
E3 - 211 Church Street	**55**	46	47	46
Passive Recreation				
P1 - Prince Alfred Square	**60**	54	55	54
Community Use				
CU1 - 353-353 Church Street	**60**	65	66	65

Notes:

Levels shaded in grey indicate a notional exceedance of NMLs based on the worst-case assumptions noted above.

Results indicate that the largest exceedances are predicted at receivers immediately adjacent to the site (CC1 - 330 Church Street), and across Parramatta River (E1 - 2 Sorrell Street), with exceedances up to 18 dB predicted.

Exceedances of up to 13 dB are predicted at surrounding commercial premises, which are located immediately adjacent to the proposed site.

3.5.4 Discussion

High predicted noise levels are attributed to a small number of high noise activities including the concrete saw and the piling rig, however the noise generated by the piling rig will depend on whether impact piling or bored piling will be required, to be determined following ground composition surveys. Predicted noise levels may therefore be conservative as noise impacts due to bored piling will likely be lower than those modelled.

The use of pulverisers is proposed for demolitions works which are a lower noise generating plant than traditional excavator mounted hammers.

3.6 Construction traffic assessment

Construction vehicles will be used for deliveries and to remove waste from the site, with the proposed access points to the site located at:

- Wilde Avenue
- Phillip Street
- Dirrabarri Lane

All construction traffic is proposed to travel to and from site via Wilde Avenue. The likely worst affected receiver by construction traffic is identified as the apartment complex at 14 Lamont Street.

Proposed construction traffic routes and most potentially affected receivers, both residential, are presented in Figure 7 and Figure 8.

Figure 7: Construction site traffic access points. Source: JMT Consulting

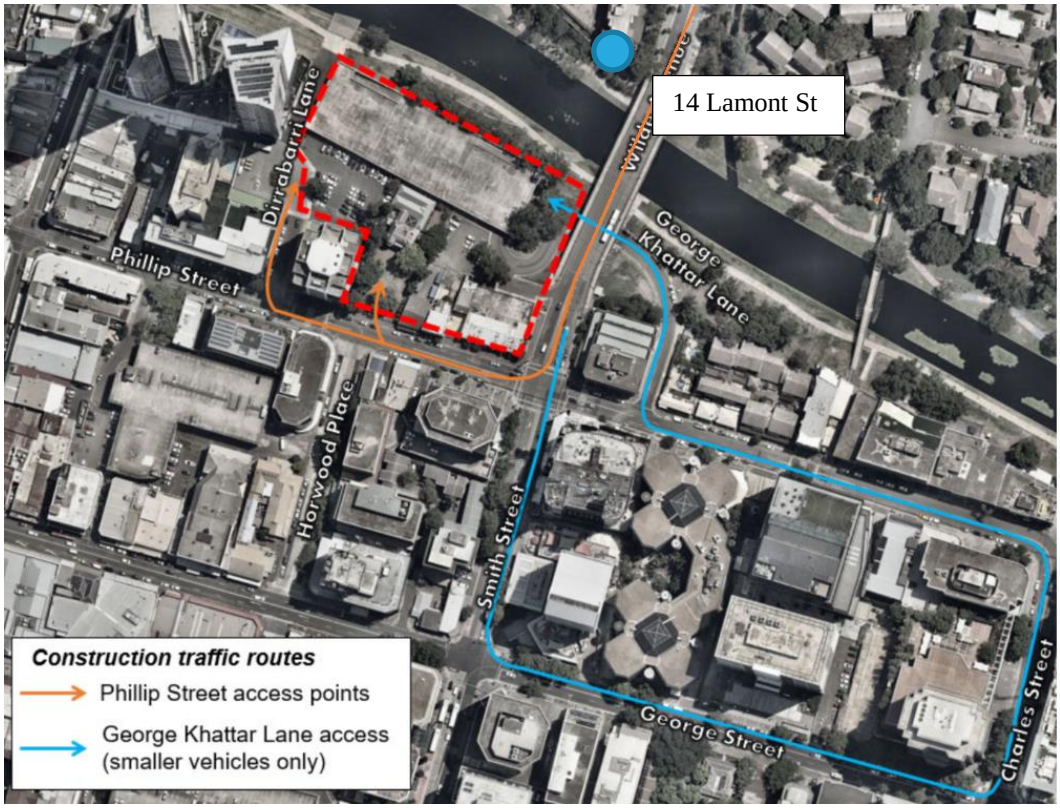


Figure 8: Construction traffic routes and likely worst affected resident. Source: JMT Consulting

Proposed construction traffic volumes are presented in Table 22.

Table 22: Proposed construction generated traffic volumes

Phase	Heavy vehicles	Light vehicles
Demolition	40-60	7
Construction	100-120	65

Regarding the assessment of potential impact and consideration of mitigation and management measures, the RNP [9] states:

> *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.*

The assessment of construction related traffic noise is presented in Table 23.

Table 23: Construction traffic assessment

Traffic route	Likely most affected residential receiver	Existing AADT[1] volumes	Daily construction movements[2]	Predicted increase in road traffic noise, $L_{Aeq(15hour)}$[3]	Criteria	Comply
Wilde Ave	14 Lamont St	Wilde Ave 14,720	240 heavy vehicles 130 light vehicles	0.7 dB	< 2 dB	Yes

Notes:

1. Average Annual Daily Traffic, provided by JMT Consulting.
2. Assumed 2 movements per vehicle, one arriving at and one leaving site
3. Based on 15 hour traffic proportion of 85% and HV% of 10.

Considering the high existing traffic numbers along Wilde Avenue and the low number of construction generated vehicles, the additional construction traffic created by construction is predicted to increase $L_{Aeq(15\ hour)}$ noise levels by 0.7 dB at the likely most affected residence. This is less than the 2 dB 'minor impact' criteria, and therefore represents an insignificant effect on the ambient noise environment.

3.7 Construction vibration assessment

The use of impact piling may generate significant adverse vibration impacts at receivers immediately adjacent and in close proximity to the site. The use of impact piling is yet to be confirmed, however recommended minimum work distances and construction vibration management recommendations are provided in Section 3.9 to minimise the risk of adverse vibration impacts.

Should vibration intensive equipment, such as rock hammers, vibratory rollers or compactors be required for the works, it is recommended that minimum work distances be developed to minimise the risk of adverse vibration impacts, and

noise and vibration monitoring may be required if work is required within these distances.

3.8 Construction noise mitigation measures

The contractor will have a key role in managing the noise and vibration levels during the works to reduce noise and vibration as far as is reasonably practicable. This will include:

Table 24: Construction noise mitigation measures

Item	Detail
Noise and vibration management plan	A Construction Noise and Vibration Management Plan shall be prepared prior to the issuing of a Construction Certificate. This will specify the actual plant to be used and will include updated estimates of the likely levels of noise and the scheduling of activities.
Staffing	Appointing a named member of the site staff who will act as the Responsible Person with respect to noise and vibration; Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise; Ensuring good work practices are adopted to avoid issues such as noise from dropped items, noise from communication radios is kept as low as is practicable; Avoid the use of radios or stereos outdoors; and Avoid shouting and minimise talking loudly and slamming vehicle doors.
Plant and equipment	Where possible stationary equipment should be located behind structures such as demountable buildings or stockpiles to maximise shielding to receivers; Consider using electric / hydraulic equipment where possible Using the smallest equipment as is practical All plant and equipment used on site must be: • maintained in a proper and efficient condition; and • operated in a proper and efficient manner. Turn off all vehicles, plant and equipment when not in use Ensuring that the Responsible Person checks the conditions of the powered equipment used on site daily to ensure plant is properly maintained and that noise is kept as low as practicable.
Scheduling	Ensure that the Responsible Person controls the working hours on site to ensure that work is only done during the acceptable periods (7am to 6pm on weekdays and 8am to 1pm on Saturdays. No work on Sundays or public holidays)
Work site training	'Toolbox talks' will be held at regular intervals with the contractor workers, including discussion of noise and vibration mitigation, monitoring and assessment. These topics will also be covered under induction processes. Operate two-way radios at the minimum effective volume, and avoid shouting or whistling at the site. Identification of all reasonable and feasible noise mitigation methods will be conducted by the Responsible Person on a daily basis during noisy works. The Responsible Person will have the authority to modify work practices in response to complaints, where this is considered appropriate.

Item	Detail
Scheduling	High noise activities will be programmed to occur during the standard construction hours wherever possible and will be scheduled with due consideration to the nearest sensitive receivers.
Community liaison	Ensuring that the Responsible Person keeps the local community advised on expected activities and coordinates scheduling and locations of noisy works around any critical user events where practicable. This shall include face to face meetings with nearby receivers if requested and a letter box drop, and shall include close liaison with neighbours during construction, including the Meriton towers and residences to the north of Parramatta River. Maintaining appropriate records of complaints to include timing, reported issues, actions taken and measures to be included for on-going works. The complaints log will need to be filed with the Responsible Person.
Reversing alarms	The use of audible movement alarms of a type that would minimise noise impacts on surrounding noise sensitive receivers must be implemented. Where practicable, broadband, non-tonal reversing alarms should be utilised on site equipment. Ensure that the difference in volume between the reversing warning devices and the base machine noise level (at maximum governed speed under no load at any given test location) is minimised (in accordance with International Standard ISO9533:1989), and ensure that warning devices are no more than 5 dB above the Australian Standard level;
Material handling	Avoid dropping equipment/materials from a height or into trucks. Where practicable, use sound dampening material to cover the surfaces on to which any materials must be dropped.
Equipment Location	Site noisy equipment away from noise-sensitive areas. Plant known to emit noise strongly in one direction is to be orientated so that the noise is directed away from noise-sensitive areas; Locate site access roads and site compounds as far away as possible from noise sensitive receptors; Plan truck movements to avoid residential streets where possible;

3.9 Construction vibration management

The following guidance provides recommended minimum working distances for vibration intensive plant proposed as part of the construction works. These are based on international standards and guidance and reproduced in Table 25 below for reference.

Table 25: Recommended minimum working distances for vibration intensive plant

Plant Item	Rating / Description	Minimum working distance	
		Cosmetic damage (BS 7385)	Human response (OH&E Vibration Guideline)
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure
Impact Piling	3500 J	24 m	20m

The safe working distances presented are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions.

The contractor will be required to manage vibration as well as noise and make use of best practice in the management of vibration using simple and practicable techniques such as avoiding dropping heavy items.

Where vibration intensive works are required within the minimum working distances outlined in Table 25, vibration monitoring at the nearest potential affected building should be considered, where real-time alerts can be generated when measured vibration levels exceed criteria.

Given the structures immediately adjacent to the site, adverse effects to both human comfort and structural damage are likely if management measures are not adhered to.

4 Operation

4.1 Overview

The primary operational noise sources with the potential to impact upon surrounding noise sensitive receivers include:

- Traffic generated by operation of the site
- Building services and external plant
- Loading dock operations & waste and recycling collection
- Patron and amplified sound including music from both internal and external spaces
- Patrons arriving at and leaving the site

4.1.1 Operational vibration impacts

The most significant sources of operational vibration would be loading of large exhibition pieces in both the loading dock and Presentation Spaces. The resulting vibration impacts at surrounding receivers is not anticipated to be high enough to affect human comfort or structural damage at surrounding premises. No vibration mitigation measures are therefore considered necessary.

4.2 Noise criteria

The following operational noise criteria have been developed in accordance with relevant NSW policy and consultation with Consent Authorities.

4.2.1 Daily operational noise

Noise level criteria for the Powerhouse Parramatta have been established in accordance with the NPfI [2], which is primarily concerned with controlling intrusive noise impacts in the short-term for residences and maintaining long-term noise level amenity for residences and other land uses.

The NPfI sets out the procedure to determine the project noise trigger levels relevant to an industrial development. The project noise trigger level is a level that, if exceeded would indicate a potential noise impact on the community and so 'trigger' a management response.

Intrusive noise trigger level

The intrusiveness noise trigger level is applicable to residential premises only and is summarised as follows:

- $L_{Aeq,15minute} \leq$ Rating Background Level (RBL) plus 5 dB

  (where $L_{Aeq,15minute}$ represent the equivalent continuous noise level of the source)

Recommended and project amenity noise level

To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from **all** industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 of the NPfI where feasible and reasonable. An extract from the policy pertinent to this assessment is given below in Table 26.

Table 26: NPfI Recommended Amenity Noise Levels (RANLs)

Receiver	Noise amenity area	Time of Day[1]	Recommended amenity noise levels (RANLs) L_{Aeq}, dBA
Residential	Urban	Day	60
		Evening	50
		Night	45
Hotels	Urban	Day	65
		Evening	55
		Night	50
School classroom - internal	All	Noisiest 1-hour period when in use	35 (see notes for table)
Place of worship – internal	All	When in use	40
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50
Commercial premises	All	When in use	65

Notes

- The recommended amenity noise levels (RANLs) 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.

1 - The NPfI defines day, evening and night time periods as:

- Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays;
- Evening: the period from 6 pm to 10 pm; and
- Night: the remaining period.

The recommended amenity noise levels (RANLs) represent the objective for total industrial noise at a receiver location, whereas the project amenity noise level (PANL) represents the objective for noise from a single industrial development at a receiver location.

To ensure that any new industrial source of noise is within the RANLs for an area, the PANL applies for each new source of industrial noise as follows:

- *Project Amenity Noise Level (PANL) = Recommended Amenity Noise Level (RANL) minus 5 dBA*

The NPfI also provides the following exceptions to the above method for deriving the project amenity noise level:

1. *In areas with high traffic noise levels.*
2. *In proposed developments in major industrial clusters.*
3. *Where the resultant project amenity noise level is 10 dB or more lower than the existing industrial noise level. In this case the project amenity noise levels can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.*
4. *Where cumulative industrial noise is not a necessary consideration because no other industries are present in the area, or likely to be introduced into the area in the future. In such cases the relevant amenity noise level is assigned as the project amenity noise level for the development.*

The area surrounding the site can be categorised as Urban in accordance with the NPfI, discussed in Section 2.1. The NPfI sets the PANLs to $L_{Aeq(period(traffic))}$ minus 15 dBA in the case that the level of transport $L_{Aeq(period(traffic))}$ exceeds the RANL by 10 dB or more. Table 27 summarises the RANLs and the PANLs applicable for the project.

Table 27: NPfI RANLs and PANLs, $dBL_{Aeq(period)}$

NCA	Indicative Noise Amenity Area	Time of day[1]	Recommended Amenity Noise Level (RANL)	Existing Traffic[2]	Project Amenity Noise Level (PANL)
Residential					
NCA 1 - Lower floors	Urban	Day	60	57	55
		Evening	50	54	45
		Night	45	50	40
NCA 2 – Upper floors	Urban	Day	60	55	55
		Evening	50	54	45
		Night	45	51	40
Hotels					
NCA 1 - Lower floors	Urban	Day	65	57	60
		Evening	55	54	50
		Night	50	50	45
NCA 2 – Upper floors	Urban	Day	65	55	60
		Evening	55	54	50
		Night	50	51	45

NCA	Indicative Noise Amenity Area	Time of day[1]	Recommended Amenity Noise Level (RANL)	Existing Traffic[2]	Project Amenity Noise Level (PANL)

1 - The NPfI defines day, evening and night time periods as:

- Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays;
- Evening: the period from 6 pm to 10 pm; and
- Night: the remaining period.

Sleep disturbance

The NSW NPfI recommends the following screening criteria for the assessment of potential sleep disturbance, for the period between 10 pm and 7 am:

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

L_{Amax} sleep disturbance criteria based on RBL + 15 dB have been adopted.

NPfI Project specific noise levels

Based on the background and ambient noise monitoring, Table 28 summarises the derived Intrusive and Amenity Levels for the project based on the NPfI.

Table 28: NPfI Project Intrusive and Amenity Levels

Receiver	Intrusive Level, $dBL_{Aeq(15minute)}$			Project Amenity Level, $dBL_{Aeq(period)}$		
	Day	Evening	Night	Day	Evening	Night
NCA 1 - Lower floors	56	54	49	55	45	40
NCA 2 – Upper floors	56	54	51	55	45	40

In addition to the above criteria, the NPfI has simplified assessment for the amenity criteria, making a crude assumption regarding the relationship between the $L_{Aeq(15min)}$ and $L_{Aeq(period)}$, applying a +3 dB correction to adjust $L_{Aeq(period)}$ Project Amenity Level to an $L_{Aeq(15min)}$. This correlates to assuming a noise source operates for half the period. This simplified adjustment has been adopted in this report.

Project Noise Trigger Levels (PNTLs) for residential receivers represent the lower of the intrusive criteria and the adjusted $L_{Aeq,15min}$ amenity criteria, shown in Table 29 and Table 30.

Table 29: Project Noise Trigger Levels – residential receivers and hotels

Receiver	PNTLs, $dBL_{Aeq(15minute)}$		
	Day	Evening	Night
Residential			
NCA 1 - Lower floors	56	48	43
NCA 2 – Upper floors	56	48	43

Receiver	PNTLs, $dBL_{Aeq(15minute)}$		
	Day	Evening	Night
Hotel			
C1(Lower) – Meriton Suites, 330 Church Street	63	53	48
C1(Upper) - Meriton Suites, 330 Church Street	63	53	48
C2 – Parkroyal Lobby 30 Phillip Street	63	53	48
C3 - Parkroyal Tower 30 Phillip Street	63	53	48

Table 30: Project Noise Trigger Levels – non-residential receivers

Receiver	PNTLs, $dBL_{Aeq(15minute)}$
Commercial receivers	
C4 - 32 Phillip Street	63
C5 - 81 Phillip Street	63
C6 - 60 Phillip Street	63
Places of Worship	
W1 - 150 Marsden Street	48[1]
W2 - 27 Elizabeth Street	48[1]
Childcare Facilities	
CC1 - 330 Church Street	53[2]
CC2 - 100 George Street	43[1]
Educational Facilities	
E1 - 2 Sorrell Street	43[1]
E2 - 3 Marist Place	43[1]
E3 - 211 Church Street	43[1]
Passive Recreation	
P1 - Prince Alfred Square	48
Community Use	
CU1 - 353-353 Church Street	63[3]

Note:

1. External noise levels have been determined by assuming a 10dB reduction through an open window.

2. MindChamps Early Learning Center does have doors on the eastern façade facing the construction area, however these doors are only used to access the outdoor play area. During sensitive times, such as rest times, these doors are closed. A 20dB reduction has been assumed through a closed door.

3. AS2107 recommends an internal noise level for a drama theatre of 25-30 dBA. A loss of 30dB through the building fabric into the theatre has been applied, based on the assumption a theatre building would require reasonably high performing building envelope.

Emergency equipment

There are no provisions in NSW legislation for noise impacts associated emergency plant.

In lieu of relevant criteria, the VIC EPA State Environment Protection Policy (SEPP) No. N-1 states:

> *Where the noise source under consideration is a standby generator, standby boiler or fire pump, the noise limit shall be increased by 10 dB for a day period and by 5 dB for all other periods.*

This is considered an appropriate provision for short and intermittent operation of equipment during testing such as stair pressurisation fans.

