MARSHALL DAY Acoustics

RIVERSIDE THEATRES REDEVELOPMENT SSDA NOISE & VIBRATION IMPACT ASSESSMENT REPORT

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Project: **RIVERSIDE THEATRES REDEVELOPMENT**

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EXECUTIVE SUMMARY

A redevelopment of the Parramatta Riverside Theatres is proposed, retaining the existing Playhouse drama theatre on the site and adding three new venues and associated ancillary spaces. A Development Application for State Significant Development is to be submitted. The Department of Planning, Housing and Infrastructure (DPHI) has issued Secretary's Environmental Assessment Requirements (SEARs) to the applicant for the preparation of an Environmental Impact Statement (EIS) for the proposed development. This report has been prepared for City of Parramatta Council to accompany the application, having regard to the noise and vibration SEARs, as detailed in this report.

The report presents the results and recommendations of an assessment of acoustic impacts from the proposed redevelopment.

Operational noise impacts from music, patrons, operation of mechanical services and vehicle movements associated with the loading dock are assessed in Section 5.0 with noise criteria for these sources set out in Section 4.0. The assessment identifies that noise from the development is capable of complying with the relevant criteria with the application of commercially available and feasible noise mitigation, based on the conceptual designs available. As the design development is ongoing, the noise control concepts in this report are not in a form suitable for inclusion as prescriptive consent requirements.

Conceptual approaches, as developed for the current concept design, have been used for calculation of noise breakout to surrounding receivers, as one means of demonstrating compliance with the required criteria can be achieved. However, the intent of this report is that the overriding acoustic requirement for the development is to achieve the noise criteria set out in Section 4.0 for the final design.

Noise and vibration impacts from construction activities are also addressed via a preliminary assessment, and mitigation strategies proposed. A more detailed Construction Noise and Vibration Management Plan for the site will need to be prepared once a builder is engaged and detailed construction plans have been developed.

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1.0 INTRODUCTION & SCOPE

This report has been prepared for City of Parramatta Council (CoPC) to accompany a State Significant Development (SSD) Development Application (DA) for redevelopment of Riverside Theatres at 351-353 Church Street Parramatta.

The Riverside Theatres redevelopment project is "Development for the purposes of an Entertainment Facility with an estimated development cost of more than $30 million". Such development is state significant development in accordance with Schedule 1, clause 13 of State Environmental Planning Policy (Planning Systems) 2021. The development is considered state significant as the proposed works are estimated to have a development cost exceeding $30 million.

The Department of Planning, Housing and Infrastructure (DPHI) has issued Secretary's Environmental Assessment Requirements (SEARs) to the applicant for the preparation of an Environmental Impact Statement (EIS) for the proposed development. This report has been prepared having regard to the noise and vibration SEARs, as detailed in this report.

Table 1: Noise & Vibration SEARs

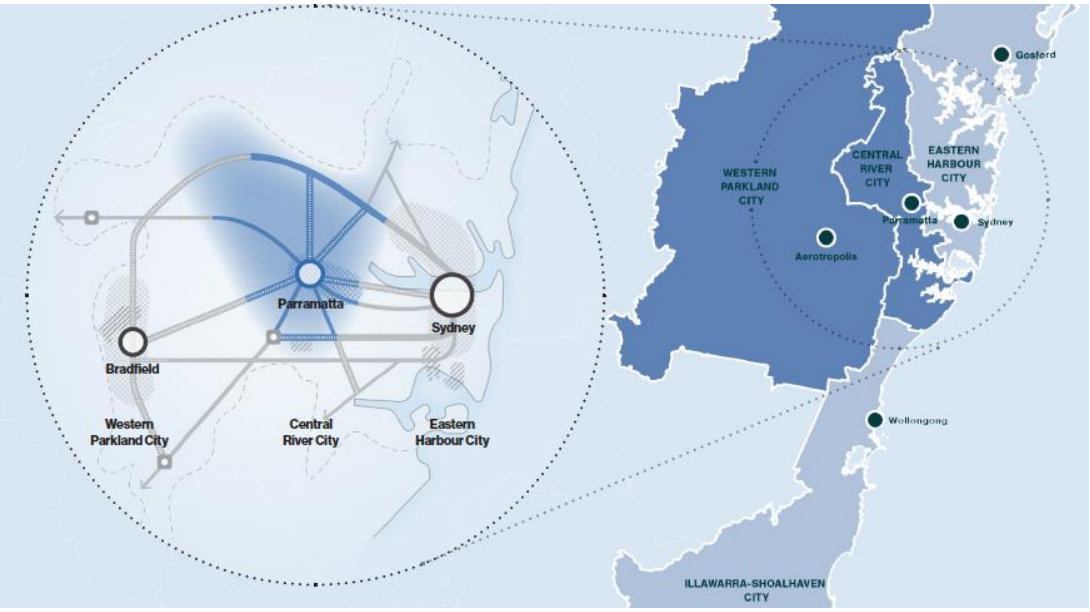
Environmental Assessment Requirement	Where addressed in this report
12. Noise and Vibration	
Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures that would be implemented.	Section 5.0 Section 0

The purpose of this report is to present the results and recommendations of an assessment of acoustic impacts from the proposed redevelopment. This includes operational noise from music, patrons, operation of mechanical services and vehicle movements associated with the loading dock. Noise and vibration impacts from construction activities are also addressed via a preliminary assessment, with mitigation strategies proposed. We note that a more detailed Construction Noise and Vibration Management Plan for the site will need to be prepared once a builder is engaged and detailed construction plans have been developed.

2.0 PROJECT & SITE DESCRIPTION

2.1 Site and surrounds

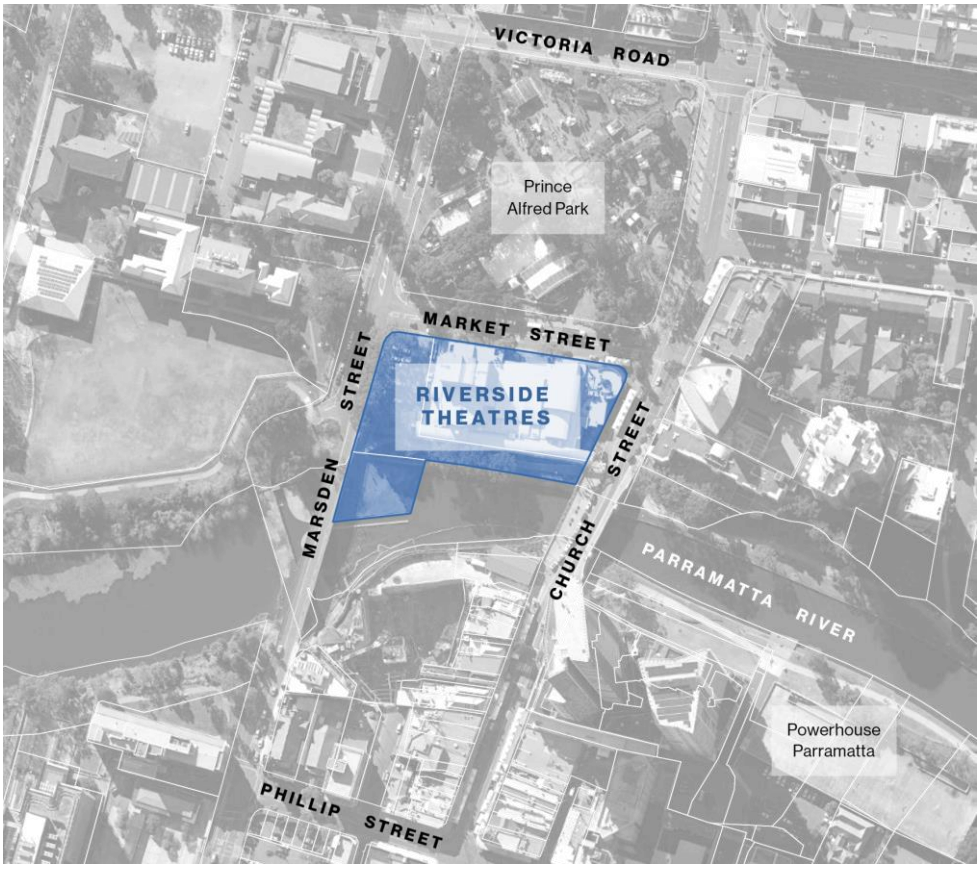
Riverside Theatres is situated upon the lands of the Dharug people. It is located within the City of Parramatta Council Local Government Area within Sydney's Central River City, see Figure 1.Figure 1: Context Plan