Application of criteria to patron and amplified noise

In the absence of NSW noise criteria which addresses amplified sound or patron noise, the NPfI [2] Project Trigger Noise Levels (PNTLs) have been applied to give an indication of potential disturbance to the community. Compliance with these criteria would indicate that these activities are considered to have a 'low risk' of disturbance to the community.

Any exceedances of these criteria have been categorised as having a 'medium risk' or 'high risk', that would trigger additional mitigation and management measures to be adopted. Further discussion is presented in Section 4.4.3.

Music low frequency noise

Low frequency noise has been assessed, however a more conservative approach has been adopted in the assessment of music noise, in which the predicted noise level has been penalised where the dBC level is more than 10 dB above the dBA level, rather than a 15 dB difference per Fact Sheet C of the NPfI. This approach has been adopted in consideration that the Parramatta Powerhouse is a new development where music noise is not a feature of the existing acoustic environment and for low-frequency music to be potentially evaluated as impulsive in nature.

4.2.2 Operational road traffic

Increased traffic generated on the surrounding road network due to either construction activities or by the operation of the Powerhouse Parramatta is assessed in accordance with the RNP. Table 3 of the NSW Road Noise Policy (RNP) which sets out the assessment criteria for particular types of project, road category and land use, shown in Table 31 below.

Table 31: Road traffic criteria for traffic generating development - residential receivers

Road category	**Type of project / land use**	**Assessment criteria – dB(A)**	
		Day (7:00am-10:00pm)	**Night (10:00pm-7:00am)**
Freeway/arterial/sub-arterial roads Wilde Avenue	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)

Road category	Type of project / land use	Assessment criteria – dB(A)	
		Day (7:00am-10:00pm)	Night (10:00pm-7:00am)

Notes: These criteria are for assessment against façade corrected noise levels when measured in front of a building façade.

Regarding the application of the assessment, the RNP states:

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.

4.3 Loading dock assessment

The majority of loading dock activities, including waste and recycling removal, deliveries for food and beverage outlets, exhibitions and installations, are proposed to take place at an internal loading dock within the ground floor of the western building. There will be a requirement for delivery vehicles to use specific routes for gaining access to the precinct, for both safety and noise mitigation reasons.

The hours of operation of these activities are not yet known, and therefore have been assessed against criteria for all time periods.

Noise breakout from activities within loading dock is anticipated to be low as the loading dock doors will remain closed at all times when vehicles are not entering or leaving.

4.3.1 Loading dock noise modelling methodology

Two scenarios have been assessed to represent potential worst-case 15-minute period of activities relating to the Powerhouse Parramatta loading dock:

Scenario 1 – Large trucks entering loading dock

- Defined as vehicles which use air brakes, considered to be trucks 6 tonnes or greater, including semi-trailers and any articulated vehicles
    - One truck entering the loading dock, travelling the length of driveway and stopping;
    - Releasing the air brake; and
    - Reversing into loading dock.

Scenario 2 – Small trucks entering loading dock

- Defined as rigid trucks which do not use air brakes, considered to be less than 6 tonnes
    - One truck entering the loading dock, travelling the length of driveway and stopping; and

- Reversing into loading dock.

Scenario 3 – Light vehicles loading goods from driveway

- Considered to be a car, van or utility vehicle
  - One vehicle entering the driveway, travelling the length of driveway and stopping;
  - Manual unloading of small goods into a standard size swing door to loading dock; and
  - Continuing forward, turning around and exiting driveway without reversing.

Truck entry is expected to generate higher noise levels than trucks leaving the loading dock, as trucks would be required to reverse into the loading dock, which requires the trucks to stop and reverse while in the driveway.

The location of the loading dock and modelled loading vehicle entry route are presented in Figure 9.

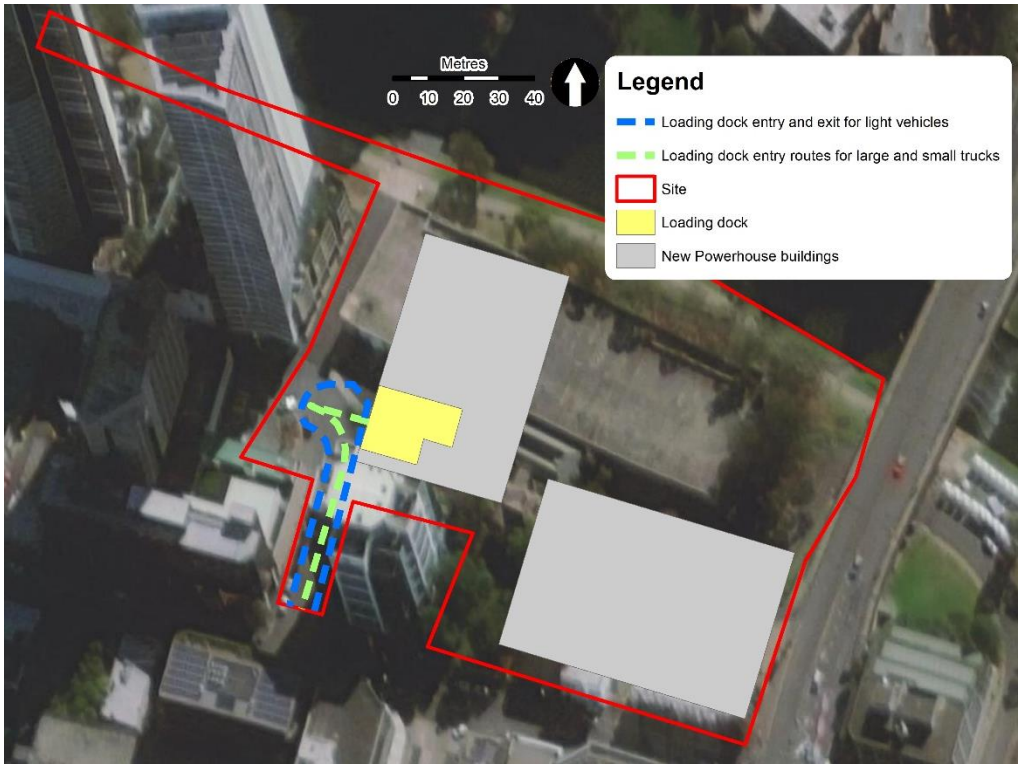


Figure 9: Loading dock and entry route

Noise from loading activities are expected to be contained within the loading dock. Doors to the loading dock will be appropriately designed to control noise egress, along with minimise noise from the opening and closing of doors. The sound insulation performance of the acoustically rated loading dock doors assumed for the assessment is presented in Table 32.

Table 32: Loading dock doors transmission loss

Item	Octave Band Centre Frequency, Hz, dB							
	63	125	250	500	1k	2k	4k	8k
Loading dock doors –automatically operated[1]	-20	-26	-40	-36	-39	-46	-50	-50

Note:

1. Assumed transmission loss based on Protec A-160 acoustic roller door

Table 33 summarises the modelled source noise levels.

Table 33: Sound power levels – loading dock activities and waste and recycling removal

Noise Source	Descriptor	Broadband level, dB(A)	Octave Band Centre Frequency – Hz, dB									Quantity operating in worst case 15 minutes
			31.5	63	125	250	500	1 k	2 k	4 k	8 k	
Large truck												
Truck accelerating – Semi-trailer / large truck, L_w	$L_{Aeq(15min)}$ / metre	70	76	73	69	66	65	67	62	58	52	1 trucks travelling length of driveway, pulling up then reversing into loading dock
Large truck releasing air brake compression (single event), L_w	$L_{Aeq(15min)}$ / metre	71	69	73	69	64	60	61	67	63	63	1 event at location truck pulls up
	L_{Amax}	116	114	118	114	109	105	106	112	108	108	
Truck reversing alarm[1], L_w	$L_{Aeq(15min)}$ / metre	69	73	75	74	65	63	62	64	53	44	Active while truck is reversing into loading dock
Small truck												
Truck accelerating – Small rigid truck, L_w	$L_{Aeq(15min)}$ / metre	64	78	71	62	63	60	59	58	52	46	1 trucks travelling length of driveway, pulling up then reversing into loading dock
Truck reversing alarm[1], L_w	$L_{Aeq(15min)}$ / metre	69	73	75	74	65	63	62	64	53	44	Active while truck is reversing into loading dock
Light vehicle												
Light vehicle accelerating, L_w	$L_{Aeq(15min)}$ / metre	64	78	71	62	63	60	59	58	52	46	1 vehicle travelling length of driveway, pulling up then continuing forward and turning around with no reversing.
Car door slam, L_w	L_{Amax}	97	99	90	90	92	94	90	88	84	84	
	$L_{Aeq(15min)}$	82	85	75	76	77	80	75	73	69	69	

Note:

1. Sound power level includes 5dB penalty for tonal noise in accordance with NPfI [2]

4.3.2 Loading dock prediction results

Results for residential receivers (including mixed use developments) and hotel receivers for the day, evening and night-time periods are presented in Table 34, Table 35 and Table 36. Results for all other noise sensitive receivers are presented in Table 37 where Project Noise Trigger Levels (PNTLs) apply when the developments are in use.

Table 34: Loading dock assessment – 1. Large trucks

Receiver	$L_{Aeq(15minute)}$ Assessment				Sleep disturbance assessment, L_{max}	
	Predicted Noise level	Project Noise Trigger Level			Predicted Noise level	Project Noise Trigger Level Night only
		Day	Evening	Night		
Residential receivers (including mixed use developments)						
R1 - 14 Lamont Street	20	56	48	43	38	61
R2 - 3 Sorrell Street	41	56	48	43	43	59
R3(Upper) - 330 Church Street	48	56	48	43	71	61
R3(Lower) - 330 Church Street	46	56	48	43	69	59
R4(Upper) - 12 Phillip Street	26	56	48	43	46	59
R4(Lower) - 12 Phillip Street	28	56	48	43	44	59
R5 - 5 Elizabeth Street	15	56	48	43	32	59
R6 - 1 Robertson Street	13	56	48	43	30	59
M1 - 66 Phillip Street	16	56	48	43	33	59
M2 - 302 Church Street	41	56	48	43	41	59
M3 - 295 Church Street	24	56	48	43	43	59
Hotels						
C1(Lower) – Meriton Suites, 330 Church Street	55	63	53	48	69	59
C1(Upper) - Meriton Suites, 330 Church Street	51	63	53	48	67	61
C2 – Parkroyal Lobby 30 Phillip Street	56	63	53	48	81	59
C3 - Parkroyal Tower 30 Phillip Street	58	63	53	48	81	59

Notes:

Levels shaded in grey indicate an exceedance of PNTL.

Table 35: Loading dock assessment – 2. Small trucks

Receiver	$L_{Aeq(15minute)}$ Assessment				Sleep disturbance assessment, L_{max}	
	Predicted Noise level	Project Noise Trigger Level			Predicted Noise level	Project Noise Trigger Level Night only
		Day	Evening	Night		
Residential receivers (including mixed use developments)						
R1 - 14 Lamont Street	29	56	48	43	41	61
R2 - 3 Sorrell Street	36	56	48	43	34	59
R3(Upper) - 330 Church Street	42	56	48	43	58	61
R3(Lower) - 330 Church Street	41	56	48	43	55	59
R4(Upper) - 12 Phillip Street	21	56	48	43	31	59
R4(Lower) - 12 Phillip Street	21	56	48	43	31	59
R5 - 5 Elizabeth Street	25	56	48	43	37	59
R6 - 1 Robertson Street	23	56	48	43	35	59
M1 - 66 Phillip Street	13	56	48	43	19	59
M2 - 302 Church Street	35	56	48	43	28	59
M3 - 295 Church Street	18	56	48	43	30	59
Hotels						
C1(Lower) – Meriton Suites, 330 Church Street	49	63	53	48	49	59
C1(Upper) - Meriton Suites, 330 Church Street	44	63	53	48	46	61
C2 – Parkroyal Lobby 30 Phillip Street	51	63	53	48	68	59
C3 - Parkroyal Tower 30 Phillip Street	52	63	53	48	67	59

Notes:

Levels shaded in grey indicate an exceedance of PNTL.

Table 36: Loading dock assessment – 3. Light vehicles

Receiver	$L_{Aeq(15minute)}$ Assessment				Sleep disturbance assessment, L_{max}	
	Predicted Noise level	Project Noise Trigger Level			Predicted Noise level	Project Noise Trigger Level Night only
		Day	Evening	Night		
Residential receivers (including mixed use developments)						
R1 - 14 Lamont Street	23	56	48	43	33	61
R2 - 3 Sorrell Street	33	56	48	43	43	59
R3(Upper) - 330 Church Street	39	56	48	43	49	61
R3(Lower) - 330 Church Street	38	56	48	43	48	59
R4(Upper) - 12 Phillip Street	12	56	48	43	23	59
R4(Lower) - 12 Phillip Street	18	56	48	43	27	59
R5 - 5 Elizabeth Street	19	56	48	43	28	59
R6 - 1 Robertson Street	17	56	48	43	27	59
M1 - 66 Phillip Street	9	56	48	43	18	59
M2 - 302 Church Street	28	56	48	43	24	59
M3 - 295 Church Street	13	56	48	43	23	59
Hotels						
C1(Lower) – Meriton Suites, 330 Church Street	45	63	53	48	55	59
C1(Upper) - Meriton Suites, 330 Church Street	41	63	53	48	51	61
C2 – Parkroyal Lobby 30 Phillip Street	45	63	53	48	55	59
C3 - Parkroyal Tower 30 Phillip Street	48	63	53	48	58	59

Notes:

Levels shaded in grey indicate an exceedance of PNTL.

Results show exceedances of night time PNTLs are predicted for large and small truck use assuming one truck entering the loading dock per 15 minute period.

Exceedances of sleep disturbance criteria are predicted at both nearest residences due to large or small trucks outside of the loading dock. Exceedances of up to 22 dB predicted at the nearest hotels. These exceedances would occur once per large truck entering or leaving the loading dock.

No exceedances are predicted with the use of light vehicles.

Table 37: Predicted noise levels at other noise-sensitive receivers (criteria apply when receivers are in use), $dBL_{Aeq(15min)}$

Receiver	PNTL	Predicted Noise level		
		1. Large trucks	2. Small trucks	3. Light vehicles
Commercial receivers				
C4 - 32 Phillip Street	**63**	52	45	42
C5 - 81 Phillip Street	**63**	44	38	31
C6 - 60 Phillip Street	**63**	23	17	11
Places of Worship				
W1 - 150 Marsden Street	**48**	15	10	<10
W2 - 27 Elizabeth Street	**48**	11	<10	<10
Childcare Facilities				
CC1 - 330 Church Street	**53**	54	47	42
CC2 - 100 George Street	**43**	18	13	<10
Educational Facilities				
E1 - 2 Sorrell Street	**43**	29	29	23
E2 - 3 Marist Place	**43**	13	<10	<10
E3 - 211 Church Street	**43**	13	<10	<10
Passive Recreation				
P1 - Prince Alfred Square	**48**	41	36	33
Community Use				
CU1 - 353-353 Church Street	**63**	18	12	<10

Results show no exceedances of PNTLs for non-residential receivers are predicted.

4.3.3 Recommendations

Loading dock doors

Loading dock doors require acoustic treatment to reduce noise emissions to meet both PNTLs and sleep disturbance criteria at surrounding receivers. An indicative transmission loss is presented in Table 32, however this performance would be

further developed as the building design and operational activities are confirmed at detailed design stage.

Only loading or unloading of light vehicles via manual handling shall take place outside the loading dock.

No loading shall take place while any loading dock doors are open.

Loading dock vehicles

Large trucks which require air brakes, generally considered to be 6 tonnes or greater, shall not enter or leave the loading dock between 6pm and 7am.

Small trucks which do not require air brakes, generally considered to be less than 6 tonnes, shall not enter or leave the loading dock between 10pm and 7am.

Light vehicles may only deliver goods via manual handling between 10pm and 7am.

Large and small trucks entering the loading dock shall not idle outside the loading dock between 10pm and 7am.

Large and small trucks shall not queue within the driveway and shall park off-site if awaiting entry to the loading dock between 10pm and 7am.

4.4 Patron and music noise assessment

A number of activities proposed to be held at the Powerhouse Parramatta may generate large crowds and include the provision of music, either in the form of background music or more focal entertainment. A program outlining proposed activities to be held in each space of the Powerhouse Parramatta has been developed and a description of these is presented in Table 38.

Table 38: Proposed activities and noise descriptions

Activity	Description of use	Primary noise sources	Overview of acoustic environment within activity space
Exhibition	Public exhibition of installations	Patron conversations Installations with sound	Low to moderate noise levels
Installation / de-installation of exhibitions	Loading / unloading and installation / de-installation of exhibition pieces	Staff conversations Loading and unloading noise	Typically low noise levels, with intermittent noise from loading / unloading activities.
Program	Conferences and symposiums	Amplified speech Patron conversations	Low to moderate noise levels.

Activity	Description of use	Primary noise sources	Overview of acoustic environment within activity space
	Film, performances and music (concerts)	Amplified music during concerts Amplified speech Noise from large crowd	Moderate to high noise levels possible, with highest noise levels associated with amplified music.
Commercial	Commercial use under lease, eg. corporate functions, Christmas parties, dinners	Amplified music during Christmas parties or functions Amplified speech Patron conversations	Medium to high noise levels.

A summary of the loudest activities to be held within each space is provided in Table 39.

Table 39: Highest intensity activities and modelled scenarios

Space	Description	Loudest activity assessed	Noise sources	Capacity based on event type		Modelled scenario
				Physical	Typical	
PS1	Internal space with large 'mega door' to north, five entry doors to south and large loading door to east	Program - concerts	Amplified live music Crowd noise	4368	2500	Rear entry doors and loading doors closed, mega door both open and closed[1]
PS2	Internal space with large loading door to south	Commerc. – corporate function	Amplified live music Crowd noise	1000	800	Loading door closed[1]
PS3	Internal space with no large openings	Emissions to surrounding external receivers readily controlled by the building design and therefore not assessed.				
PS4	Internal space with no large openings	Emissions to surrounding external receivers readily controlled by the building design and therefore not assessed.				
PS5	Internal space with no large openings	Emissions to surrounding external receivers readily controlled by the building design and therefore not assessed.				
PS6	Internal space with no large openings	Emissions to surrounding external receivers readily controlled by the building design and therefore not assessed.				
PS7	Internal space with no large openings	Emissions to surrounding external receivers readily controlled by the building design and therefore not assessed.				
PS7 terrace	Outdoor area on Level 4	Commerc. – corporate function	Amplified pre-recorded music or acoustic live music Crowd noise	1000 – combined PS7 and terrace	1000 – combined PS7 and terrace	Patrons occupying the north and east areas of the balcony

Space	Description	Loudest activity assessed	Noise sources	Capacity based on event type		Modelled scenario
				Physical	Typical	
Roof. garden	Outdoor area on Level 4	Commerc. – corporate function	Amplified pre-recorded music or acoustic live music Crowd noise	465	465	Patrons occupying the entire rooftop garden

Notes:

1. Mega door, entry doors and loading door assumed transmission losses presented in Table 42.

It is generally anticipated that loud activities would not be scheduled to occur concurrently. Some commercial activities (eg. functions) on may overlap with loud program activities (eg. concerts), however the loudest 'program' activities occurring simultaneously would be infrequent.

4.4.1 Modelling methodology

Modelled noise sources which represent loudest activities in each space are presented in Table 40.

Table 40: Modelled noise sources

Space	Source	Space capacity	Modelled parameters		
			Day	Evening	Night
PS1 – mega door closed	Patrons	4368	4368	4368	4368
	Music		Amplified live music	Amplified live music	Amplified live music – limited to 94dBA
PS1 – mega door open	Patrons	4368	750	300	160
	Music		No music	No music	No music
PS7 terrace	Patrons	1000 – combined PS7 and terrace	500 – combined east and north terrace[1]	300 – combined east and north terrace[1]	250 – on east terrace only[1]
	Music		Amplified pre-recorded music or acoustic live music	Amplified pre-recorded music or acoustic live music	No music at night
Rooftop garden	Patrons	465	465	300	300
	Music		Amplified pre-recorded music or acoustic live music	Amplified pre-recorded music or acoustic live music	No music at night

Note:

1. See Figure 10.

Noise source spectra used in modelling of music and patron activity is presented in Table 41.

Table 41: Modelled noise source spectra $dBL_{eq15min}$

Noise source	Overall		Octave Band Centre Frequency, Hz, dB							
	dBA	dBC	63	125	250	500	1k	2k	4k	8k
PS1 and PS2 - Internal sound pressure level										
Amplified live music[1]	100	111	111	98	95	95	97	92	85	79
Indicative internal crowd noise in PS1 – 4368 people[2]	88	89	64	69	79	85	84	79	74	64
PS7 terrace and Rooftop garden - Sound power level										
Amplified pre-recorded music or acoustic live music – equivalent to 80dBA at 5m from speaker	102	109	108	100	97	97	99	94	87	81
Indicative outdoor crowd noise on PS7 terrace – 500 people[3]	106	105	81	86	96	102	101	96	91	81

Notes:

1. Spectrum based on front of house measurements conducted in 2016 of Coldplay at Allianz Stadium, Sydney to capacity crowd. Noise level based on Powerhouse Parramatta Stage 3 Design brief [10]. Based on Arup's measurement database of music played at concert events, a typical difference between L_{Aeq} and L_{A10} levels is 5dB, therefore a conservative level of 100 $dBL_{Aeq(15min)}$ has been used to model concert noise levels.

2. Noise level and spectra calculated using Rindell [11]. Crowd noise levels have been calculated by adjusting the spectrum according to the sound power level for the corresponding crowd size.

3. Noise level calculated using Hayne et. al. [12], spectra adopted from Cushing et. al. [13]. Crowd noise levels have been calculated by adjusting the spectrum according to the sound power level for the corresponding crowd size.

The location of modelled noise sources are shown in Figure 10, Figure 11, Figure 12 and Figure 13. Noise transmission via these elements are anticipated to be the highest contributors to noise at surrounding receivers. Noise transmission through other paths such as ventilation openings or smaller doors have not been considered in this assessment but all noise paths in the building envelopes shall be assessed and appropriately acoustically treated at detailed design stage.

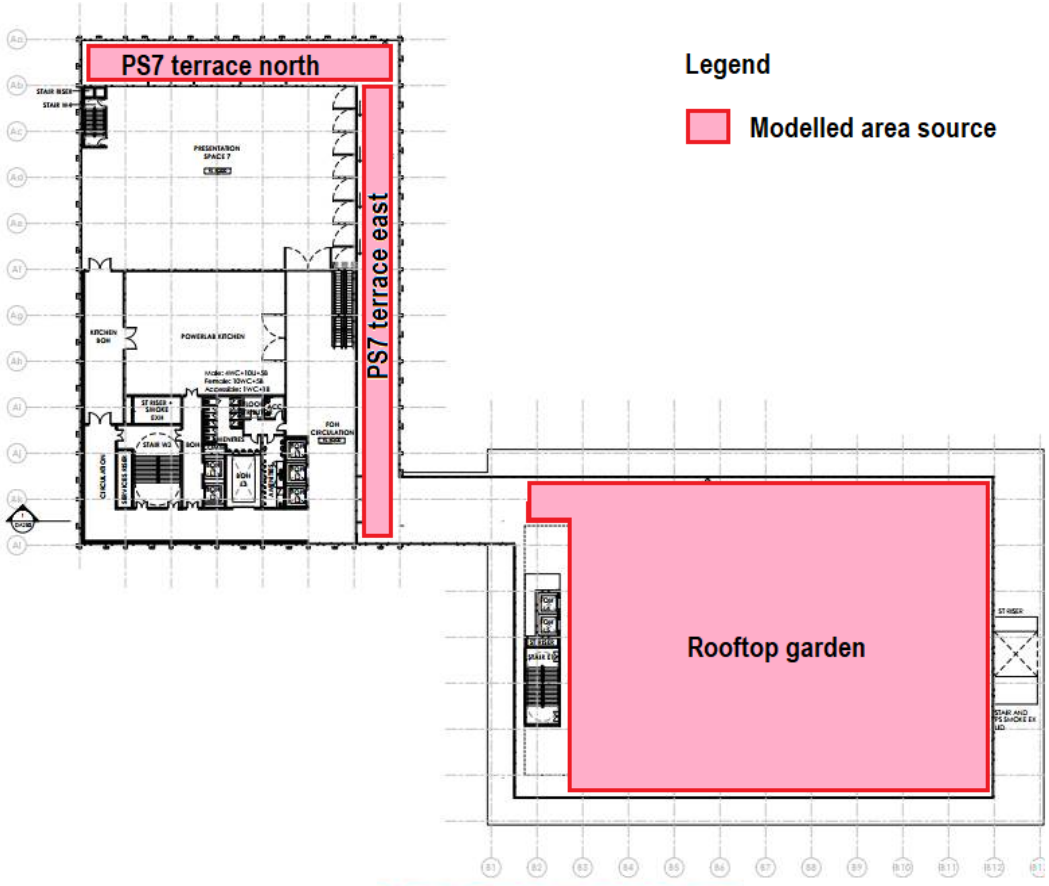


Figure 10: Modelled patron and music noise sources - Level 4 plan

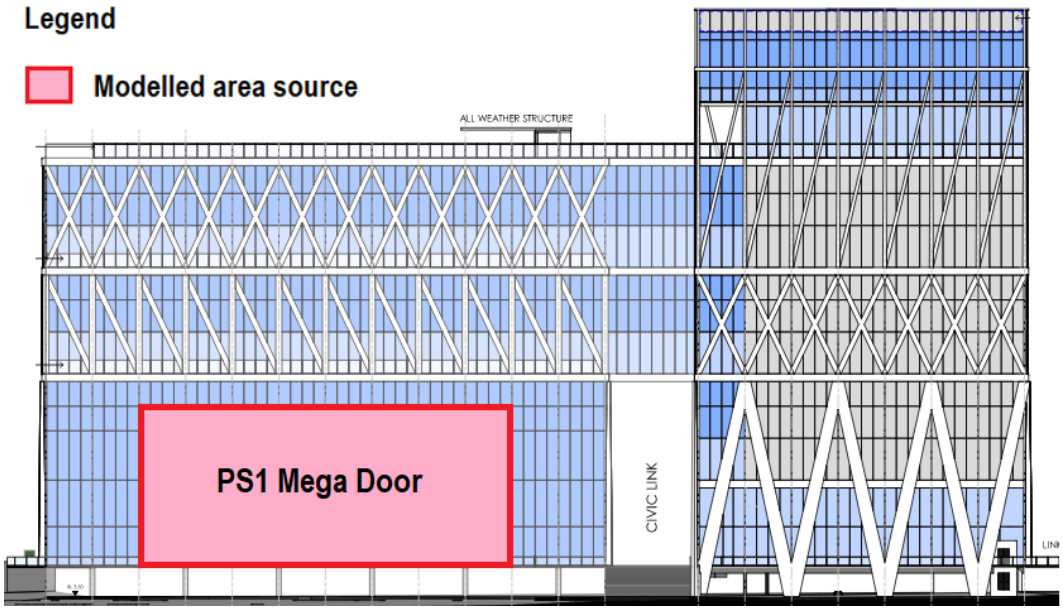


Figure 11: Modelled patron and music noise source - Northern elevation

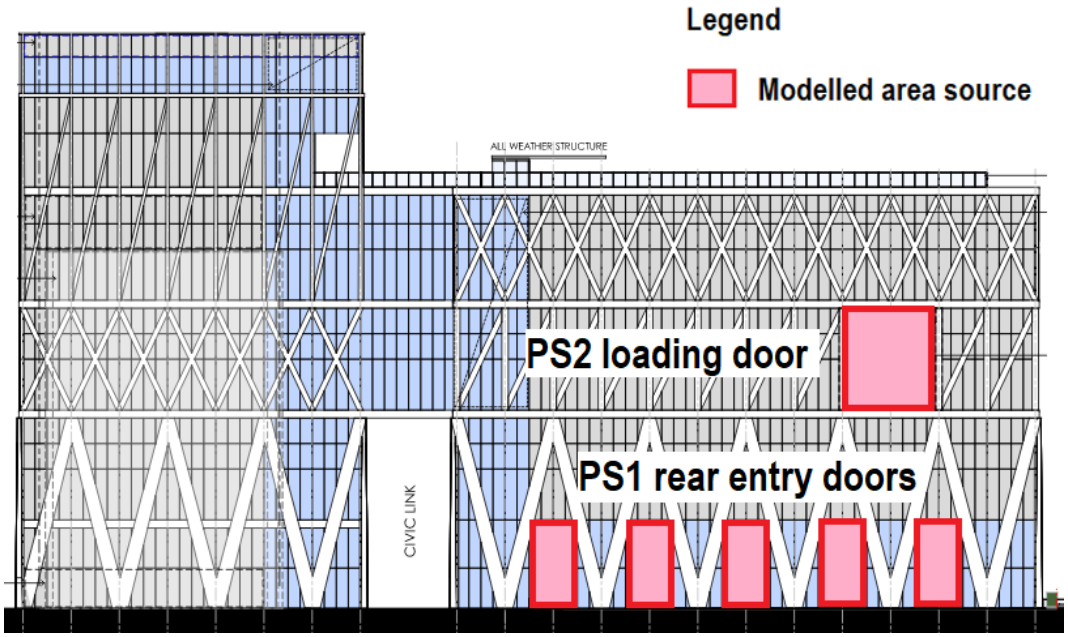


Figure 12: Modelled patron and music noise source - Southern elevation

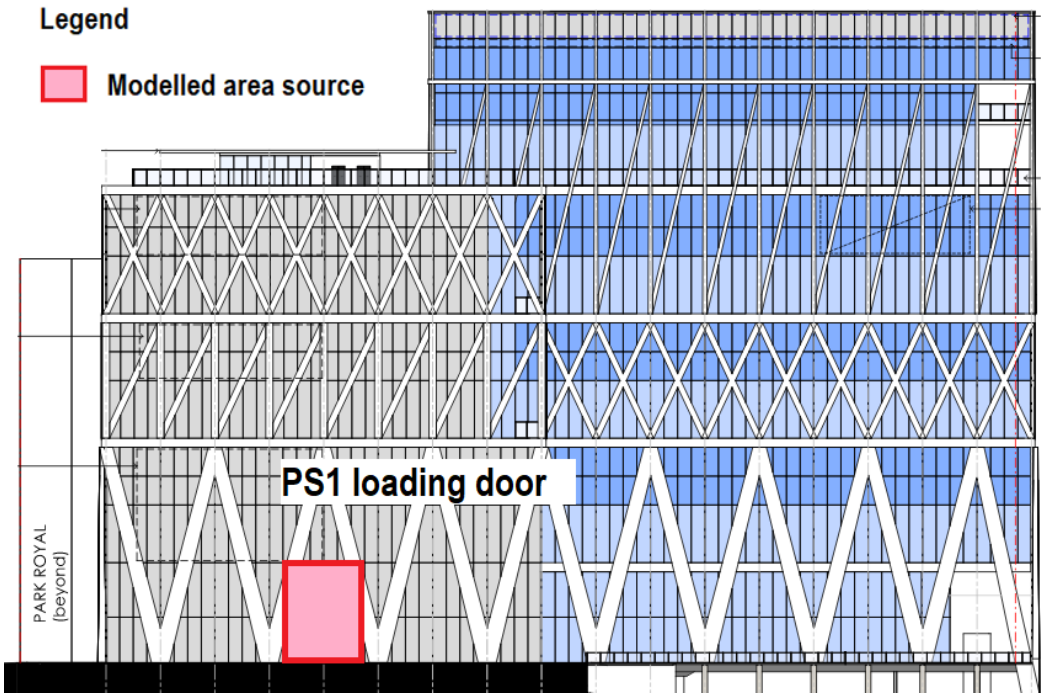


Figure 13: Modelled patron and music noise source - Eastern elevation

Assumed transmission loss performances of the mega door, rear entry doors and loading doors to PS1 and PS2 are presented in Table 42.

Table 42: Modelled door transmission losses

Transmission loss - Item	Octave Band Centre Frequency, Hz, dB							
	63	125	250	500	1k	2k	4k	8k
Mega door, entry doors and loading doors[1]	-17	-23	-37	-33	-36	-43	-47	-47

Note:

1. Assumed transmission losses based on Protec A-100 acoustic roller door

Noise emissions have been modelled using SoundPlan 8 using the ISO 9613-2 algorithm, which is considered appropriate for this scenario with nearest receivers located within 100 metres of the noise sources.

The model included:

- Activity noise sources listed in Table 40;
- Powerhouse Parramatta and surrounding buildings;
- Receivers listed in Section 2.3; and
- Ground terrain and absorption.

4.4.2 Results

Results for loudest proposed activities in each space of the Powerhouse Parramatta are presented in the following tables:

- Table 43: Residential and hotel receivers – Day period
- Table 44: Residential and hotel receivers – Evening period
- Table 45: Residential and hotel receivers – Night period
- Table 46: Other sensitive receivers – When in use

Table 43: Patron and music assessment at residential and hotels - Day

Receiver	PNTL	Predicted Noise level, $dBL_{Aeq(15min)}$				
		PS1 – Doors closed	PS1 – Doors open	PS2	PS7 terrace	Rooftop garden
Residential receivers (including mixed use developments)						
R1 - 14 Lamont Street	**56**	48	56	11	52	43
R2 - 3 Sorrell Street	**56**	42	50	<10	54	44
R3(Upper) - 330 Church Street	**56**	30	36	10	35	34
R3(Lower) - 330 Church Street	**56**	31	32	12	40	48
R4(Upper) - 12 Phillip Street	**56**	25	31	<10	25	35
R4(Lower) - 12 Phillip Street	**56**	27	31	<10	26	37
R5 - 5 Elizabeth Street	**56**	46	54	17	49	39
R6 - 1 Robertson Street	**56**	44	52	13	45	39

Receiver	PNTL	Predicted Noise level, dBL$_{Aeq(15min)}$				
		PS1 – Doors closed	PS1 – Doors open	PS2	PS7 terrace	Rooftop garden
M1 - 66 Phillip Street	**56**	42	49	20	44	36
M2 - 302 Church Street	**56**	48	27	31	28	32
M3 - 295 Church Street	**56**	23	25	<10	25	32
Hotels						
C1(Lower) – Meriton Suites, 330 Church Street	63	32	38	10	51	31
C1(Upper) - Meriton Suites, 330 Church Street	63	30	35	10	52	46
C2 – Parkroyal Lobby 30 Phillip Street	63	29	31	<10	35	39
C3 - Parkroyal Tower 30 Phillip Street	63	31	35	10	41	33

Table 44: Patron and music assessment at residential and hotels - Evening

Receiver	PNTL	Predicted Noise level dBL$_{Aeq(15min)}$				
		PS1 – Doors closed	PS1 – Doors open	PS2	PS7 terrace	Rooftop garden
Residential receivers (including mixed use developments)						
R1 - 14 Lamont Street	**48**	48	48	11	48	42
R2 - 3 Sorrell Street	**48**	42	42	<10	37	42
R3(Upper) - 330 Church Street	**48**	30	28	10	26	33
R3(Lower) - 330 Church Street	**48**	31	24	12	25	47
R4(Upper) - 12 Phillip Street	**48**	25	23	<10	19	34
R4(Lower) - 12 Phillip Street	**48**	27	23	<10	20	35
R5 - 5 Elizabeth Street	**48**	46	46	17	46	38
R6 - 1 Robertson Street	**48**	44	44	13	43	38
M1 - 66 Phillip Street	**48**	42	42	20	41	35
M2 - 302 Church Street	**48**	48	19	31	24	30
M3 - 295 Church Street	**48**	23	18	<10	20	31
Hotels						
C1(Lower) – Meriton Suites, 330 Church Street	53	32	31	10	30	30
C1(Upper) - Meriton Suites, 330 Church Street	53	30	27	10	31	44
C2 – Parkroyal Lobby 30 Phillip Street	53	29	23	<10	27	37

Receiver	PNTL	Predicted Noise level dBL$_{Aeq(15min)}$				
		PS1 – Doors closed	PS1 – Doors open	PS2	PS7 terrace	Rooftop garden
C3 - Parkroyal Tower 30 Phillip Street	53	31	27	10	31	31

Table 45: Patron and music assessment at residential and hotels - Night

Receiver	PNTL	Predicted Noise level, dBL$_{Aeq(15min)}$				
		PS1 – Doors closed	PS1 – Doors open	PS2	PS7 terrace	Rooftop garden
Residential receivers (including mixed use developments)						
R1 - 14 Lamont Street	**43**	43	43	11	43	38
R2 - 3 Sorrell Street	**43**	36	37	<10	32	39
R3(Upper) - 330 Church Street	**43**	24	23	10	21	29
R3(Lower) - 330 Church Street	**43**	25	19	12	21	43
R4(Upper) - 12 Phillip Street	**43**	19	18	<10	15	30
R4(Lower) - 12 Phillip Street	**43**	21	18	<10	15	32
R5 - 5 Elizabeth Street	**43**	41	41	17	41	34
R6 - 1 Robertson Street	**43**	39	39	13	38	34
M1 - 66 Phillip Street	**43**	36	37	20	37	31
M2 - 302 Church Street	**43**	42	14	31	20	27
M3 - 295 Church Street	**43**	18	13	<10	15	27
Hotels						
C1(Lower) – Meriton Suites, 330 Church Street	48	27	26	10	26	26
C1(Upper) - Meriton Suites, 330 Church Street	48	24	22	10	26	41
C2 – Parkroyal Lobby 30 Phillip Street	48	23	18	<10	23	34
C3 - Parkroyal Tower 30 Phillip Street	48	25	22	10	26	28

Table 46: Patron and music assessment at non-residential receivers – When in use

Receiver	PNTL	Predicted Noise level dBL$_{Aeq(15min)}$				
		PS1 – Doors closed	PS1 – Doors open	PS2	PS7 terrace	Rooftop garden
Commercial receivers						
C4 - 32 Phillip Street	**63**	36	37	17	47	45
C5 - 81 Phillip Street	**63**	66	44	45	36	40

Receiver	PNTL	Predicted Noise level dBL$_{Aeq(15min)}$				
		PS1 – Doors closed	PS1 – Doors open	PS2	PS7 terrace	Rooftop garden
C6 - 60 Phillip Street	**63**	58	66	28	33	39
Places of Worship						
W1 - 150 Marsden Street	**48**	28	18	22	26	36
W2 - 27 Elizabeth Street	**48**	22	29	<10	41	27
Childcare Facilities						
CC1 - 330 Church Street	**53**	37	45	<10	37	29
CC2 - 100 George Street	**43**	43	42	29	26	30
Educational Facilities						
E1 - 2 Sorrell Street	**43**	46	54	<10	50	41
E2 - 3 Marist Place	**43**	18	24	<10	41	16
E3 - 211 Church Street	**43**	23	20	23	31	37
Passive Recreation						
P1 - Prince Alfred Square	**48**	42	50	<10	54	44
Community Use						
CU1 - 353-353 Church Street	**63**	28	35	<10	44	20

Results show no exceedances of PNTLs are predicted during the day, evening or night at residences or hotels.