Located at 351-353 Church Street, Parramatta, the site comprises Lots 1 and 2 DP 740382. The site contains the existing Riverside Theatres, originally constructed in 1988 and modified since. The site also contains a small at-grade car park to the west adjacent to Marsden Street and accessed from Market Street.

The site is bordered by Church Street in the east, the Parramatta River in the south, Marsden Street to the west and Market Street to the north, see **Figure 2**.

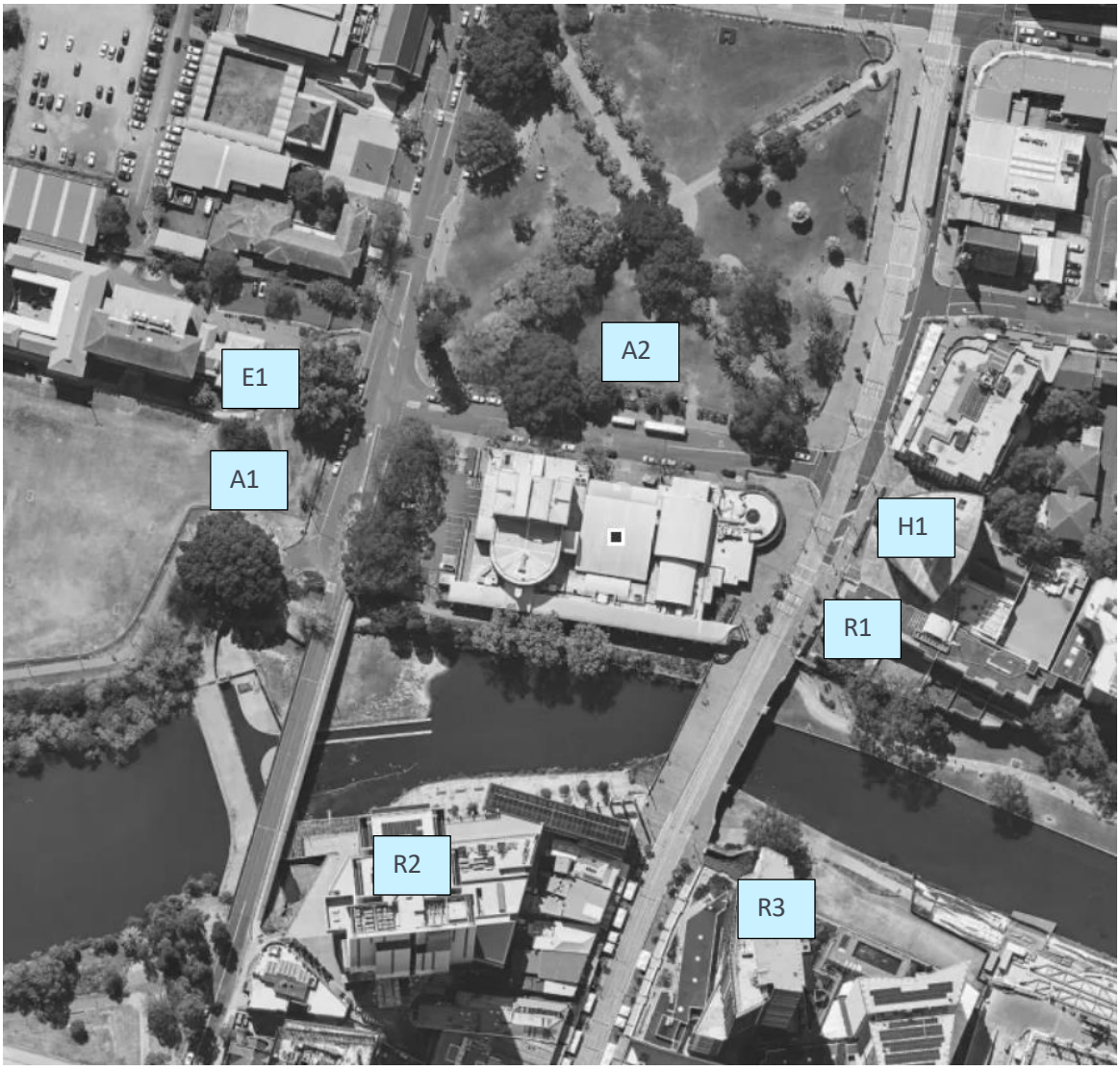
Figure 2: Riverside Theatres redevelopment site boundary (source: Arup)



2.2 Surrounding Receivers

There are a range of surrounding land uses, predominantly commercial and residential, but also a school (with playground) and Parramatta Stadium to the west, a public park to the north and a hotel to the east. The most affected receiver locations have been identified and summarised below. Other residential receivers located further from the site will likely have lower noise impacts due to the greater separation distance.

Figure 3: Most affected receivers



The following are identified as the most affected receivers for assessment. Compliance at these representative receivers will likely also result in compliance being achieved at more distant or less sensitive receivers.

Table 2: Representative receivers for assessment

Receiver ID	Address / Description	Receiver type
R1	342 Church St	Residential
R2	12 Phillip St 'The Lennox'	Residential
R3	330 Church St 'Meriton'	Residential
H1	350 Church St – Novotel	Hotel / motel
E1	3 Marist Pl – Bayanami Public School – classrooms	School classroom – internal
A1	3 Marist Pl – Bayanami Public School – playground	Active recreation area
A2	Prince Alfred Square	Active recreation area

2.3 Proposed Development

This SSD DA seeks consent for the design, construction and operation of the redeveloped Riverside Theatres. Specifically, approval is sought for the following:

- Site preparation works, including site services and infrastructure works, earthworks and the erection of site protection hoardings and fencing.
- Retention of the existing 761-seat Playhouse (Riverside) Theatre drama theatre and demolition of all remaining buildings on the site.
- Construction of new front of house foyer spaces including:
  - New public entries facing Parramatta River and Church Street;
  - Food and beverage 'theatre' bars;
  - Arrival and gathering space;
  - Function spaces; and
  - Amenities.
- Construction of new theatre spaces including:
  - A 1,500 seat Lyric Theatre;
  - A 324 seat Studio Theatre with retractable seating; and
  - A 100 seat Cinema/Rehearsal space with dedicated entry from the public domain.
- Refurbishment of interiors and building envelope to the 761 seat Playhouse (Riverside) Theatre.
- Construction of a new loading dock with access from Market Street.
- Construction of back of house spaces including:
  - Staff offices and amenities;
  - Central kitchen;
  - Dressing rooms;
  - Technical production spaces; and
  - Storage, cleaning and support spaces.
- Landscaping and public domain works including:
  - A new landscaped area between Riverside Theatres and the river foreshore;
  - An enhanced upper-level pedestrian connection between Church and Marsden Streets;
  - An enhanced landscape treatment to the Marsden Street interface;
  - A new lower-level pedestrian and cycle connection connecting to existing paths east and west; and
  - A riverfront café integrated within the landscape terraces.