Although night-time activities have been assessed across the entire period, i.e. 10pm till 7am, it is unlikely activities will continue past midnight.

Results show exceedances of PNTLs are predicted at E1 - 2 Sorrell Street and P1 - Prince Alfred Square due to the use of the PS7 terrace and PS1 when mega door is open, as well as two commercial receivers when PS1 is used during the daytime. Exceedances are not expected to be a significant issue at these receivers, as the loudest activities on the PS7 terrace and PS1 are expected to be infrequent, and predicted noise levels assume open windows to the E1 - 2 Sorrell Street, which if closed could reduce the predicted noise levels by 10 dB as a conservative estimate. Exceedances of 3dB at commercial receivers is not anticipated to generate significant disturbances at these receivers.

4.4.3 Recommendations

As results indicate that predicted noise levels at all residential receivers and all but two non-residential receivers comply with the NPfI PNTLs, the proposed activities presented in Table 40 have been categorised as ‘low risk’ operations and considered reasonably permissible to occur on a regular basis.

Although noise emissions have been assessed to night time PNTLs, the risk of noise disturbance to the community at times between 12:00 am and 7:00 am is considered higher than other times due to the communities higher sensitivity to

noise during these times, therefore any activity which is proposed to extend beyond 12:00 am or begin prior to 7:00 am is automatically considered a ‘medium risk’ activity.

Notwithstanding these findings, further detailed assessment and design will required during the detailed design stage of the project to confirm all building design and operational assumptions.

Potential disturbance to the community due to activities which have been categorised as medium or high risk would be dependent on a number of factors:

- Frequency of activity per year
- Magnitude to which patron numbers and/or music levels exceed those deemed as ‘low risk’
- Duration of activities and operating hours

Definitions and requirements for each risk category are outlined below.

Low risk activities

Defined as:

- Occurring between 7:00 am and 12:00 am
- Patron numbers and music levels are equal to or below Table 40

Required mitigation measures

- Ensure patron numbers are equal to or below Table 40

Medium risk activities

Defined as:

- Extending beyond the period from 7:00 am to 12:00 am
- Patron numbers and music levels are equal to or below Table 40

Required mitigation measures

- Noise monitoring at nearest affected receivers for the duration of any ‘medium risk’ activities
- An Event Representative(s) shall be appointed for each activity at the Parramatta Powerhouse, with the responsibility and appointed authority to exercise control of noise emissions from the Parramatta Powerhouse.
- Provide details of the activity on the Powerhouse website, including date, time, duration, location and nature of event and noise sources.
- An information Hot Line would be available at all times during an activity. Details of the Hot Line will be provided via the Powerhouse website.

High risk activities

Defined as:

- Extending beyond the period from 7:00 am to 12:00 am
- Patron numbers or music levels exceed Table 40

Required mitigation measures

- All medium mitigation measures
- Written notification of the upcoming activity will be distributed by a letterbox drop to noise sensitive receivers within the notification boundary between 5 to 14 days prior to the activity.

It is recommended that a 'trial period' be put in place which would extend over the first 12 months of the Powerhouse Parramatta's operation. During the trial period, a comparison of PNTLs and measured noise levels at nearby receivers during 'medium' or 'high' risk activities shall be made to refine values in Table 40 and determine the appropriateness of the above mitigation measures.

The operational mitigation measures, including revised 'deemed to comply' conditions to be developed during detailed design, shall be incorporated into an Operational Noise Management Plan (ONMP). The ONMP shall be reviewed annually or more regularly on an 'as needs' basis. These reviews should consider any changes to the acoustic environment and whether additional noise monitoring is appropriate to re-establish NPfI PNTLs.

The review shall be conducted in consultation with an Accredited Acoustic Consultant.

4.5 Public domain and patron ingress and egress

The use of on-site areas external to the buildings during day to day operations is expected to be generally limited to:

- arriving on site and entering the buildings;
- leaving the buildings and leaving site;
- moving between buildings; and
- congregating, passive recreation such as eating, reading, talking.

The use of the public domain and ground floor terraces for activities such as community festivals, events and partnerships with City of Parramatta Council will be developed through a program prior to operation. Separate approval will be sought for these through City of Parramatta when the parameters are known.

The loudest activity considered part of the Powerhouse Parramatta daily operations is anticipated to be the egress of patrons from site, for which large numbers of patrons may exit at similar times and congregate in the public domain. The extent to which this will occur will be dependent on the programming of activities throughout the site, however when it occurs, it is expected to be for a limited duration. This may occur late at night at the closure of the Powerhouse Parramatta.

A worst-case and typical-case scenario for patrons leaving the site have been assessed, with 10,000 and 1,100 patrons leaving the building within a 1-hour

period respectively based on data provided by the traffic consultants JMT Consulting.

4.5.1 Modelling methodology

Noise from patrons leaving the site has been predicted to nearby residential and hotel receivers. Patron noise is not anticipated to significantly affect non-residential receivers due to the temporary nature of patron egress noise, and the likely timing of these activities being outside of business hours, therefore noise impacts at these receivers has not been assessed.

Modelled noise source levels, being isolated to people noise, are presented in Table 47.

Table 47: Modelled noise source sound power levels, $dBL_{eq15min}$

Egress direction	Patrons in public domain area on site[1]	Overall dBA	Octave Band Centre Frequency, Hz, dB							
			63	125	250	500	1 k	2 k	4 k	8 k
Worst case – 10,000 patrons leaving site within 1 hour										
North west	500	93	81	81	89	92	89	85	79	72
North east	250	90	78	78	86	89	86	82	76	69
West	175	89	77	77	85	87	85	81	74	67
South west	175	89	77	77	85	87	85	81	74	67
South	1400	98	86	86	94	96	94	90	83	76
Total	**2500 in 15 minutes**									
Typical case – 1,100 patrons leaving site within 1 hour										
North west	55	84	72	72	80	82	80	75	69	62
North east	28	81	69	69	77	79	77	72	66	59
West	20	79	67	67	75	77	75	71	65	58
South west	19	79	67	67	75	77	75	71	65	58
South	154	88	76	76	84	86	84	80	74	67
Total	**550 in 15 minutes**									

Notes:

1. Provided by JMT Consulting

Sound power level and spectra calculated from Cushing et. al. [13], from a sound pressure level at 1 metre. Noise levels assume one in five patrons are talking, based on patrons actively leaving the site and less engaged in conversation.

The locations of these egress routes are presented in Figure 14.

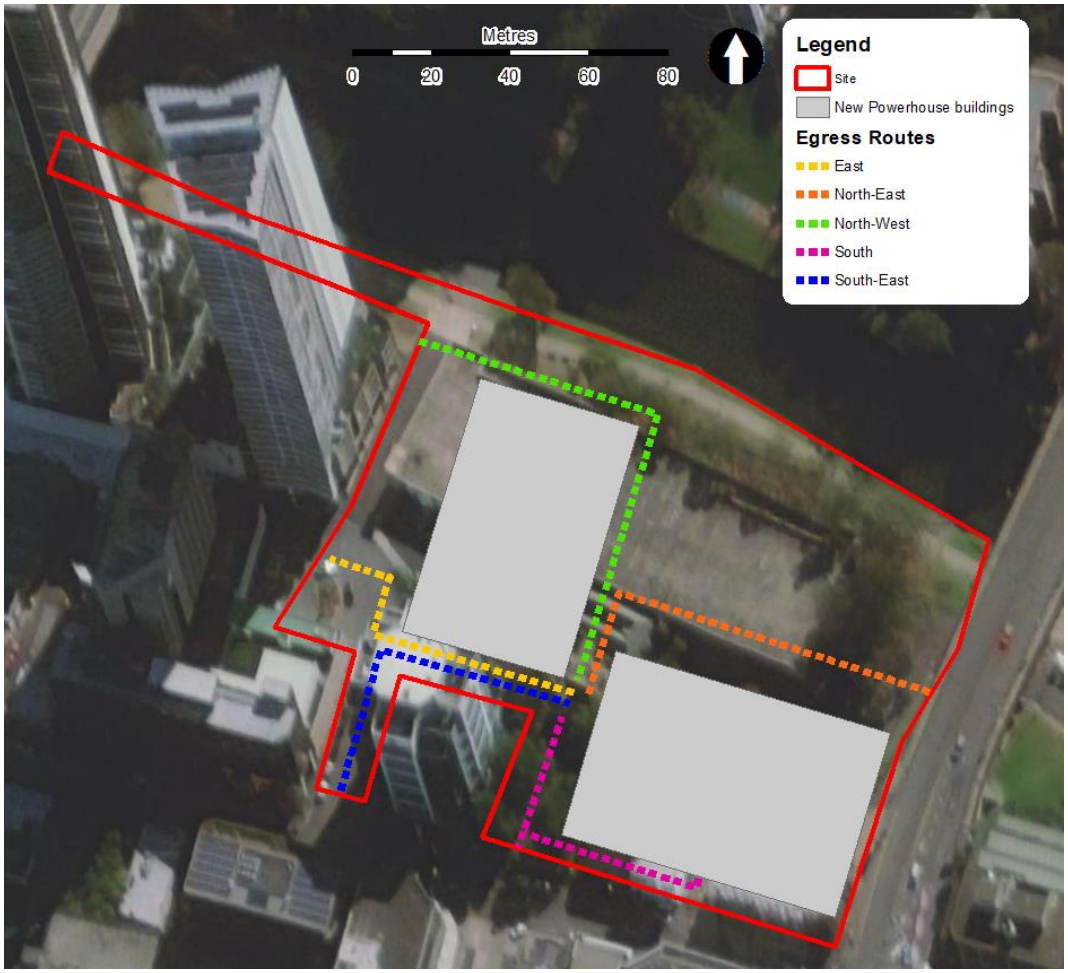


Figure 14: Modelled patron egress routes

Noise emissions have been modelled using SoundPlan 8 using the ISO 9613-2 algorithm, which is considered appropriate for this scenario with nearest receivers located within 100 metres of the noise sources. The model included:

- Patron noise sources listed in Table 47;
- Powerhouse Parramatta and surrounding buildings;
- Receivers listed in Section 2.3; and
- Ground terrain and absorption.

4.5.2 Results

As discussed in Section 4.2.1, the NPfI [2] PNTLs have been adopted in the absence of NSW policy for patron noise. Assessment to these criteria are considered to indicate disturbance to the community, but exceedance is not considered a non-compliance.

Results for both worst case scenarios and typical case scenarios are presented in Table 48 and Table 49 respectively.

Table 48: Patrons in public domain - worst case egress scenario, $L_{Aeq(15minute)}$

Receiver	Day		Evening		Night	
	PNTL	**Pred. noise level**	**PNTL**	**Pred. noise level**	**PNTL**	**Pred. noise level**
Residential receivers (including mixed use developments)						
R1 - 14 Lamont Street	**56**	45	**48**	45	**43**	45
R2 - 3 Sorrell Street	**56**	45	**48**	45	**43**	45
R3(Upper) - 330 Church Street	**56**	43	**48**	43	**43**	43
R3(Lower) - 330 Church Street	**56**	41	**48**	41	**43**	41
R4(Upper) - 12 Phillip Street	**56**	26	**48**	26	**43**	26
R4(Lower) - 12 Phillip Street	**56**	27	**48**	27	**43**	27
R5 - 5 Elizabeth Street	**56**	39	**48**	39	**43**	39
R6 - 1 Robertson Street	**56**	36	**48**	36	**43**	36
M1 - 66 Phillip Street	**56**	39	**48**	39	**43**	39
M2 - 302 Church Street	**56**	36	**48**	36	**43**	36
M3 - 295 Church Street	**56**	23	**48**	23	**43**	23
Hotels						
C1(Lower) – Meriton Suites, 330 Church Street	**63**	50	**53**	50	**48**	50
C1(Upper) - Meriton Suites, 330 Church Street	**63**	45	**53**	45	**48**	45
C2 – Parkroyal Lobby 30 Phillip Street	**63**	53	**53**	53	**48**	53
C3 - Parkroyal Tower 30 Phillip Street	**63**	52	**53**	52	**48**	52

Results show under worst case scenarios, noise levels from patrons in the public domain on-site are predicted to comply with PNTLs during the daytime and evening.

Exceedances of up to 5 dB are predicted at the Parkroyal hotel during the night. Minor exceedances of 2 dB are predicted at R1 - 14 Lamont Street, R2 - 3 Sorrell Street and C1(Lower) – Meriton Suites, 330 Church Street at night.

Table 49: Patrons in public domain - typical case egress scenario, $L_{Aeq(15minute)}$

Receiver	Day		Evening		Night	
	PNTL	**Pred. noise level**	**PNTL**	**Pred. noise level**	**PNTL**	**Pred. noise level**
Residential receivers (including mixed use developments)						
R1 - 14 Lamont Street	**56**	35	**48**	35	**43**	35
R2 - 3 Sorrell Street	**56**	35	**48**	35	**43**	35

R3(Upper) - 330 Church Street	**56**	33	**48**	33	**43**	33
R3(Lower) - 330 Church Street	**56**	31	**48**	31	**43**	31
R4(Upper) - 12 Phillip Street	**56**	16	**48**	16	**43**	16
R4(Lower) - 12 Phillip Street	**56**	17	**48**	17	**43**	17
R5 - 5 Elizabeth Street	**56**	29	**48**	29	**43**	29
R6 - 1 Robertson Street	**56**	27	**48**	27	**43**	27
M1 - 66 Phillip Street	**56**	29	**48**	29	**43**	29
M2 - 302 Church Street	**56**	27	**48**	27	**43**	27
M3 - 295 Church Street	**56**	13	**48**	13	**43**	13
Hotels						
C1(Lower) – Meriton Suites, 330 Church Street	**63**	40	**53**	40	**48**	40
C1(Upper) - Meriton Suites, 330 Church Street	**63**	35	**53**	35	**48**	35
C2 – Parkroyal Lobby 30 Phillip Street	**63**	44	**53**	44	**48**	44
C3 - Parkroyal Tower 30 Phillip Street	**63**	42	**53**	42	**48**	42

Results show noise levels comply with PNTLs during all time periods.

4.5.3 Discussion

The assessment of general patron egress indicates that there is minimal potential for disturbance for the ‘typical-case’ scenario. Regarding the higher ‘worst-case’ patron numbers, while the assessment indicates potential for noise impact, there is a low likelihood that such large patron numbers would occur, as it requires large capacity activities to occur concurrently across a number of spaces and for each activity to conclude at a similar time.

The occurrence of a worst-case scenario would also be infrequent and occur over a short duration. Nonetheless, noise due to crowds leaving site after 10pm would be managed by staff directing patrons to keep noise to a minimum when leaving the site.

No significant disturbance due to patrons in the public domain are therefore anticipated.

4.6 Building services equipment

Building service equipment (e.g. mechanical, hydraulic and electrical equipment) for the development has not been selected at this stage of design. During ongoing design of the development, building services equipment will be selected and provided with noise and vibration attenuation measures as required to meet the Project goals.

Chillers are proposed to be installed on the rooftop of the western building, which will require acoustic treatment to comply with NPfI PNTLs established in Section 4.2.1. The nearest affected receivers overlook the rooftop plant area from C1 – Meriton Suites, 330 Church Street.

Two substation locations are also proposed to in the western driveway adjacent to the Parkroyal hotel, and east of the eastern building facing Wilde Avenue, both shown in Figure 13 and Figure 14 respectively. The nearest affected receivers are C2 – Parkroyal Hotel to the western substation, and M1 - 66 Phillip Street, Parramatta to the eastern substation.

Noise mitigation treatment is anticipated to be required, including:

- Specification of maximum sound power levels for all items of plant as part of the project documentation.
- Enclosures for the substations in the western driveway
- Acoustic screens to the west of rooftop plant of adequate height to shield receivers to the west, including those on upper floors overlooking the rooftop plant
- Use of attenuators to control fan noise
- Acoustic louvres to control noise from plantroom ventilation openings
- Vibration isolators to reduce vibration input to the building structure
- Incorporation of sound absorptive treatments in plantroom spaces.