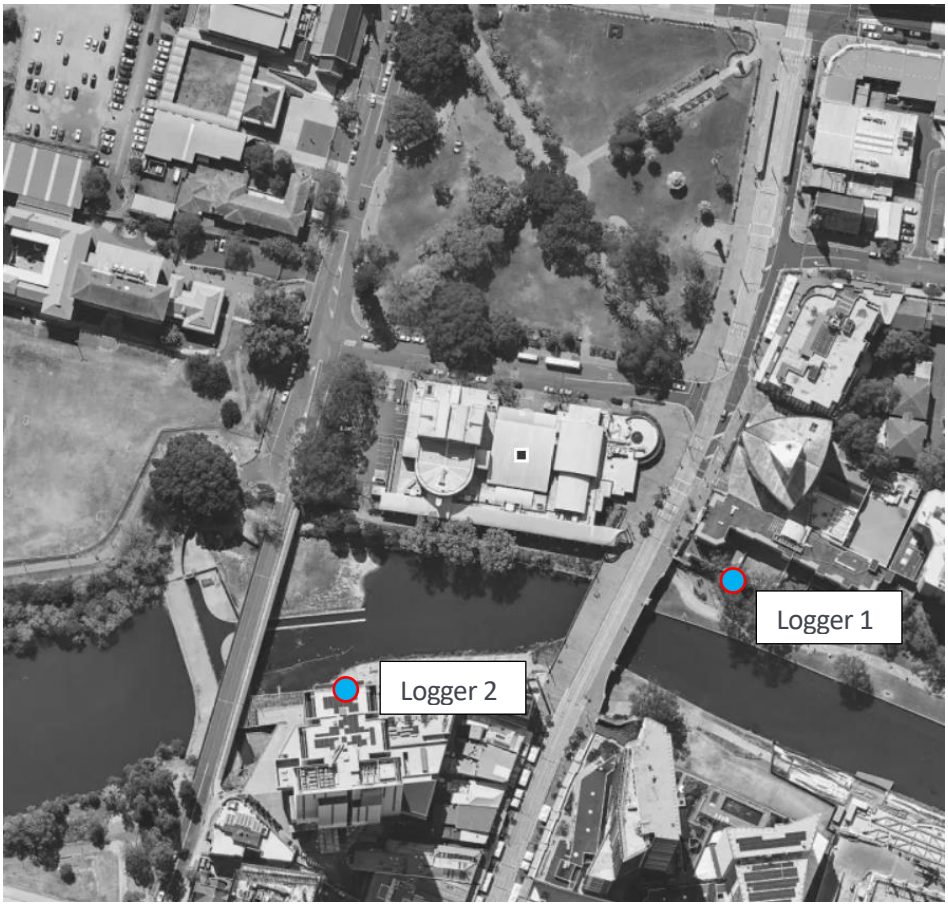
Full details of the proposed development are set out in the Architectural Drawings and Landscape and Public Domain Drawings accompanying the DA.

3.0 EXISTING NOISE ENVIRONMENT

The site is within the Parramatta City Centre, surrounded by significant urban development. The ambient noise environment is dominated by man-made noise, including significant transport related noise primary from road traffic but also from the Parramatta Light Rail line, which runs past the site on Church Street, and pedestrian/cycle traffic along the river paths. There is also significant noise from the operation of the 'Eat Street' area on Church Street, south of the river, with outdoor dining along the majority of the street. Noise from mechanical services associated with commercial and residential buildings are also a feature of the area.

Unattended monitoring of ambient noise levels was undertaken between Thursday 5 December 2024 to Friday 13 December 2024. Logger 1 was installed at 342 Church Street, on the north side of the Parramatta River, on a level 1 southern terrace overlooking the river. The results from this location have been used as representative for receivers north of the river. Logger 2 was installed at 12 Phillip Street, on the south side of the river, on a level 36 northern balcony overlooking the river. The results from this location have been used as representative for receivers south of the river. The monitoring locations are shown in Figure 4. Both loggers were located adjacent building façades and a -2 dB adjustment factor has been applied to measured results, to represent free-field conditions, when deriving criteria from these results.

Figure 4: Noise logger locations



Instrumentation for the survey comprised 01dB FUSION Sound Level Meters (SN 15393 Logger 1 and SN 15392 Logger 2) and an on-site weather station adjacent to the noise logger in Church Street to assist with the exclusion of data affected by adverse weather conditions. Calibration of the meters was checked prior to and following measurements. Drift in calibration did not exceed ±0.5 dBA. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

The logger continuously sampled noise levels over the entire survey period and calculated relevant statistical indices for each 15-minute interval. All measurements were undertaken in general accordance with AS1055:2018 *Acoustics – Description and Measurement of Environmental Noise* and the NSW EPA's *Noise Policy for Industry* (NPfI). Data measured during periods of adverse weather, established through weather data collected by the on-site weather station, has been excluded. The survey results are shown in Table 3. The plots of the daily monitoring results are shown in 0 and Appendix C.

Table 3: Ambient noise survey results (as measured, including façade reflection), dB

Period	Time	Logger 1 – Church St		Logger 2 – Phillip St	
		RBL $L_{A90,\ 15\ min}$	Average $L_{Aeq,\ 15\ min}$	RBL $L_{A90,\ 15\ min}$	Average $L_{Aeq,\ 15\ min}$
Day	0700[1]-1800hrs	54	63	56	60
Evening	1800-2200hrs	53	62	54	58
Night	2200-0700[1]hrs	45	53	48	55

[1]0800 Sundays and Public Holidays

4.0 CRITERIA

4.1 Planning Secretary's Environmental Assessment Requirements

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

Table 4: Noise & Vibration SEARs requirements

Environmental Assessment Requirement
12. Noise and Vibration
Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures that would be implemented.

The following sections provide a detailed summary of the relevant EPA Guidelines as they apply to the development, including:

- EPA NSW Noise Policy for Industry (NPfI)
- EPA Interim Construction Noise Guideline (ICNG)
- EPA NSW Road Noise Policy (RNP)
- EPA Assessing Vibration: A Technical Guideline (AVTG)

Assessment aligned with the Parramatta Development Control Plan 2023 – Part 10 Late Night Trading (DCP Part 10) is also included.

4.2 Operational noise – music and patrons

The site falls within the Parramatta City Centre Late Night Trading Area 2 (LNTA 2) as defined in the *Parramatta Development Control Plan 2023 – Part 10 Late Night Trading* (DCP Part 10). The DCP Part 10 is intended to "provide businesses, venues and operators with a consistent set of

requirements and conditions that will balance community desires for a vibrant nightlife with the amenity of surrounding uses as well as community expectations."

The Planning Secretary's Environmental Assessment Requirements only refer to EPA guidelines for noise, which do not directly address noise from entertainment venues. DCP Part 10 does address noise from entertainment venues, however it not referenced directly by the SEARS.

Whilst the DCP Part 10 is not technically required to be assessed by the SEARS, it does provide guidance on entertainment noise in the Parramatta Late Night Trading area. For this reason, and to provide a development consistent with other development in the area, we have referenced DCP Part 10 in determining noise targets for the venue.

The controls within the DCP Part 10 apply to noise emanating from activities associated with the Night Time Economy, including music and/or patron noise. Regulation of noise from mechanical services or road traffic are regulated by other criteria, as detailed in following sections. Part 10.4.3 C.07 requires that "Noise emission from building services or other sources typically assessed in accordance with the NSW Noise Policy for Industry (NPfI) must comply with the amenity requirements only. No correction to amenity levels is to be applied for high traffic noise environments." Such noise sources are addressed in Section 4.3.

The subject development classifies as 'New Emitter Premises' under Part 10.1.1 of the DCP, due to the significant changes proposed to the site. In accordance with Part 10.1.2 the development is classified as a 'High Impact' emitter, being a dedicated entertainment facility and having a capacity of more than 120 patrons.

DCP Part 10.3.1 identifies the following base and extended trading hours for a High Impact venue within the City Centre LNTA 2.

Table 5: DCP Part 10 Base and Extended Hours

Location	Base hours	Extended hours
Indoor	6am to 2am	24 hours
Outdoor	6am to midnight*	24 hours

**Outdoor areas with a direct frontage to the Parramatta River foreshore will have maximum trading hours until 10pm. Council may consider varying this subject to merit assessment and trial period.*

Note: Alignment of outdoor and indoor hours can be achieved subject to a trial period.

We understand the application seeks approval for the outdoor dining area on the river foreshore to 12am, aligned with the remainder of the development. As such we have assessed this source to 12am.

The DCP Part 10 sets out External Noise Category Cumulative Levels apply on all days, to the frontage or boundary of lots and to all floors to the maximum LEP building heights. From the LEP the maximum LEP building heights are 36 m to Receivers R1/H1, 150 m to Receiver R2 and 211 m to Receiver R3.

External Noise Category (NC) Cumulative Levels $L_{eq(15minute)}$ are provided in Table 10.4.2 of the DCP, with a 5dB reduction applied to determine the permitted noise contribution from an individual noise generating development. Noise Categories are defined in Figure 10.4.2 of the DCP, with both Church Street and Phillip Street defined as Noise Category B. For Receiver R2 (12 Phillip Street) the most affected facade is the north facade, facing the river, and in accordance with Part 10.4.3 C.03 an additional 5 dB reduction to the Category B levels for this facade has been applied (i.e. adopting a limit 5 dB more stringent), as it is not facing a defined NC road.

The applicable external noise levels to be achieved from the subject development are set out in Table 6.

Table 6: Riverside allowable external noise levels at receivers $L_{Aeq(15minute)}$

Receiver	Period	Overall dBA	Octave Band, dB		
			31.5 Hz	63 Hz	125 Hz
R1 R3 H1	Day/Evening 7am-10pm	60	60	60	56
R1 R3 H1	Night 10pm-12am	55	55	55	51
R2	Day/Evening 7am-10pm	55	55	55	51
R2	Night 10pm-12am	50	50	50	46
E1	Day/Evening[1] 7am-10pm	53	55	55	53

Noise levels are 'free field', i.e. not facade corrected.
[1] Night period (after 10pm) not assessed at school as not in use at this time

4.3 Operational noise – mechanical services and vehicles on site

The EPA *Noise Policy for Industry* (NPfI) is a guideline for assessing noise emissions from industrial facilities regulated under an EPA licence. It is often used for the assessment of commercial developments in the absence of council policy or criteria. In this instance City of Parramatta specifically nominate assessment in accordance with the NPfI. Part 10.4.3 C.07 of the DCP requires that "Noise emission from building services or other sources typically assessed in accordance with the NSW Noise Policy for Industry (NPfI) must comply with the amenity requirements only. No correction to amenity levels is to be applied for high traffic noise environments."

We have used the NPfI to set noise criteria for operational of mechanical plant and equipment as well as assessing impacts from use of the loading dock.

The NPfI sets out a procedure such that a noise source can be evaluated against a series of noise assessment levels. In the NPfI, these project specific noise levels are derived from an analysis of the ambient noise environment and the site zoning. An NPfI assessment normally requires the derivation of two sets of noise trigger levels, one is derived from an Intrusiveness assessment and another from an Amenity assessment. However, in this instance only the Amenity criteria are assessed per the DCP direction.

Project amenity noise trigger levels are designed to prevent industrial noise continually increasing above an acceptable level over time with expansion of infrastructure and development. The initial stage in determining the Amenity level is to derive the acceptable noise levels set for the appropriate amenity area based on the baseline noise monitoring.

A review of the land zoning shows the site and surrounding receivers are in a MU1 Mixed Use area. Residential receivers would be classified as Urban Residential in accordance with Section 2.4 of the NPfI. Modification is undertaken to account for the standardisation of the assessment time periods to recommended amenity noise levels (as detailed in Section 2.2 of the NPfI) as well as to account for other potential commercial noise sources in the area (as detailed in Section 2.4 of the NPfI). Resultant levels and the relevant modifications are presented within Table 7.

Table 7: Derived Amenity noise level

Receiver Type	Period	Recommended Amenity Noise Level $L_{Aeq(Period)}$, dB	Modified Amenity Noise Level $L_{Aeq,\ 15\ min}$, dB
Residential (Urban)	Day	60	58 (60 – 5 + 3)
	Evening	50	48 (50 – 5 + 3)
	Night	45	43 (45 – 5 + 3)
Hotel / motel (Urban)	Day	65	63 (65 – 5 + 3)
	Evening	55	53 (55 – 5 + 3)
	Night	50	48 (50 – 5 + 3)
School classroom – internal	Noisiest 1-hour period when in use	40 (internal) [1] 50 (external) [2]	35 (internal) (40 – 5) $L_{Aeq,\ 1hr}$ 45 (external) (50 – 5) $L_{Aeq,\ 1hr}$
Active recreation area (e.g. school playground)	When in use	55	53 (55 – 5 + 3)
Commercial	When in use	65	63 (65 – 5 + 3)

Source: Table 2.2 NSW *Noise Policy for Industry*

[1] *Per note to NPfI Table 2.2 where existing schools are affected by noise from existing industrial noise sources*

[2] *External target based on 10 dB attenuation with open windows per Section 2.6 of NPfI*

Compliance with the NPfI requires that cumulative project noise from mechanical services and loading dock operations not exceed the Modified Amenity Noise Level limits in Table 7.

For residential receivers these apply at the reasonably most affected point on or within the property boundary at 1.2-1.5 m above ground level. For multi-story buildings we have also assessed to elevated floors, adjusted to reflect a free field location per Section 2.6 of the NPfI.

For commercial receivers these have been assessed at the reasonably most affected point on or within the property boundary at 1.2-1.5 m above ground level.

For active recreation areas, being the school playground to the west of Marsden Street and Prince Alfred Square to the north of Market Street, these have been assessed at the most-affected point within the area that is reasonably expected to be regularly used by people, for example picnic areas or walking tracks.

4.4 Operational noise – emergency plant

A power generation plant for emergency use only (e.g. diesel generator) may be subject to different noise limits to general plant. The Protection of the Environment Operations Act 1997 notes that the scheduling of electricity generation activities may not apply "to the generation of electricity by means of electricity plant that is emergency stand-by plant operating for less than 200 hours per year" (Schedule 1 Part 1 Item 17 of the Act).

No emergency plant is currently proposed in the design, however if such plant were to be incorporated the applicability of this aspect of the Act would need to be reviewed by a planner. Noise criteria for such plant may still be required in practice, for example with consideration to Work Health and Safety obligations.

Emergency plant is not considered further in this report.

4.5 Operational noise – additional vehicles on public roads

The NSW EPA *Road Noise Policy* (RNP) is a policy often referenced to assess noise from land use developments generating additional traffic flows on public roads. Section 3.4 of the RNP includes the following notes:

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

As such, where traffic noise increases of less than 2 dB are predicted with the proposed development, traffic impacts would be considered minor and no additional mitigation would typically be applied.