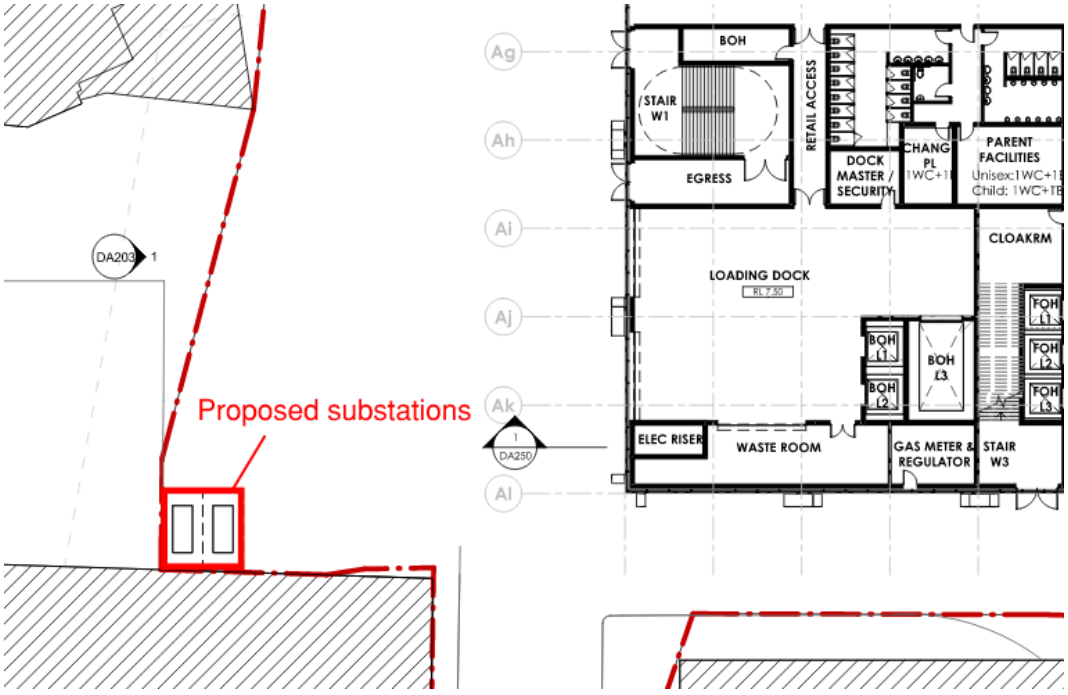


Figure 15: Substations - Western driveway

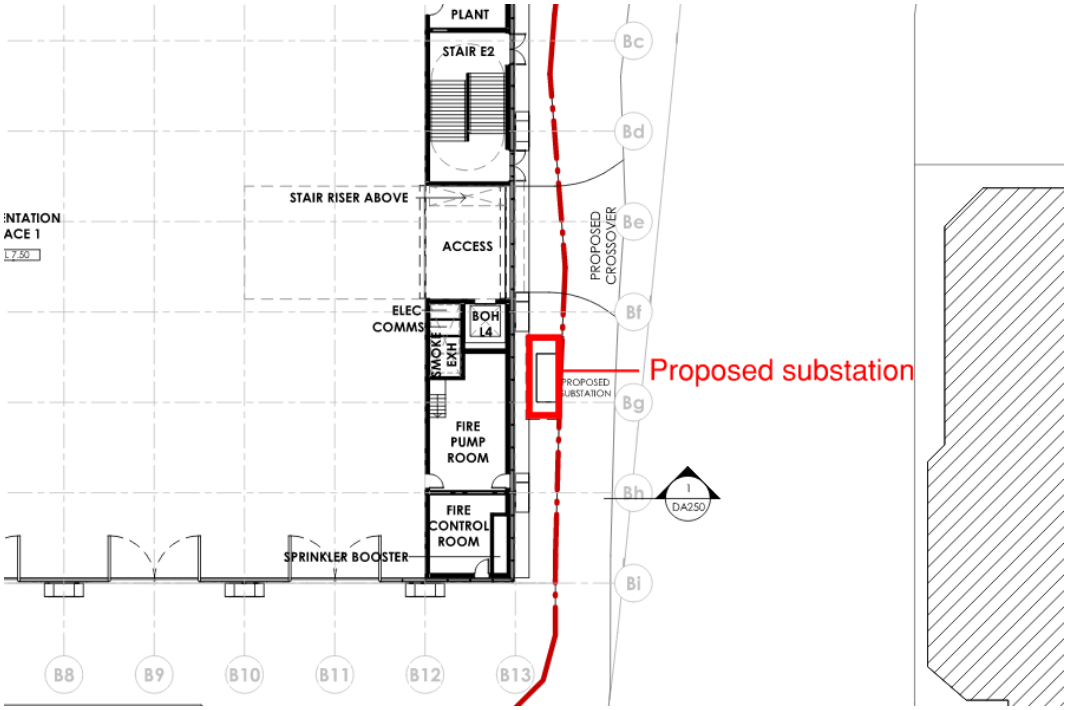


Figure 16: Substations - Wilde Avenue

4.7 Operational traffic assessment

Road traffic generated by the operation of the site is anticipated to be less than that generated during the busiest stage of construction, shown in Table 50.

Table 50: Busiest construction stage generated traffic

Heavy vehicles	Light vehicles
100-120	65

An assessment of construction generated traffic is presented in Section 3.6 which demonstrates increases in traffic are predicted to be insignificant, represented by a less than 1 dBA increase in traffic noise.

Lower operational traffic volumes are therefore deemed to comply.

5 Conclusion

An assessment of noise and vibration impacts associated with the construction and operation of the Parramatta Powerhouse has been conducted in accordance with Secretary's Environmental Assessment Requirements and relevant Strategic Policy, Technical Guidelines and National Codes.

The assessment has covered the following issues and concluded:

5.1 Construction noise

Noise generated from the various stages of demolition and construction have been predicted at surrounding noise sensitive receivers. This has been informed by guidance from the project Construction Consultant.

Should construction require the use of impact piling, dependent on yet unknown factors such as ground composition, these works are predicted to generate the most significant noise impacts. Excavation works are also predicted to exceed project NMLs, where the use of equipment such as the excavator, concrete saws, are the highest contributors to noise emissions.

Some residential receivers along the northern bank of the Parramatta River may be 'highly affected' during some periods of works, experiencing noise levels in excess of $L_{eq(15min)}$ 75dBA, however, these periods are likely to be limited in duration and frequency. Noise impacts may also significantly affect occupants in the adjacent Parkroyal hotel and Meriton Suites, including MindChamps Early Learning Centre located within the Meriton tower building, and scheduling of works and consultation is recommended.

The likelihood of adverse vibration impacts as a result of proposed construction works will be dependent on the piling method, with impact piling potentially generating adverse impacts at receivers in close proximity. Mitigation should be considered where vibration intensive works are required closer than 'safe working distances' to sensitive receivers, presented in Table 25.

Detailed recommendations are given for the control of construction noise for the periods where exceedances are predicted of relevant Noise Management Levels. The construction contractor is required to prepare a detailed Construction Noise and Vibration Management Sub Plan which reviews the modelled construction details and noise and vibration impacts.

5.2 Operational noise

Operation noise criteria have been established for noise emissions, which include:

- Traffic generated by operation of the site
- Building services and external plant
- Loading dock operations & waste and recycling collection
- Patron and music from both internal and external spaces

- Patrons arriving at and leaving the site

Impacts due to the operational traffic and loading dock operations have been assessed, mitigation measures have been recommended where required and resulting noise from these operations have been assessed are predicted to comply with established noise criteria.

Acoustic mitigation measures for building services plant shall be developed to meet PNTLs at detailed design stage when equipment selections have been finalised and locations confirmed.

Activity noise from within the Parramatta Powerhouse due to patrons and music has been assessed to the NPfI PNTLs. Patron noise and music are strictly not addressed by the NPfI, however PNTLs have been adopted to indicate intrusive and amenity noise limits for activity noise in the absence of applicable policy. An assessment has been conducted for activity noise in spaces where compliance with PNTLs would not be easily achievable through building envelope design.

Patron numbers and music levels have been provided which are predicted to meet PNTLs at surrounding residences and would generally be considered to generate minimum disturbance to the community and are deemed ‘low risk’ activities. Should higher patron numbers or music levels than those stipulated to comply with PNTLs be proposed for activities within the Parramatta Powerhouse, or should activities extend beyond the 7:00 am to 12:00 am times, these activities would be considered ‘medium risk’ or ‘high risk’ activities, and mitigation measures have been provided to minimise the community disturbance from these activities.

A trial period is recommended to further develop and refine the parameters around each risk category, as well as the mitigation measures to be implemented should these activities occur.

Definitions and parameters of each activity risk category, as well as mitigation measures, should be captured in an Operational Noise Management Plan.

6 Mitigation measures

A summary of recommended construction and operational noise and vibration mitigation measures are presented in Table 51.

Table 51: Summary of mitigation measures

Item	Detail	Timing
Construction - Noise and vibration management plan	A Construction Noise and Vibration Management Plan shall be prepared prior to the issuing of a Construction Certificate. This will specify the actual plant to be used and will include updated estimates of the likely levels of noise and the scheduling of activities.	Pre-construction
Construction - Staffing	Appointing a named member of the site staff who will act as the Responsible Person with respect to noise and vibration; Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise; Ensuring good work practices are adopted to avoid issues such as noise from dropped items, noise from communication radios is kept as low as is practicable; Avoid the use of radios or stereos outdoors; and Avoid shouting and minimise talking loudly and slamming vehicle doors.	During construction
Construction - Plant and equipment	Where possible stationary equipment should be located behind structures such as demountable buildings or stockpiles to maximise shielding to receivers; Consider using electric / hydraulic equipment where possible Using the smallest equipment as is practical All plant and equipment used on site must be: • maintained in a proper and efficient condition; and • operated in a proper and efficient manner. Turn off all vehicles, plant and equipment when not in use Ensuring that the Responsible Person checks the conditions of the powered equipment used on site daily to ensure plant is properly maintained and that noise is kept as low as practicable.	During construction
Construction - Scheduling	Ensure that the Responsible Person controls the working hours on site to ensure that work is only done during the acceptable periods (7am to 6pm on weekdays and 8am to 1pm on Saturdays. No work on Sundays or public holidays)	During construction

Item	Detail	Timing
Construction - Work site training	'Toolbox talks' will be held at regular intervals with the contractor workers, including discussion of noise and vibration mitigation, monitoring and assessment. These topics will also be covered under induction processes. Operate two way radios at the minimum effective volume, and avoid shouting or whistling at the site. Identification of all reasonable and feasible noise mitigation methods will be conducted by the Responsible Person on a daily basis during noisy works. The Responsible Person will have the authority to modify work practices in response to complaints, where this is considered appropriate.	During construction
Construction - Scheduling	High noise activities will be programmed to occur during the standard construction hours wherever possible and will be scheduled with due consideration to the nearest sensitive receivers.	During construction
Construction - Community liaison	Ensuring that the Responsible Person keeps the local community advised on expected activities and coordinates scheduling and locations of noisy works around any critical user activities where practicable. This shall include face to face meetings with nearby receivers if requested and a letter box drop, and shall include close liaison with neighbours during construction, including the Meriton towers and residences to the north of Parramatta River. Maintaining appropriate records of complaints to include timing, reported issues, actions taken and measures to be included for on-going works. The complaints log will need to be filed with the Responsible Person.	Pre-construction and during construction
Construction - Reversing alarms	The use of audible movement alarms of a type that would minimise noise impacts on surrounding noise sensitive receivers must be implemented. Where practicable, broadband, non-tonal reversing alarms should be utilised on site equipment. Ensure that the difference in volume between the reversing warning devices and the base machine noise level (at maximum governed speed under no load at any given test location) is minimised (in accordance with International Standard ISO9533:1989), and ensure that warning devices are no more than 5 dB above the Australian Standard level;	During construction
Construction - Material handling	Avoid dropping equipment/materials from a height or into trucks. Where practicable, use sound dampening material to cover the surfaces on to which any materials must be dropped.	During construction

Item	Detail	Timing
Construction - Equipment Location	Site noisy equipment away from noise-sensitive areas. Plant known to emit noise strongly in one direction is to be orientated so that the noise is directed away from noise-sensitive areas; Locate site access roads and site compounds as far away as possible from noise sensitive receptors; Plan truck movements to avoid residential streets where possible;	During construction
Operation – Loading dock doors	Assess noise transmission through loading dock doors, specify appropriate doors to meet PNTLs at surrounding receivers.	Detailed design
Operation – Loading dock doors	No loading activities shall take place while any loading dock doors are open.	During operation
Operation – Loading dock deliveries	Only loading or unloading of light vehicles via manual handling shall take place outside the loading dock.	During operation
Operation – Loading dock vehicles	Large trucks which require air brakes, generally considered to be 6 tonnes or greater, shall not enter or leave the loading dock between 6pm and 7am.	During operation
Operation – Loading dock vehicles	Small trucks which do not require air brakes, generally considered to be less than 6 tonnes, shall not enter or leave the loading dock between 10pm and 7am.	During operation
Operation – Loading dock deliveries	Only loading or unloading of light vehicles via manual handling shall take place outside the loading dock.	During operation
Operation – Loading dock vehicles	Large and small trucks entering the loading dock shall not idle outside the loading dock between 10pm and 7am.	During operation
Operation – Loading dock vehicles	Large and small trucks shall not queue within the driveway and shall park off-site if awaiting entry to the loading dock between 10pm and 7am.	During operation
Operation – Patron and music noise	Further develop and refine the parameters around each activity risk category, as well as the mitigation measures to be implemented should these activities occur.	Detailed design and 'trial period' during first 12 months of operation
Operation – Patron and music noise	The operational mitigation measures, including revised 'deemed to comply' conditions, shall be incorporated into an Operational Noise Management Plan (ONMP).	Prior to opening
Operation – Patron noise	Patron noise leaving the site after 10pm to be managed by staff directing patrons to keep noise to a minimum	During operation
Operation – Patron and music noise	The ONMP shall be reviewed annually or more regularly on an 'as needs' basis. The review shall be conducted in consultation with an Accredited Acoustic Consultant.	Post-opening annually

Item	Detail	Timing
Operation – Building services equipment	Acoustic mitigation measures for building services plant to meet PNTLs shall be developed at detailed design stage when equipment selections have been finalised and locations confirmed.	Detailed design

References

[1] Department of Planning NSW, "Development Near Rail Corridors and Busy Roads – Interim Guideline," Department of Planning NSW, Sydney, 2008.

[2] NSW Environment Protection Authority, "NSW Noise Policy for Industry," NSW Environment Protection Authority , Sydney, 2017.

[3] Department of Environment and Conservation (NSW), "Assessing Vibration: A technical guideline," Department of Environment and Conservation (NSW), Sydney, 2006.

[4] British Standards, "BS 6472-1:2008 Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting," British Standards, 2008.

[5] British Standards, "BS 7385-1:1990 - Evaluation and measurement for vibration in buildings. Guide for measurement of vibrations and evaluation of their effects on buildings," British Standards, 1990.

[6] German Institute for Standardisation, "DIN 4150 - Part 3 'Structural vibration in buildings - Effects on Structure'," German Institute for Standardisation, 1999.

[7] Standards Australia, "AS 2436-2010 - Guide to noise and vibration control on construction, demolition and maintenance sites," Standards Australia, 2010.

[8] Department for Environment Food and Rural Affairs, "Update of noise database for prediction of noise on construction and open sites," Department for Environment Food and Rural Affairs, 2006.

[9] Department of Environment, Climate Change and Water NSW, "NSW Road Noise Policy," NSW Environmental Protection Authority, Sydney, 2011.

[10] Museum of Applied Arts & Sciences, "Powerhouse Parramatta - Stage 3 Design Brief," Museum of Applied Arts & Sciences, Sydney, 2020.

[11] H. Rindel, "Acoustical capacity as a means of noise control in eating establisments," in *Joint Baltic-Nordic Acoustics Meeting*, Lyngby, 2012.

[12] M. Hayne, J. Taylor, R. Rumble and D. Mee, "Prediction of Noise from Small to Medium Sized Crowds," in *Acoustics 2011*, Gold Coast, 2011.

[13] I. R. Cushing, F. F. Li, T. J. Cox, K. Worral and T. Jackson, "Vocal effort levels in anechoic conditions," *Applied Acoustics*, vol. 72, pp. 695-701, 2011.

[14] Infrastructure NSW, "Methodology Statement - Working Near Busby's Bore," Infrastructure NSW, Sydney, 2018.

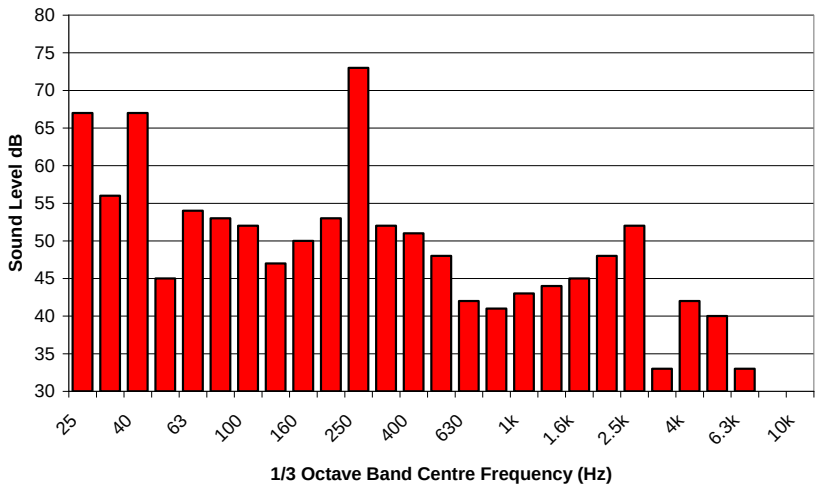
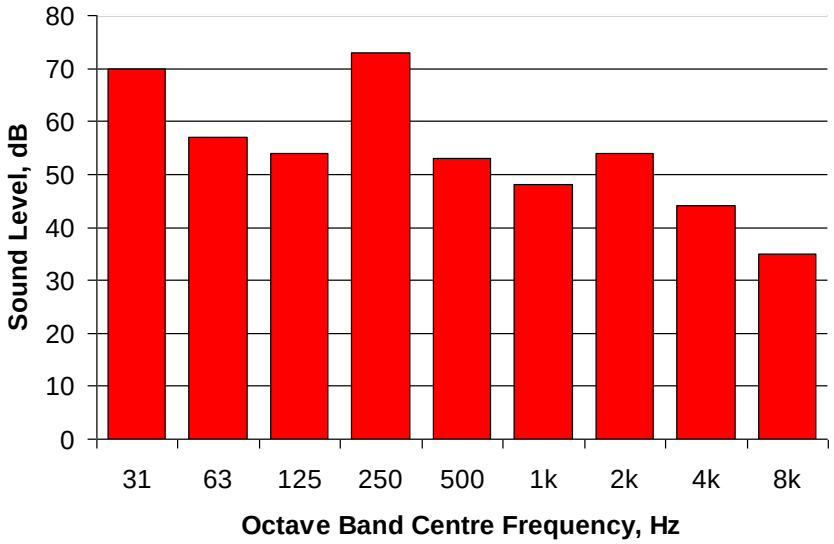
Appendix A

Acoustic Terminology

A1 Acoustic Terminology

Term	Definition
Ambient Noise Level	The ambient noise level is the overall noise level measured at a location from multiple noise sources. When assessing noise from a particular development, the ambient noise level is defined as the remaining noise level in the absence of the specific noise source being investigated. For example, if a fan located on a city building is being investigated, the ambient noise level is the noise level from all other sources without the fan running. This would include sources such as traffic, birds, people talking and other nearby fans on other buildings.
Background Noise Level	The background noise level is the noise level that is generally present at a location at all or most times. Although the background noise may change over the course of a day, over shorter time periods (e.g. 15 minutes) the background noise is almost-constant. Examples of background noise sources include steady traffic (e.g. motorways or arterial roads), constant mechanical or electrical plant and some natural noise sources such as wind, foliage, water and insects. **Assessment Background Level (ABL)** A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night time period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background LA90 noise levels – i.e. the measured background noise is above the ABL 90% of the time. **Rating Background Level (RBL / min $L_{A90,1hour}$)** A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey. This parameter is denoted RBL in NSW, and min $L_{A90,1hour}$ in QLD.
Decibel	The decibel scale is a logarithmic scale which is used to measure sound and vibration levels. Human hearing is not linear and involves hearing over a large range of sound pressure levels, which would be unwieldy if presented on a linear scale. Therefore, a logarithmic scale, the decibel (dB) scale, is used to describe sound levels. An increase of approximately 10 dB corresponds to a subjective doubling of the loudness of a noise. The minimum increase or decrease in noise level that can be noticed is typically 2 to 3 dB.
dBA	dBA denotes a single-number sound pressure level that includes a frequency weighting (“A-weighting”) to reflect the subjective loudness of the sound level. The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, and so the A-weighting is used to account for this effect. An A-weighted decibel level is written as dBA.

<table>
<tr><th>Term</th><th>Definition</th></tr>
<tr><td></td><td>Some typical dBA levels are shown below.
<table>
<tr><th>Sound Pressure Level dBA</th><th>Example</th></tr>
<tr><td>130</td><td>Human threshold of pain</td></tr>
<tr><td>120</td><td>Jet aircraft take-off at 100 m</td></tr>
<tr><td>110</td><td>Chain saw at 1 m</td></tr>
<tr><td>100</td><td>Inside nightclub</td></tr>
<tr><td>90</td><td>Heavy trucks at 5 m</td></tr>
<tr><td>80</td><td>Kerbside of busy street</td></tr>
<tr><td>70</td><td>Loud stereo in living room</td></tr>
<tr><td>60</td><td>Office or restaurant with people present</td></tr>
<tr><td>50</td><td>Domestic fan heater at 1m</td></tr>
<tr><td>40</td><td>Living room (without TV, stereo, etc.)</td></tr>
<tr><td>30</td><td>Background noise in a theatre</td></tr>
<tr><td>20</td><td>Remote rural area on still night</td></tr>
<tr><td>10</td><td>Acoustic laboratory test chamber</td></tr>
<tr><td>0</td><td>Threshold of hearing</td></tr>
</table></td></tr>
<tr><td>L_1</td><td>The L_1 statistical level is often used to represent the maximum level of a sound level that varies with time.
Mathematically, the L_1 level is the sound level exceeded for 1% of the measurement duration. As an example, 87 dB $L_{A1,15min}$ is a sound level of 87 dBA or higher for 1% of the 15 minute measurement period.</td></tr>
<tr><td>L_{10}</td><td>The L_{10} statistical level is often used as the “average maximum” level of a sound level that varies with time.
Mathematically, the L_{10} level is the sound level exceeded for 10% of the measurement duration. L_{10} is often used for road traffic noise assessment. As an example, 63 dB $L_{A10,18hr}$ is a sound level of 63 dBA or higher for 10% of the 18 hour measurement period.</td></tr>
<tr><td>L_{90}</td><td>The L_{90} statistical level is often used as the “average minimum” or “background” level of a sound level that varies with time.
Mathematically, L_{90} is the sound level exceeded for 90% of the measurement duration. As an example, 45 dB $L_{A90,15min}$ is a sound level of 45 dBA or higher for 90% of the 15 minute measurement period.</td></tr>
<tr><td>L_{eq}</td><td>The ‘equivalent continuous sound level’, Leq, is used to describe the level of a time-varying sound or vibration measurement.
Leq is often used as the “average” level for a measurement where the level is fluctuating over time. Mathematically, it is the energy-average level over a period of time (i.e. the constant sound level that contains the same sound energy as the measured level). When the dBA weighting is applied, the level is denoted dB LAeq. Often the measurement duration is quoted, thus LAeq,15 min represents the dBA weighted energy-average level of a 15 minute measurement.</td></tr>
</table>

Term	Definition
L_{max}	The Lmax statistical level can be used to describe the "absolute maximum" level of a sound or vibration level that varies with time. Mathematically, Lmax is the highest value recorded during the measurement period. As an example, 94 dB LAmax is a highest value of 94 dBA during the measurement period. Since Lmax is often caused by an instantaneous event, Lmax levels often vary significantly between measurements.
Frequency	Frequency is the number of cycles per second of a sound or vibration wave. In musical terms, frequency is described as "pitch". Sounds towards the lower end of the human hearing frequency range are perceived as "bass" or "low-pitched" and sounds with a higher frequency are perceived as "treble" or "high pitched".  
Peak Particle Velocity (PPV)	Peak Particle Velocity (PPV) is the highest velocity of a particle (such as part of a building structure) as it vibrates. Most sound level meters measure root mean squared (RMS) values; it is common to approximate the PPV based on an RMS measurement. PPV is commonly used as a vibration criterion, and is often interpreted as a PPV based on the Lmax or Lmax,spec index.

Term	Definition
Sound Power and Sound Pressure	The sound power level (L_w) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level (L_p) varies as a function of distance from a source. However, the sound power level is an intrinsic characteristic of a source (analogous to its mass), which is not affected by the environment within which the source is located.
Vibration	Waves in a solid material are called "vibration", as opposed to similar waves in air, which are called "sound" or "noise". If vibration levels are high enough, they can be felt; usually vibration levels must be much higher to cause structural damage. A vibrating structure (eg a wall) can cause airborne noise to be radiated, even if the vibration itself is too low to be felt. Structureborne vibration limits are sometimes set to control the noise level in a space. Vibration levels can be described using measurements of displacement, velocity and acceleration. Velocity and acceleration are commonly used for structureborne noise and human comfort. Vibration is described using either metric units (such as mm, mm/s and mm/s^2) or else using a decibel scale.

Appendix B

Noise monitoring methodology and results

B1 Noise monitoring

B1.1 Instrumentation

The noise loggers used for long-term monitoring and their locations are presented in Table 52. The sound level meter used to conduct attended surveys was a Bruel & Kjaer 2270 (Serial Number 2754328).

All the acoustic instrumentation employed during the noise measurements comply with the requirements of "*AS IEC 61672.1-2004 Electroacoustics – Sound level meters – Specifications*" and was calibrated prior to and after the monitoring session with a drift in calibration not exceeding ± 0.5 dB.

All instruments used were within their current National Association of Testing Authorities, Australia (NATA) certified in-calibration period (i.e. calibration in the last 2 years).

Table 52: Noise logger details

NCA	Location	Model	Serial number
1	Ground floor - 3 Sorrell Street	ARL Ngara	8780E7
2	Level 38 rooftop - 330 Church Street	ARL Ngara	878107

B1.2 Meteorological conditions

In accordance with the NPfI, any noise monitoring conducted during periods of extraneous weather conditions was excluded from the data set. The NPfI advises that data may be affected where adverse weather, such as wind speeds higher than 5 m/s or rain, occurs. During the measurement period for this assessment, periods of adverse weather occurred during three daytime periods. This was confirmed by using weather data from the Bureau of Meteorology's (BOM) Sydney Olympic Park weather station.

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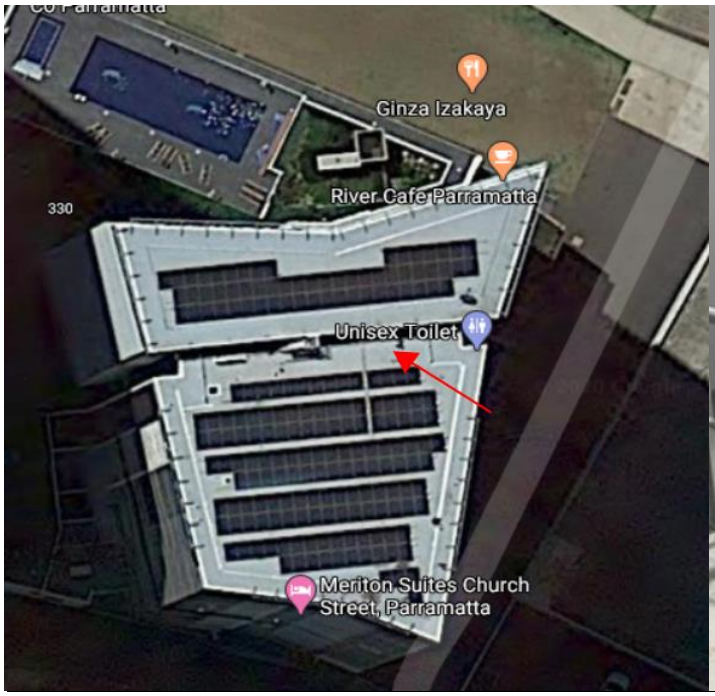
330 Church St, Parramatta (Free Field)

Additional detail:



Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

	L_{A90} Background noise levels[4]			L_{Aeq} Ambient noise levels		
Date	**Day[1]**	**Evening[2]**	**Night[3]**	**Day[1]**	**Evening[2]**	**Night[3]**
Thursday-20-February-2020		49	46		54	50
Friday-21-February-2020	53	51	47	56	55	51
Saturday-22-February-2020	50	49	44	55	54	49
Sunday-23-February-2020	48	48	45	53	52	52
Monday-24-February-2020	53	48	45	56	53	51
Tuesday-25-February-2020	54	49		57	54	
Wednesday-26-February-2020			47			52
Thursday-27-February-2020		49			53	
Friday-28-February-2020	53	51	47	57	55	51
Saturday-29-February-2020	50	48	45	55	53	50
Sunday-01-March-2020	48	48		53	52	
Monday-02-March-2020						
Tuesday-03-March-2020						
Wednesday-04-March-2020						
Representative Weekday[5]	**53**	**49**	**47**	**56**	**54**	**51**
Representative Weekend[5]	**49**	**48**	**45**	**54**	**53**	**50**
Representative Week[5]	**51**	**49**	**46**	**55**	**54**	**51**

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Evening is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Road / Rail noise monitoring results

Date	L_{Aeq} Noise levels		$L_{Aeq\ 1hr}$ Noise levels (upper 10th percentile)	
	Day[1]	**Night**[2]	**Day**	**Night**
Thursday-20-February-2020	55	50	57	54
Friday-21-February-2020	56	51	57	54
Saturday-22-February-2020	55	48	56	52
Sunday-23-February-2020	53	52	54	57
Monday-24-February-2020	55	51	56	56
Tuesday-25-February-2020	56	50	57	55
Wednesday-26-February-2020	56	52	58	56
Thursday-27-February-2020	55	51	57	56
Friday-28-February-2020	56	51	57	54
Saturday-29-February-2020	54	50	0	56
Sunday-01-March-2020	53	49	54	53
Monday-02-March-2020	56	49	57	52
Tuesday-03-March-2020	56	49	57	50
Wednesday-04-March-2020				
Representative Weekday[3]	**56**	**51**	**57**	**54**
Representative Weekend[3]	**54**	**50**	**54**	**55**
Representative Week[3]	**55**	**50**	**56**	**55**

Notes:

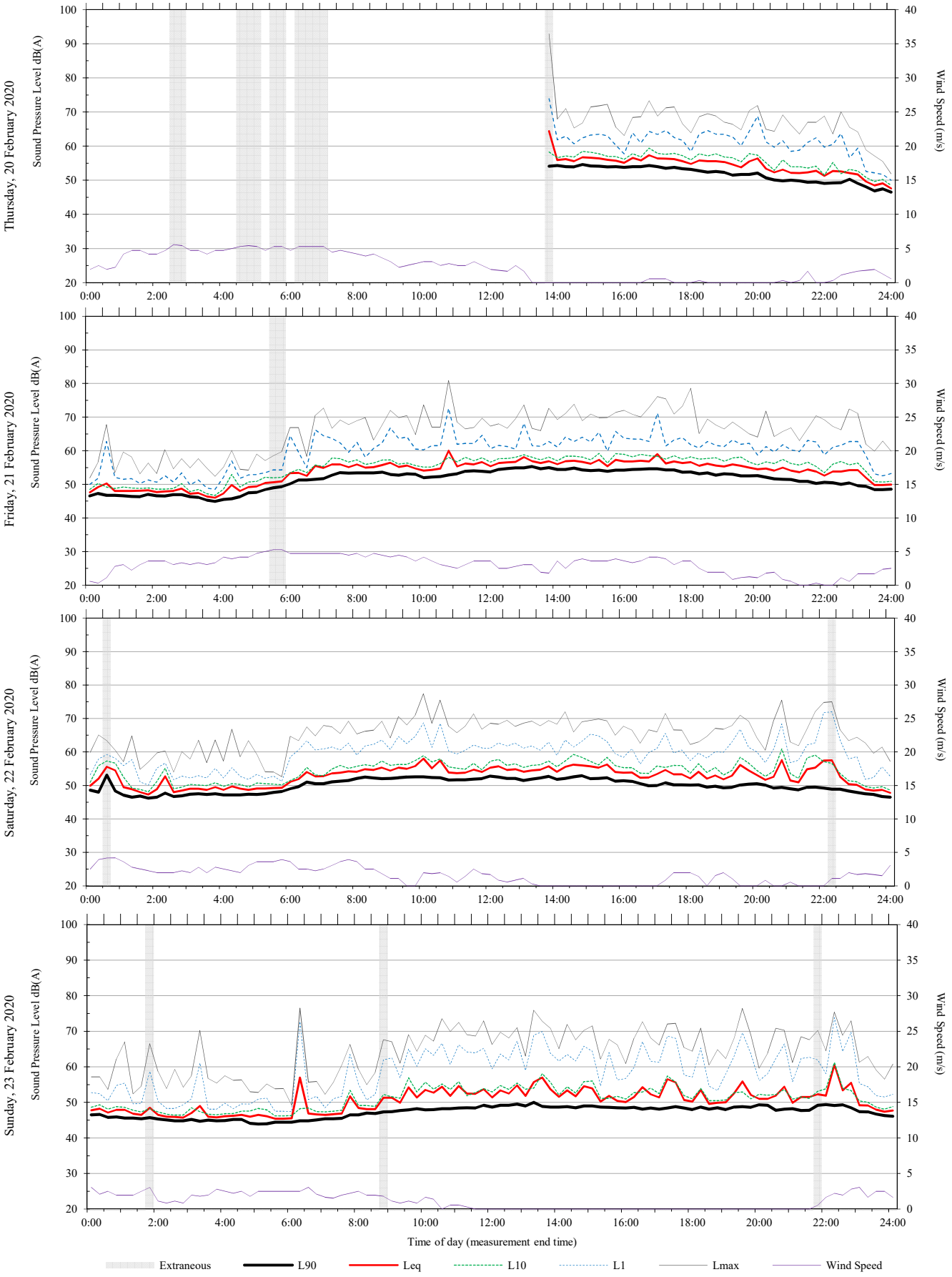
1. Day is 7:00am to 10:00pm

2. Night is 10:00pm to 7:00am

3. Logarithmic average of daily L_{Aeq}

Unattended monitoring: 330 Church St, Parramatta (Free Field)

ARUP



Unattended monitoring: 330 Church St, Parramatta (Free Field)

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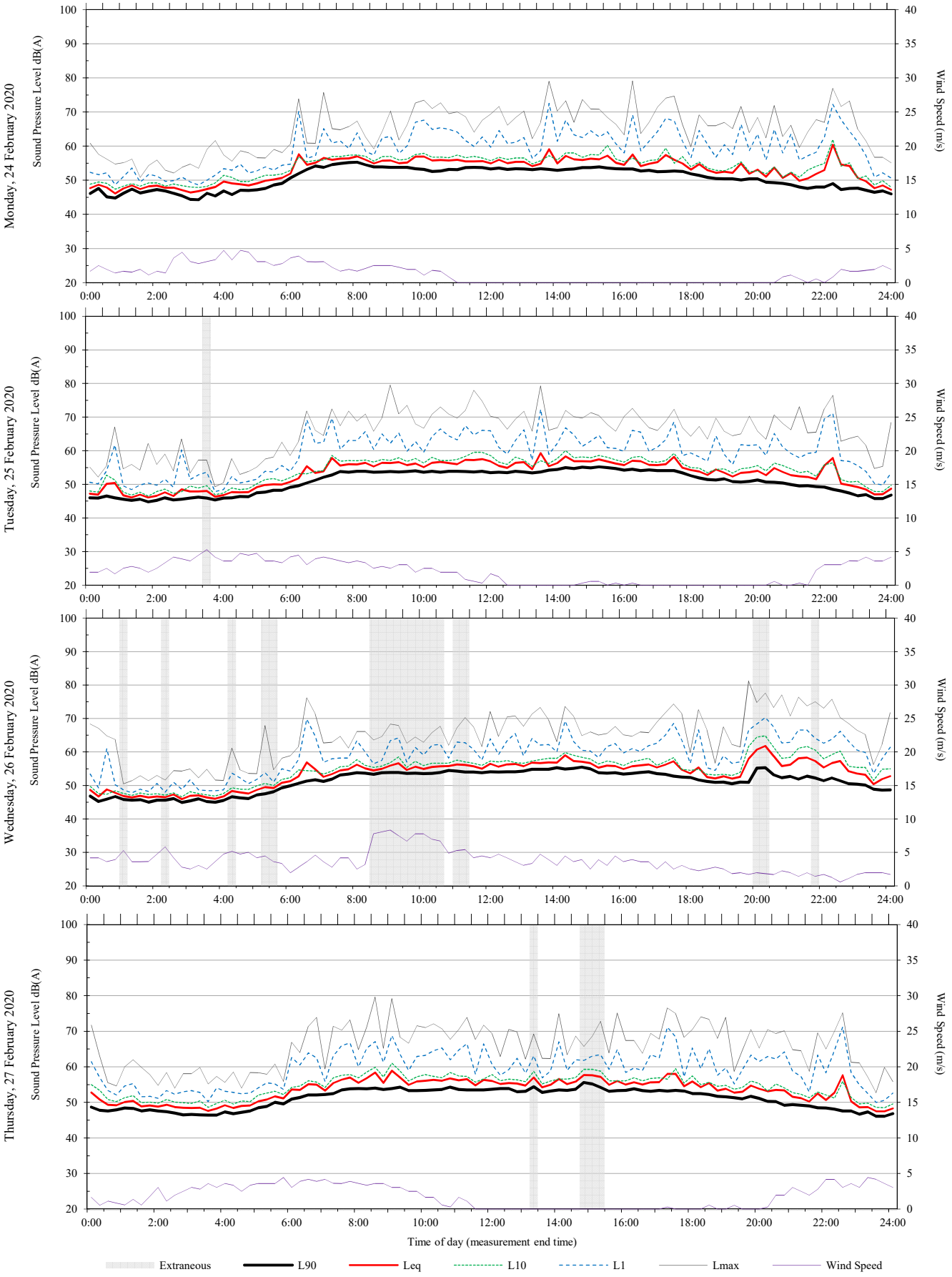

Unattended monitoring: 330 Church St, Parramatta (Free Field)