The development does not include propose any on-site parking, and in fact removes the existing on-site car park. The design does retain a loading dock, however the number of vehicles accessing the dock will be very small in relation to the existing traffic flows on the surrounding road network. Any increases in noise levels on the existing road network would be marginal, or even reductions due to the deletion of the carpark.

On the above basis the potential for significant noise impacts from additional operational vehicles on public roads is considered minimal, and traffic noise impacts are not considered further in this report.

4.6 Construction noise

Criteria for assessment of construction noise are set out in the EPA Interim Construction Noise Guideline (ICNG). Rather than providing fixed criteria that cannot be reliably implemented, the ICNG seeks to manage construction noise levels within a noise management goal framework, in the context of site specific noise management levels.

Management levels are described as:

- Noise Affected level - which is a level "above which there may be some community reaction to noise"
- Highly Noise Affected level - which is a level "above which there may be a strong community reaction to noise"

The ICNG also sets out recommended standard hours for construction work, these are:

- Monday to Friday 0700-1800 hrs
- Saturdays 0800-1300 hrs
- No work on Sundays or public holidays

Based on the above, the Noise Affected management level is derived by considering the background noise level (referred to in the ICNG as the rating background level, RBL) and hours at which construction works occur, adding 10 dB for work during the recommended hours or adding 5 dB outside these recommended hours.

The Highly Noise Affected level applies only for residential receivers and is set independent of the RBL, as 75 dB $L_{Aeq(15minutes)}$.

For non-residential receivers the ICNG specifies Noise Management Levels independent of the RBL and applicable when the receiver property is in use.

Table 8 summarises the ICNG noise management goals applicable to this project.

Table 8: ICNG noise management goals - external

Receiver type	Applicable Receivers	Noise Affected Level $L_{Aeq(15min)}$	Highly Noise affected $L_{Aeq(15min)}$
Residential – north of river	R1, H1[1]	62 (52 + 10)	75
Residential – south of river	R2, R3	64 (54 + 10)	75
Classrooms at schools	E1	55 external (45 internal)[2]	NA
Active recreation areas	A1, A2	65	NA

Notes: [1] Hotel receivers are not separately identified in the ICNG and we have assessed to the same levels as long term residential receivers

[2] ICNG specifies an internal level of 45 dBA and that "external noise level is typically 10 dB with windows open for adequate ventilation"

The Noise Affected Management 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 receivers of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.

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 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.

For increased traffic generated on surrounding public roads from construction vehicles the NSW Road Noise Policy criteria Section 4.5 would apply. Note that "an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person".

4.7 Construction vibration

4.7.1 Vibration limits – human comfort

Humans can detect and be disturbed by vibration levels which are well below those causing any risk of damage to a building or its contents. Recommendations for vibration from construction works in relation to human comfort in relation to is assessed under the NSW EPA document *Assessing Vibration – a technical guideline* (AVTG).

The AVTG provides guidance with respect to intermittent, impulsive and continuous vibration sources, which can be generated by construction activities. The vibration characteristics of many construction activities (e.g. excavation, rock breaking and piling) are generally considered to be intermittent. Continuous vibration sources may include tunnel boring and impulsive vibration sources may include drop piling or blasting.

Intermittent Vibration

The vibration characteristics of most construction activities (e.g. excavation and piling) are considered to be intermittent. Intermittent vibration can be defined as interrupted periods of continuous vibration (e.g. heavy truck pass bys or rock breaking) or continuous periods of impulsive

vibration (e.g. impact pile driving). Higher vibration levels are allowed for intermittent vibration compared with continuous vibration on the basis that the higher levels occur over a shorter time period. Hence, for intermittent vibration, human disturbance vibration levels are assessed on the basis of the Vibration Dose Value (VDV), based on the level and the duration of the vibration events. Vibration criteria applicable to the site for intermittent vibration sources, are summarised in Table 9. Only the Day time criteria is provided as no out of hours construction activities are proposed.

Table 9: Preferred and Maximum Vibration Levels for Human Comfort – Intermittent Vibration

Location	Daytime (0700-2200 hrs)[1]	
	Preferred Value, VDV	Maximum Value, VDV
Residences	0.20	0.40
Offices, schools, educational institutions & places of worship	0.40	0.80
Workshops	0.80	1.60

1 Daytime is 7.00 am to 10.00 pm and Night-time is 10.00 pm to 7.00 am.
2 These criteria are only indicative, and there may be a need to assess to other sensitive areas against the relevant criteria.

Continuous Vibration

Vibration criteria applicable to the site for continuous vibration sources, are summarised in Table 10. Only Daytime criteria are provided as no out of hours construction activities are proposed.

Table 10: Preferred and Maximum Vibration Levels for Human Comfort - Continuous Vibration

Vibration type	Location	Assessment period	Preferred values (m / s^2)		Maximum values (m / s^2)	
			z axis	x and y axes	z axis	x and y axes
Continuous vibration	Residences	Daytime	0.010	0.0071	0.020	0.014
	Offices, schools, educational institutions & places of worship	Daytime or night time	0.020	0.0014	0.040	0.028
	Workshops	Daytime or night time	0.04	0.0029	0.080	0.058

1 The preferred and maximum values are weighted RMS acceleration values in accordance with NSW EPA document *Assessing Vibration – a technical guideline.*
2 These criteria are only indicative, and there may be a need to assess to other sensitive areas against the relevant criteria.

4.7.2 Vibration limits – effects on structures

Whilst the AVTG provides guidelines for the assessment of vibration impacts on people (human comfort), no direct instruction or guidance is provided for the assessment of impacts on structures. For assessment of vibration effects on structures the German standard DIN4150-3 *Structure vibration – Effects of vibration on structures -1999* is generally adopted.

The guideline vibration limits, as reproduced from the standard, are detailed in Table 11.

Table 11: Vibration limits used to assess the effects of short-term vibration according to DIN 4150-3

Line	Type of structure	Guideline values for vibration velocity (mm/s) at foundation			Guideline values for vibration velocity (mm/s) in horizontal plane of highest floor, at all frequencies
		Less than 10 Hz	10 to 50Hz	50 to 100Hz	
I	Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	40
II	Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15
III	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines I and II and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10	8

The Lennox Bridge, forming the Church Street crossing of the Parramatta River, is a heritage listed (NSW Heritage Register ref 00750) sandstone single arch bridge. Whilst it is heritage listed, we are not aware of any indications that it is structurally unsound or more vibration sensitive than other surrounding structures, and in fact now carries the Parramatta Light Rail which is likely to impose vibration levels on the structure significantly in excess of any resulting from Riverside construction works. As such the criteria under Line I in Table 11 would be applicable for Lennox Bridge.

We are not aware of the nature of any buried services adjacent to, or within, the site however the effect of vibration on buried services may need to be considered. This will depend on the type and nature of such services. In many cases the infrastructure owner will have vibration limits that must not be exceeded. These services should be assessed for vibration sensitivity once identified.

5.0 OPERATIONAL NOISE ASSESSMENT

5.1 Assessment methodology & modelling assumptions

A 3-dimensional computer acoustic model of the site was created in the environmental noise modelling program SoundPLANnoise v9.1 to predict noise levels from the proposed operations to the noise affected premises in the vicinity of the site. The noise model has been used to calculate noise levels in accordance with ISO-9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation (ISO 9613-2). Note that while a recent 2024 upgrade to ISO 9613-2 has been released, the 1996 version is still considered applicable and valid, and is a noise model that is referenced as part of the NPfI. The noise model enables the calculation of noise levels over a wide area, and accounts for key considerations including site arrangement, terrain and noise-increasing atmospheric conditions.

The ISO 9613-2 standard specifies an engineering method for calculating noise at a known distance from a variety of sources under meteorological conditions that are “favourable” to sound propagation –, i.e. meteorological conditions that increase noise levels at the receiver. The standard defines favourable conditions as downwind propagation where the source blows from the source to the receiver within an angle of +/-45 degrees from a line connecting the source to the receiver, at wind speeds between approximately 1 m/s and 5 m/s, measured at a height of 3 m to 11 m above the ground. Equivalently, the method accounts for average propagation under a well-developed moderate ground based thermal inversion.

Accordingly, predictions on the basis of ISO 9613-2 account for the instances when local atmospheric conditions at the site favour the propagation of sound to surrounding receptor locations. Under other atmospheric conditions, such as when the wind is blowing from a receiver location to the development site, the resultant noise levels from the use of the site would generally be expected to be lower than calculated.

To calculate far-field noise levels according to the ISO 9613-2, the noise levels of each source are firstly characterised in the form of octave band frequency spectral levels. A series of octave band attenuation factors are then calculated for a range of effects including:

- Geometric divergence
- Air absorption
- Reflecting obstacles
- Screening
- Ground reflections.

The octave band attenuation factors are then applied to the noise data to determine the corresponding octave band and total calculated noise level at relevant receiver locations.

Geometry data for the model has been sourced from public aerial photography, visual inspections of the area, and building heights defined on the basis of standard assumed heights per floor level. The geometries in the model are simplified representations of the built environment that have been configured to a level of detail that is appropriate for noise calculation purposes.

Noise levels are calculated external to receiver buildings, i.e. free-field noise levels.

5.2 Music & Patron noise assessment

In order to calculate noise emissions from music in the venues to the neighbouring noise sensitive receivers, MDA has developed a typical sound pressure level spectrum for noise in the venues. These noise levels would correspond to the noisiest uses of the venues. For the Lyric Theatre this reflects a loud bass-heavy rock concert or heavily amplified musical theatre performance, for the Playhouse and Studio (which are used for smaller shows) a loud music event and for the Cinema a loud film screening. The levels represent levels at the audience, with a modern directional sound system noise levels at the underside of ceiling etc will be somewhat lower than these levels. As a conservative assumption, at this stage, the noise level at audience has been assumed incident on the building envelope.

The assessment therefore assumes that amplified events are occurring concurrently in all four venues simultaneously, which is expected to be a conservative assumption.

Table 12: Typical upper reverberant SPL within the auditorium audience area – L_{eq} dB

Venue	Octave band centre frequency Hz								Broadband	C
	31.5	63	125	250	500	1000	2000	4000	dBA	dBC
Lyric Theatre	95	105	105	104	102	101	97	93	105	111
Playhouse	90	100	100	102	102	101	97	93	105	108
Studio Theatre	90	100	100	102	102	101	97	93	105	108
Cinema	85	95	97	92	93	90	88	81	95	101

For the river side dining / bar area on the southern side of the venue we have assumed 76 patrons talking in groups of three. Noise data for external patrons considers a single speaker talking at 'Raised' speaking volume as detailed in the *Licensed Premises Noise Assessment Technical Guideline*

v3.0 published by the Association of Australasian Acoustical Consultants (AAAC), with additional corrections made for talkers facing in random directions.

The derived sound power spectra for a single talker in the outdoor area is detailed in Table 13.

Table 13: General external patron sound power data used for assessment ('Raised' volume)

Source	Octave band centre frequency Hz									A
	31.5*	63	125	250	500	1000	2000	4000	8000	
General Tenancies Sound Power Level per one talking patron L_{eq} *'Raised'*	43	43	49	68	74	72	66	61	61	76

**speaker data at 31.5 Hz is not available. For the purposes of assessment 63 Hz levels have been used.*

The assessment assumes that music in outdoor areas would only be played at "background music" levels that do not form a significant contribution to the overall noise emissions.

The breakout of music noise from the four main venues in the building is complex, with many wall, roof/ceiling and glazed elements. This including a mix of existing and new construction, an external building facade structure (the visible building 'cladding') that forms part of the acoustic envelope in some but not all instances and parts of the building where venues directly adjoin the facade while in others there are interstitial spaces (such as foyers, plantrooms or corridors) between a venue and the facade. The breakout noise to receivers is also influenced by factors such as the acoustic finishes within the venues and sound system design and performance which affect the noise level incident on the building envelope. None of these elements is finalised at the current design stage.

As such the construction, and final acoustic transmission loss, of building envelope elements are not specified in this report in a form suitable for inclusion as prescriptive consent requirements.

Nominal constructions, as developed for the current concept design, have been used for calculation of noise breakout to surrounding receivers, as one means of demonstrating compliance with the required criteria can be achieved. However, the intent of this report is that the overriding acoustic requirement for music and patron noise is that the criteria set out in Section 4.2 are complied with for the final design, taking into account the final room acoustic conditions in each venue and the detailed contribution to noise breakout from each facade element and air paths including smoke exhaust. The builder must ensure that this can be achieved as the design evolves and is constructed.

Noise emission has been modelled in SoundPlanNoise for all four internal venues and the river side bar operating simultaneously at maximum volume. The results have been compared to the most stringent criteria for that receiver and presented in Table 14.

Table 14: Noise at most affected receiver locations from music and patron noise $L_{eq(15min)}$

Receiver	Predicted Levels				Criteria			
	A	31.5Hz	63Hz	125Hz	A	31.5Hz	63Hz	125Hz
R1	36	47	46	31	55	55	55	51
R2	45	48	49	38	50	50	50	46
R3	45	48	49	37	55	55	55	51
H1	35	48	49	34	55	55	55	51
E1	18	42	40	27	53	55	55	53

The noise predicted levels in Table 14 indicate compliance with noise criteria for music and patron noise can be achieved at all receiver locations with the current design concept. We again note that compliance with the criteria at receivers remains a primary requirement as the design is developed and constructed.

5.3 Mechanical services & on-site vehicle assessment

5.3.1 Mechanical services

The mechanical services systems for a development such as this are complex, with hundreds of plant items serving the building, spread across a number of internal and external plant areas and terminations at louvres/grilles in the building envelope. Noise levels from plant items (fans, cooling towers, heat pumps etc) vary from manufacturer to manufacturer, for plant that provides the same mechanical output. Noise levels for plant also change over time as manufacturers evolve and modify their offered products. The mechanical services design for the development is at a conceptual design stage only and equipment selections are not available for many items at this time.

For the above reasons it is not possible to calculate final noise levels for a services design that can be enforced in a consent condition. Nominal plant selections and configurations, as developed for the current concept design, have been used for calculation of noise emission to surrounding receivers, as one means of demonstrating that compliance with the required criteria can be achieved.

However, the intent of this report is that the overriding acoustic requirement for mechanical services noise is that the criteria set out in Section 4.3 are complied with for the final design. The builder and services contractor must ensure that this can be achieved as the design evolves, plant is selected and the project is constructed.

Noise emission has been modelled in SoundPlanNoise based on the preliminary mechanical services design and selections. The results have been compared to the most stringent criteria for that receiver and presented in Table 15.

Table 15: Noise at most affected receiver locations from mechanical services $L_{eq(15min)}$

Receiver	Predicted level	Criteria
R1	30[2]	43
R2	41[2]	43
R3	40[2]	43
H1	39[2]	48
E1	[1]45[1]	45[1]
A1	44	53
A2	53	53

[1] $L_{eq(1hr)}$ level per criteria

[2] Levels at Residential and Hotel receivers assessed to Night (to 12am) criteria, with Night setback mode for cooling towers

These predictions include conceptual acoustic treatment as set out in Section 5.4. The levels for the concept can comply with the criteria.