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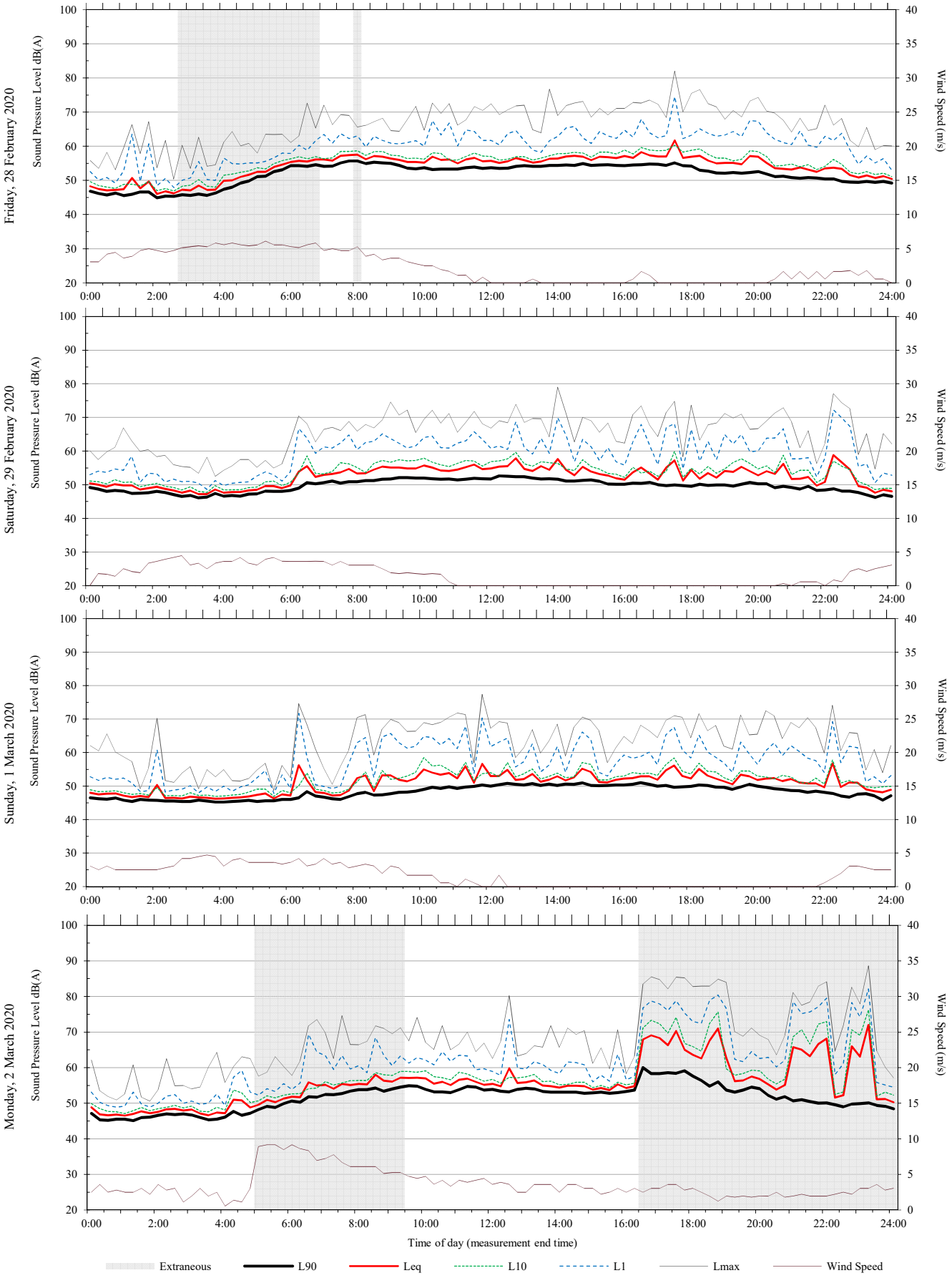

Unattended monitoring: 330 Church St, Parramatta (Free Field)

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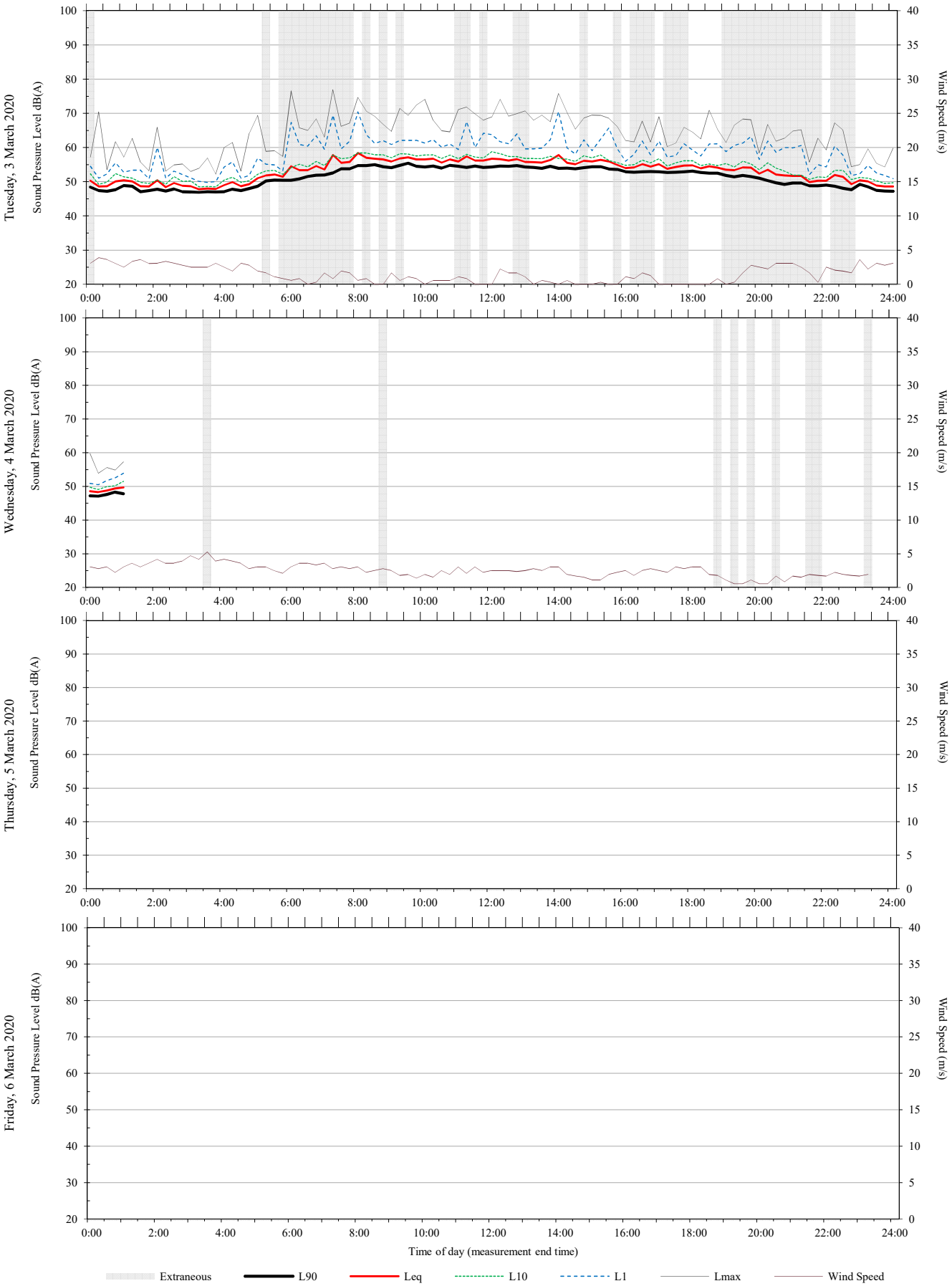

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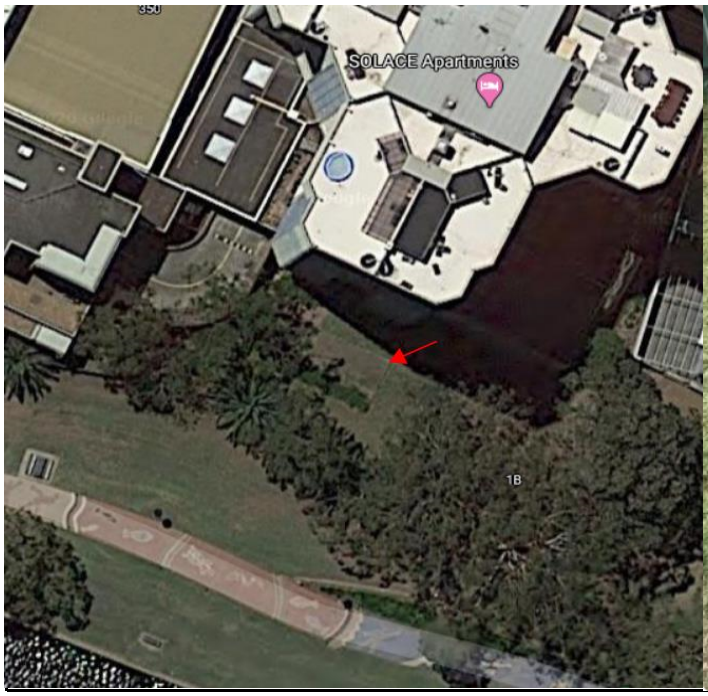
3 Sorrell St, Parramatta (Free Field)

Additional detail:



Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

	L_{A90} Background noise levels[4]			L_{Aeq} Ambient noise levels		
Date	**Day[1]**	**Evening[2]**	**Night[3]**	**Day[1]**	**Evening[2]**	**Night[3]**
Thursday-20-February-2020		48	43		54	50
Friday-21-February-2020		52	45		55	51
Saturday-22-February-2020	51	51	43	56	56	51
Sunday-23-February-2020	47	49	44	54	53	51
Monday-24-February-2020		49	44		53	50
Tuesday-25-February-2020	51	49	44	60	53	50
Wednesday-26-February-2020	51	50	44	58	54	50
Thursday-27-February-2020	52	49	44	57	53	50
Friday-28-February-2020	52	51	44	57	55	51
Saturday-29-February-2020	49	51	44	56	55	51
Sunday-01-March-2020	47	49	44	53	53	50
Monday-02-March-2020						
Tuesday-03-March-2020						
Wednesday-04-March-2020						
Representative Weekday[5]	**51**	**49**	**44**	**58**	**54**	**50**
Representative Weekend[5]	**48**	**50**	**44**	**55**	**54**	**51**
Representative Week[5]	**51**	**49**	**44**	**57**	**54**	**50**

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Evening is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Road / Rail noise monitoring results

Date	L_{Aeq} Noise levels		$L_{Aeq\ 1hr}$ Noise levels (upper 10th percentile)	
	Day[1]	**Night**[2]	**Day**	**Night**
Thursday-20-February-2020	55	50	58	57
Friday-21-February-2020	58	51	60	55
Saturday-22-February-2020	56	50	58	54
Sunday-23-February-2020	54	51	56	55
Monday-24-February-2020	57	50	60	55
Tuesday-25-February-2020	59	50	63	55
Wednesday-26-February-2020	57	50	59	55
Thursday-27-February-2020	56	50	59	55
Friday-28-February-2020	57	51	58	54
Saturday-29-February-2020	56	51	0	56
Sunday-01-March-2020	53	50	54	55
Monday-02-March-2020	55	46	57	49
Tuesday-03-March-2020	56	50	58	55
Wednesday-04-March-2020	57		60	
Representative Weekday[3]	**57**	**50**	**59**	**55**
Representative Weekend[3]	**55**	**50**	**55**	**55**
Representative Week[3]	**56**	**50**	**59**	**55**

Notes:

1. Day is 7:00am to 10:00pm

2. Night is 10:00pm to 7:00am

3. Logarithmic average of daily L_{Aeq}

Unattended monitoring: 3 Sorrell St, Parramatta (Free Field)

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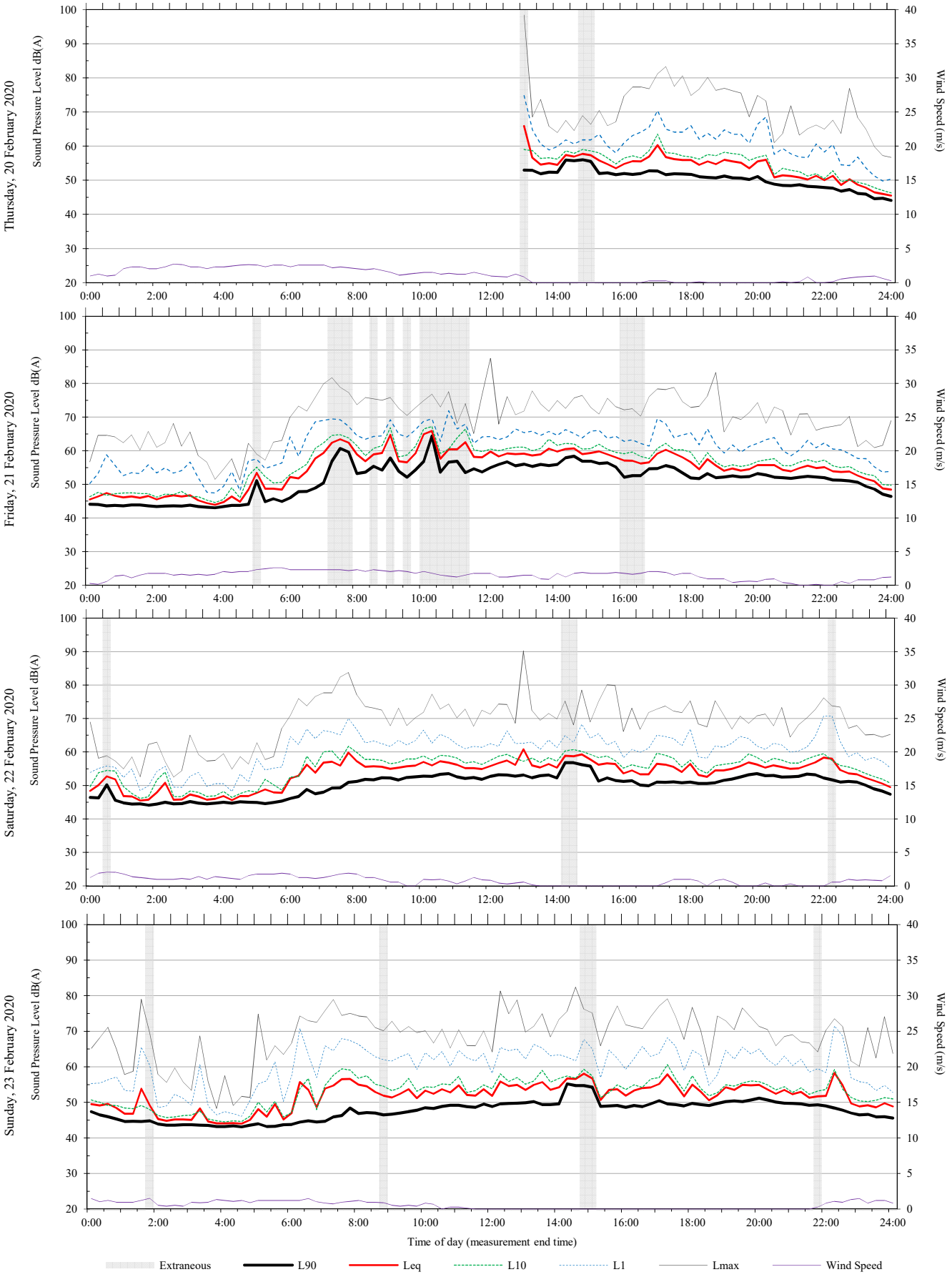

Unattended monitoring: 3 Sorrell St, Parramatta (Free Field)

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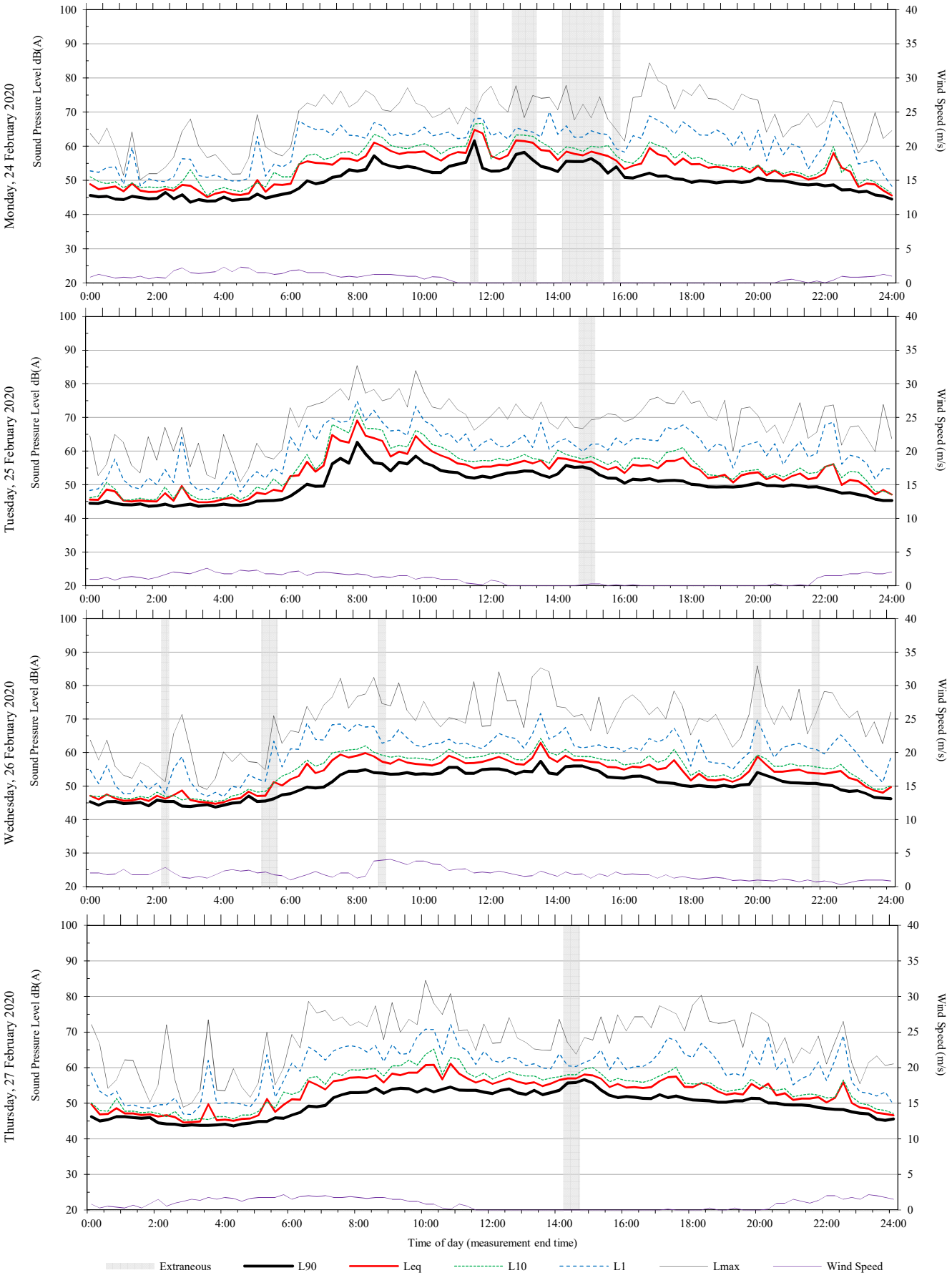