5.3.2 On-site vehicles (loading dock)

Sound power data for the various noise generating elements associated with the loading dock are defined in Table 16.

Table 16: Sound Power noise source data used for operational assessment

Source	Sound Power Level, dB L_{WA}	Parameter
Semi-trailer truck for dock deliveries. Instantaneous sound power of vehicle in motion. L_{eq} calculated in model based on source moving at 10km/h	106	$L_{w,\ instantaneous}$
Medium Rigid Vehicle (MRV) truck for dock deliveries. Instantaneous sound power of vehicle in motion. L_{eq} calculated in model based on source moving at 10km/h	100	$L_{w,\ instantaneous}$

In assessing noise from the loading dock, we have assumed one semi-trailer and one medium rigid truck access the dock in a single 15-minute period, with dock activity (pallet jacks etc) occurring for the full 15-minutes. For receiver E1, which assesses noise over a 1-hour period we have assumed the above activities are repeated twice in 1-hour.

Noise emission has been modelled in SoundPlanNoise for the loading dock activities, including truck movements occurring within the site boundaries. The results have been compared to the most stringent criteria for that receiver and presented in Table 17.

Table 17: Noise at most affected receiver locations from loading dock $L_{eq(15min)}$

Receiver	Predicted level	Criteria
R1	14	43
R2	13	43
R3	21	43
H1	28	48

Receiver	Predicted level	Criteria
E1	45[1]	45[1]
A1	37	53
A2	57	53

[1] $L_{eq(1hr)}$ level per criteria

Noise levels at all residential, hotel and educational receivers are compliant with the criteria.

Noise levels at receiver A2, that is within Prince Alfred Square park across Market Street from the loading dock, are predicted to be above the NPfI criteria. However, context is important in evaluating this prediction. The north side of Market Street, directly between the loading dock and the park, is a bus and coach parking and loading area. Noise from the movements of existing busses and coaches would likely give rise to louder and more-consistent noise levels in the park than loading dock operations. The park is surrounded by Victoria Road, Church Street, Market Street and Marsden Street and existing ambient noise levels in the park from road traffic will generally be higher than noise from loading dock activities. It is unlikely that occasional truck movements in the loading dock will give rise to any measurable change in acoustic amenity in the park. For this reason, we do not propose any additional acoustic mitigation or administrative controls to the loading dock.

5.4 Operational noise mitigation measures

As discussed previously the breakout of music noise from the four main venues in the building is complex, with many wall, roof/ceiling and glazed elements, including a mix of existing and new construction. As such the building envelope is not finalised at the current design stage. Accordingly, the construction and final acoustic transmission loss requirements of building envelope elements are not specified in this report in a form suitable for inclusion as a prescriptive consent requirement.

The intent of this report is that the overriding acoustic requirement for music and patron noise is that the criteria set out in Section 4.2 are complied with for the final design. It will be necessary to ensure that this can be achieved as the design evolves and is constructed.

Notwithstanding the above the following conceptual approaches are indicative of the construction likely required for the building envelope to control noise breakout:

- Roof/ceiling structures in the venues will require a double skin system, incorporating a mass layer nominally below the roof sheet, a large airgap with insulation and a second mass layer below (nominally at ceiling level). The Lyric Theatre will require the heaviest system with the largest airgap as it has the loudest internal noise levels and largest roof area, with similar but lighter / smaller systems required for the other venues.
- Walls between a venue and the external facade will similarly require a double skin system, incorporating two discrete wall elements, each having significant mass, with an airgap and insulation between.
- Glazed elements to venues (to the external facade) will require very high acoustic performance, typically primary and secondary glazing incorporating two heavy glazing panes in separate frames with a significant airgap (in the order of 300 mm).
- Leakage paths from venues to the outside will need to be acoustically treated. Generally, the most significant of these will be the Smoke Exhaust Fans which operate in emergencies to exhaust smoke from venues. When not in use (i.e. in normal operation) the fans do not create noise however noise from music can travel into the air grilles in the venue, through the ductwork and emerge outside. For this reason all such air paths must be acoustically treated. The current concept design includes in-duct acoustic attenuators, dampers and duct cladding to address this noise.

The above approaches are reflected in the current concept design, however alternative construction systems are possible that are also capable of achieving compliance with the external noise criteria.

Mechanical services will also require noise controls works. Such noise controls will need to consider the wholistic impact of plant and its impact on all affected receivers. Initial modelling has identified the following conceptual noise control approaches will likely need to be employed.

- There are three large semi-enclosed plantrooms housing Air Handling Units (AHUs) on level 5, on the north side of the Playhouse flytower, on the north side of the Lyric flytower and on the south side of the Lyric flytower. Plant in these rooms will need to be treated in order to reduce breakout noise to external. This might typically be by applying acoustic duct attenuators to outside air intake and relief air exhaust ducts.
- There is a Chiller plant room on the north western corner of the site (on Level 2) with access to fresh air on the western façade. The fresh air path will require acoustic attenuation, for example with an acoustic attenuator or lined duct with elbow.
- There is a Cooling Tower and Heat Pump plant room on the north-western corner of roof on Level 3 housing three large cooling towers and 10-12 heat pumps.

  The cooling towers will be required to be low noise units via either: (a) low noise plant selection (e.g. oversized units running below 100% fan capacity); (b) acoustic attenuation (e.g. with manufacturers 'low noise' noise treatments) or (c) having night-setback mode to reduce noise levels in Evening and Night periods; or a combination of these.

  Acoustic screening will also be required around the cooling towers and the adjacent heat pumps, particularly on the western and northern sides of the plant room (the east and south of the room abut taller sections of the building). The height and extend of the barrier will be subject to detailed design (and plant selection) but the area is already semi-enclosed by the hit-miss façade elements. The barrier may be implemented by changing some (or all) of this façade to solid (i.e. not hit-miss) or more likely via a secondary acoustic screen (possibly with acoustic louvres) set behind the visible façade.

We again note that not all plant has been selected or designs finalised and mechanical services noise controls will need to be developed during subsequent design stages to ensure compliance with the relevant criteria.

6.0 CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

6.1 Construction hours

We have assessed construction works during the standard recommended work hours in the NSW EPA Interim Construction Noise Guideline, being:

- Monday to Friday: 7 am – 6 pm
- Saturday: 8 am to 1 pm
- Sunday and public holidays: No work

6.2 Construction staging, activities & assessment methodology

Details of construction phasing, duration, equipment etc are not available at the current time. As such a series of assumptions have been made to carry out the initial construction noise assessment. Council has confirmed that bored piling (i.e. not impact piling) and rock pulverisers (but not rock breaking hammers) will be used for the site. We note that a more detailed Construction Noise & Vibration Management Plan will need to be carried out once a builder is appointed, in order to develop management plans specific to that builder's construction plan.

We have assessed the works in three phases assumed phases / durations:

1. Site establishment and demolition – 3 months
2. Excavation and piling – 3 months
3. Construction – 18 months

Noise levels during proposed work stages have been calculated at the nominated receivers under guidance from *AS 2436-2010 Guide to noise control on construction, maintenance and demolition sites* and utilising the information provided in *BS 5228-1-2009 Code of practise for noise and vibration control on construction and open sites.*

For the purpose of our calculations, assumptions have been made with respect to the equipment items that will be working together simultaneously. Equipment has been assumed to operate concurrently, however an assumption of operational time per plant item has been made, defined between 0 to 100% of the time over a 15-minute period. Penalty corrections have also been applied to 'particularly annoying' activities, as defined by the *NSW EPA Interim Construction Noise Guideline*.