Unattended monitoring: 3 Sorrell St, Parramatta (Free Field)

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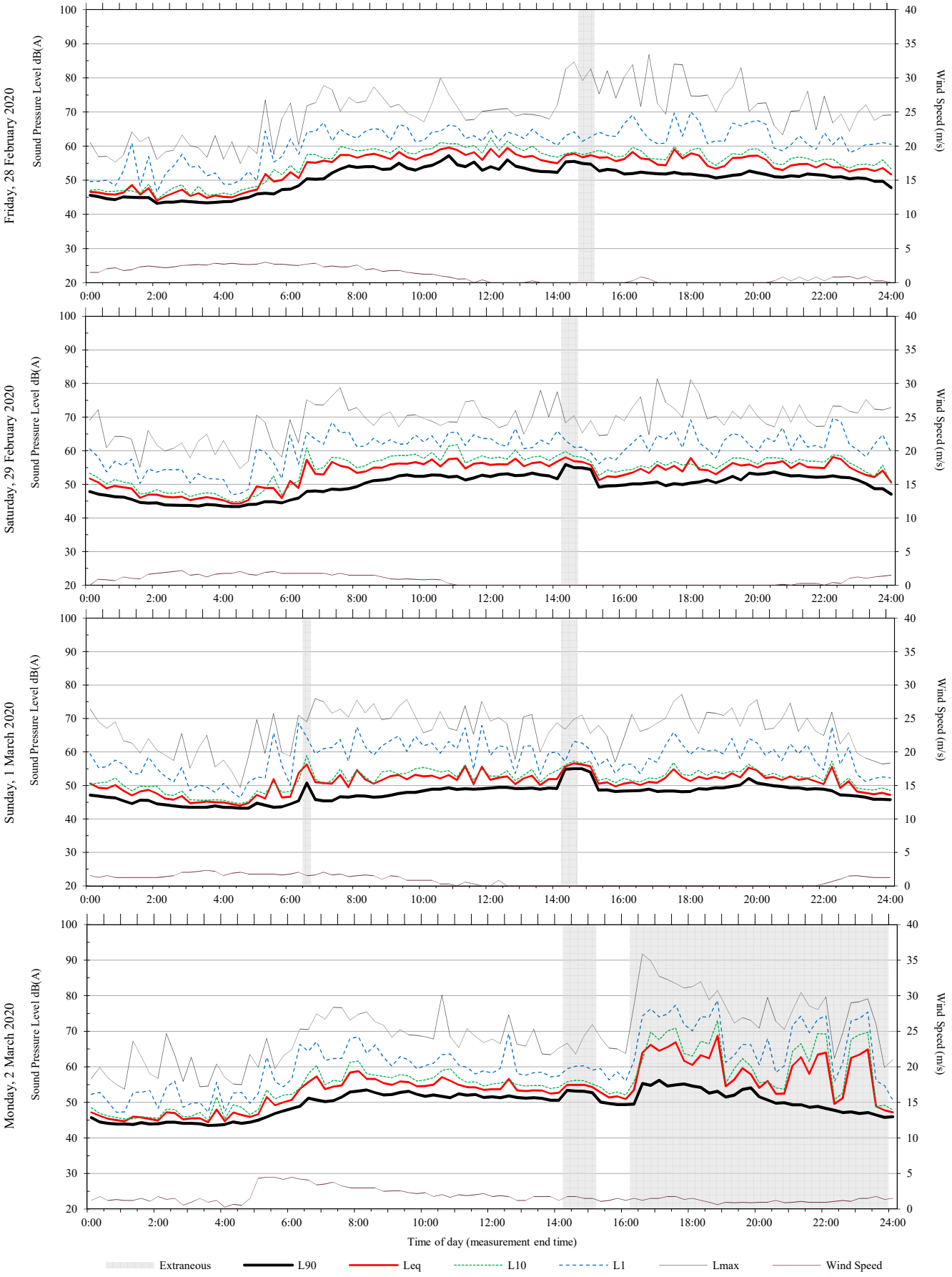

Unattended monitoring: 3 Sorrell St, Parramatta (Free Field)

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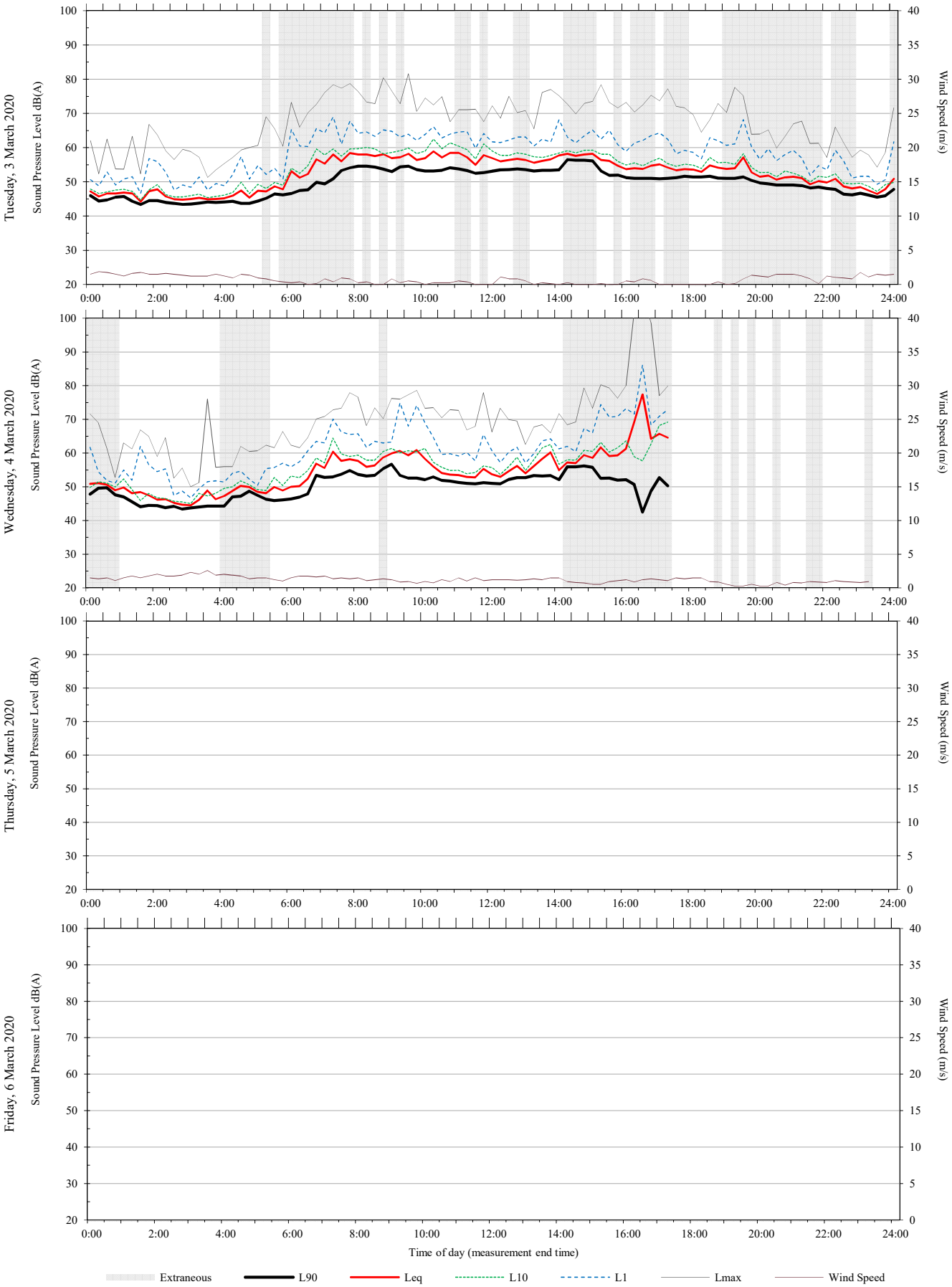
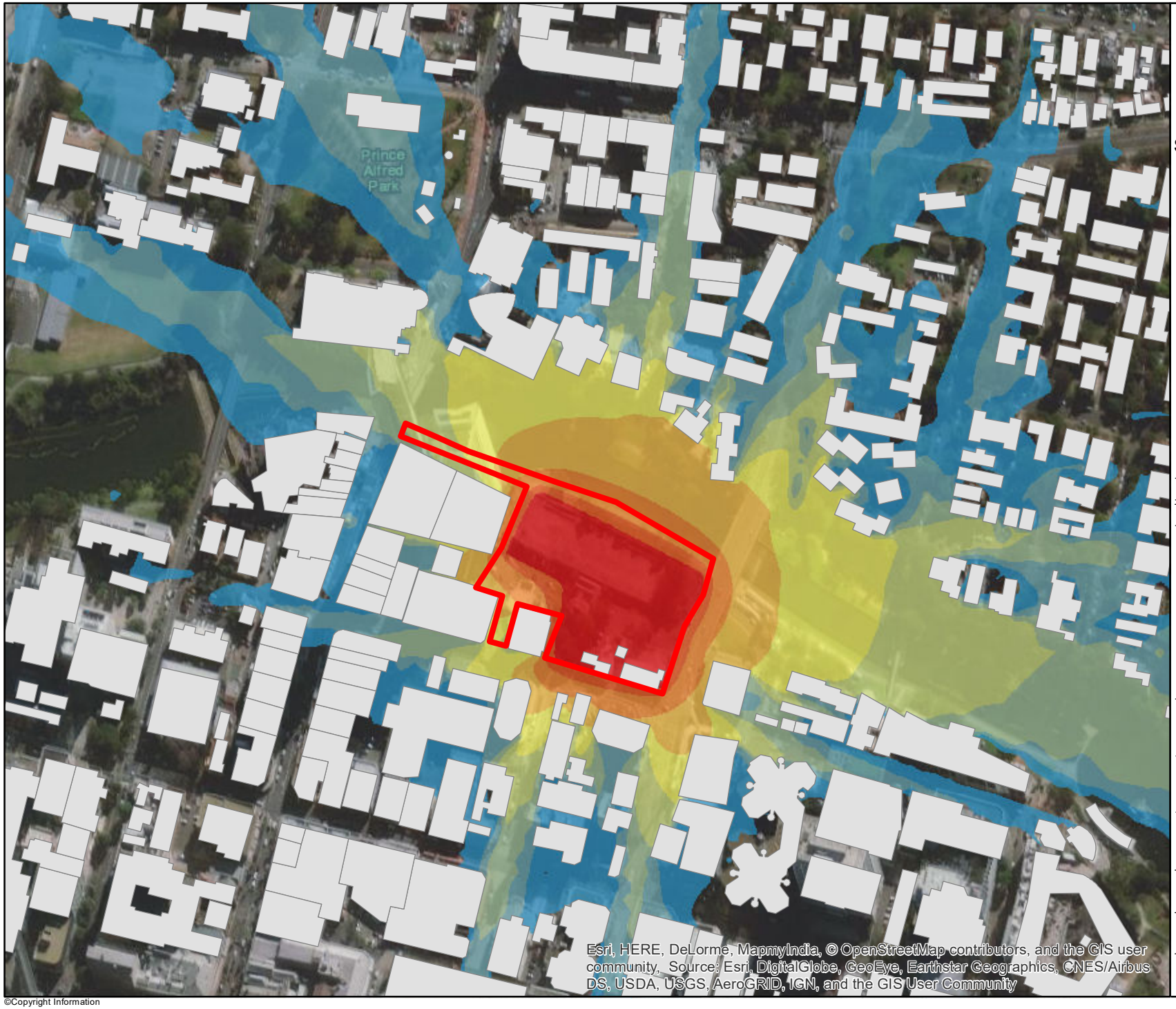


Appendix C

Construction noise contour maps



Legend

Site

Receiver buildings

Sound Pres. Level, dBL$_{Aeq(15min)}$

45 50 55 60 65 70 75 80 85

Issue	Date	By	Chkd	Appd
D1	17/04/2020	NJ	MS	EZ

Metres

0 50 100 150 200

ARUP

Level 5, 151 Clarence Street
Sydney, NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client

Infrastructure NSW

Job Title

Powerhouse Precinct Parramatta

Drawing Title

Construction Noise Contour
Site Est., Demo. & Exc. - Std. hours

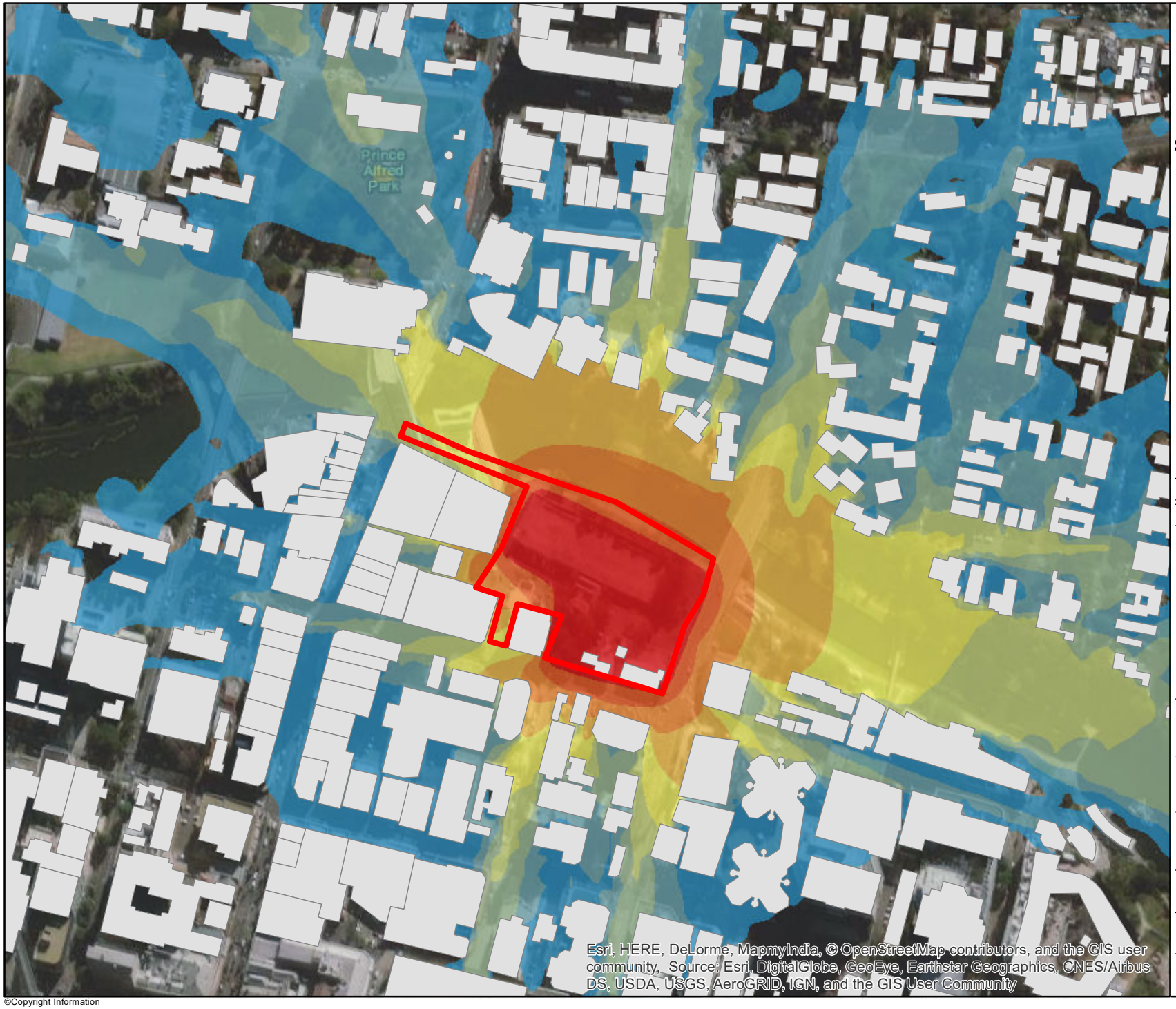
Scale at A4	Drawing Status
1:4,000	**Issue**

Coordinate System

GDA 1994 MGA Zone 56

Job No	Drawing No
273467-00	**001**

\\global.arup.com\australasia\SYD\Projects\273000\273467-00 Powerhouse Precinct\Work\Internal\Design\Acoustics\4_Dwgs\MAAS Site map_2.mxd



Legend

Site

Receiver buildings

Sound Pres. Level, dBL$_{Aeq(15min)}$

45 50 55 60 65 70 75 80 85

Issue	Date	By	Chkd	Appd
D1	17/04/2020	NJ	MS	EZ

Metres

0 50 100 150 200

ARUP

Level 5, 151 Clarence Street
Sydney, NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client

Infrastructure NSW

Job Title

Powerhouse Precinct Parramatta

Drawing Title

Construction Noise Contour Construction. - Std. hours

Scale at A4	Drawing Status
1:4,000	**Issue**

Coordinate System

GDA 1994 MGA Zone 56

Job No	Drawing No
273467-00	**001**

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Legend

Site

Receiver buildings

Sound Pres. Level, dBL$_{Aeq(15min)}$

45 50 55 60 65 70 75 80 85

Issue	Date	By	Chkd	Appd
D1	17/04/2020	NJ	MS	EZ

Metres

0 50 100 150 200

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Infrastructure NSW

Job Title

Powerhouse Precinct Parramatta

Drawing Title

Construction Noise Contour
Site Est. & Demo. - Out of hours

Scale at A4	Drawing Status
1:4,000	**Issue**

Coordinate System

GDA 1994 MGA Zone 56

Job No	Drawing No
273467-00	**001**

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Legend

Site

Receiver buildings

Sound Pres. Level, dBL$_{Aeq(15min)}$

45 50 55 60 65 70 75 80 85

Issue	Date	By	Chkd	Appd
D1	17/04/2020	NJ	MS	EZ

Metres

0 50 100 150 200

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Client

Infrastructure NSW

Job Title

Powerhouse Precinct Parramatta

Drawing Title

Construction Noise Contour Bulk /Detailed Exc. - Out of hours

Scale at A4	Drawing Status
1:4,000	**Issue**

Coordinate System

GDA 1994 MGA Zone 56

Job No	Drawing No
273467-00	**001**

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Legend

Site

Receiver buildings

Sound Pres. Level, dBL$_{Aeq(15min)}$

45 50 55 60 65 70 75 80 85

Issue	Date	By	Chkd	Appd
D1	17/04/2020	NJ	MS	EZ

Metres

0 50 100 150 200

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Job Title

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Drawing Title

Construction Noise Contour Construction. - Out of hours

Scale at A4	Drawing Status
1:4,000	**Issue**

Coordinate System

GDA 1994 MGA Zone 56

Job No	Drawing No
273467-00	**001**

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