We have assumed construction plant sources at the centre of the site, or as an area source over the breadth of the site, in order to calculate typical long term average noise levels at receivers. We note that noise levels generated from construction sites vary over time and the measured noise level during any particular 15-minute period will not always match the long term average.

Table 18: Construction plant assumptions and sound power levels

Noise source	Sound Power Level, L_{Aeq} dBW	Data reference	Penalty dB	Operational on-time per 15-min %	Site establishment & demolition	Excavation & piling	Construction
Excavator mounted rock pulverizer	108	BS 5228-1-2009	0	100	2		
Concrete cutting (petrol saw 3kW)	115	BS 5228-1-2009	5	50	1		
Generator (150kVA)	93	BS 5228-1-2009	0	100	1	1	
Wheeled loader (209kW)	107	BS 5228-1-2009	0	100	1	1	
Articulated dump truck	109	BS 5228-1-2009	0	20	1	1	
Large rotary bored piling rig	111	BS 5228-1-2009	0	20		1	
Excavator (20T)	103	BS 5228-1-2009	0	100		1	
Tower Crane (22T)	104	BS 5228-1-2009	0	100			1

Noise source	Sound Power Level, L_{Aeq} dBW	Data reference	Penalty dB	Operational on-time per 15-min %	Site establishment & demolition	Excavation & piling	Construction
Concrete truck and pump (26T)	103	BS 5228-1-2009	0	100			1
Concrete pump boom and vibrating poker	99	BS 5228-1-2009	0	100			1

6.3 On site construction noise prediction results

Construction noise levels have been predicted in SoundPlanNoise, with resultant levels set out in Table 19. Note that these levels include penalties set out in Table 19 but do not include any noise mitigation measures.

Table 19: Predicted construction noise levels

Applicable Receivers	Noise Affected Level $L_{Aeq(15min)}$	Highly Noise Affected $L_{Aeq(15min)}$	Site establishment & demolition	Excavation & piling	Construction
R1	62	75	71	72	60
H1	62	75	70	71	59
R2	64	75	67	68	55
R3	64	75	66	68	55
E1	55 (external)	NA	66	68	54
A1	65	NA	71	72	59
A2	65	NA	72	72	60

Levels shown shaded indicate predicted exceedance of the Noise Affected Level. No levels are predicted to exceed the Highly Noise Affected Level.

In the above modelled scenarios the works during the longest phase, i.e. Construction, are below the Noise Affected Levels. Nevertheless, feasible and reasonable noise mitigation should still be considered in the detailed Construction Noise and Vibration Management Plan.

During the initial works phases, i.e. Site establishment & demolition and Excavation & piling, the predicted levels are above the Noise Affected Level at all receiver locations. The predicted levels are below the Highly Noise Affected Level at all residential receivers. All feasible and reasonable noise mitigation should be considered in the detailed Construction Noise and Vibration Management Plan to minimise noise impacts during these stages.

6.4 Construction traffic impact assessment

The Traffic Impact Assessment (TIA) prepared by Arup (ref 296335-00 TF-RP-01) identifies the following overall construction traffic generation for a typical 7am to 6pm day, reproduced in Table 20.

Table 20: Overall construction traffic generation

Type	AM peak hour		PM peak hour		Daily	
	In	Out	In	Out	In	Out
Construction vehicles	-	-	-	-	60	60
Construction workers (light vehicles)	50	-	-	50	100	100
Total	50	-	-	50	160	160

From the above traffic projections there would be approximately 6 construction vehicles entering and 6 departing the site per hour. The busiest 1-hour period from a traffic generation perspective would be the morning or afternoon peak hour when 50 lights vehicles access the site along with 6 arriving and 6 departing construction vehicles.

For the purposes of our assessment we have assumed the following, based on the advice in the Arup Traffic Impact Assessment:

- Incoming access primarily via Marsden Street from arterial network at Victoria Rd and egress via Church Street
- Marsden Street having existing peak hour flows of 929 vehicles per hour. Existing peak hour flows on Church Street are not provided and we have assumed 150 vehicles per hour.

On the above basis the additional traffic flows would result in increases on less than 1 dB on Marsden Street and less than 1.5 dB on Church Street (in practice the increase is likely to be even less due to existing light rail noise). Given the predicted increase is less than 2dB with the proposed construction traffic no additional mitigation would typically be required.

6.5 Construction noise mitigation measures

A detailed assessment of the construction approach proposed by the appointed builder will need to be carried out in the form of a Construction Noise and Vibration Management Plan (CNVMP), determining specific noise mitigation strategies applicable for the development. The following section outlines items that should be considered as part of the CNVMP.

6.5.1 Training

Staff to participate in an induction training session before starting work on the construction, with attention given to the following matters:

- Activities with the potential to generate high levels of noise and/or vibration;
- Mitigation and management measures;
- Sensitive receivers and any agreements made through engagement (if any); and
- Monitoring requirements (if any).

As the construction progresses, any updates of noise and vibration matters will be addressed during regular site meetings and/or 'toolbox' training sessions.

6.5.2 Equipment selection and operation

When selecting construction equipment:

- Use quieter construction methodologies where practicable
- Use electric motors rather than diesel engines where practicable

- Use rubber-tracked equipment rather than steel tracked equipment where practicable
- Use equipment that is suitably sized for the task
- Maintain equipment well to minimise rattles, squeaks etc
- Fit engines with exhaust silencers and engine covers where practicable
- Avoid tonal reversing or warning alarms (beepers). Alternatives include broadband alarms (squawkers/quackers), flashing lights, proximity sensors, reversing cameras and spotters.
- Mitigate track squeal from tracked equipment, such as excavators. This may include tensioning and watering or lubricating the tracks regularly.
- Locate stationary equipment (e.g. generators) away from noise sensitive receivers and/or screen them behind site buildings and material stores.
- Orient mobile machinery to maximise the distance between the engine exhaust and the nearest sensitive building facade (e.g. excavators).
- For bolt/nut tightening prioritise use of a tension control bolt, hydraulic wrench or manual torque wrench to minimise rattle gun slippage on a tightened nut.

All excavators can generate high noise and vibration levels. The actual level they generate depends very much on the manner in which the plant is operated. The following approach must be adopted for all excavator use:

- Use an excavator of appropriate capacity for the work
- Operate the bucket and armature smoothly (avoid jerking)
- Tip material from the bucket rather than shaking it clean where practicable
- Avoid hitting the bucket on the ground or dropping heavy objects
- Control the weight shift of the excavator to avoid the tracks lifting and thudding on the ground.

6.5.3 Demolition strategy

As outlined previously the use of excavator mounted rock pulverizers (rather than hydraulic rock breakers) is proposed for demolition. Off-site demolition with minimal cutting of material on site for removal to an off-site facility for breaking should also be explored in the CNVMP.

6.5.4 Piling strategy

As outlined previously the use of bored piling (rather than impact piling) is proposed and recommended.

6.5.5 Scheduling of activities

There may be times when receivers are more or less sensitive to noise. For residential and hotel receivers they may be less sensitive on weekday mid-morning or mid-afternoon. For the school the times of sensitivity may be different, depending on their schedule/timetable. Consideration should be given to the scheduling of high noise activities around these times.

Scheduling high noise-generating activities to be undertaken when background noise, including local road traffic, is high may also provide masking to construction noise.

6.5.6 Community consultation

Written communication (e.g. newsletter) should be provided to affected receivers prior to commencement of construction works. The communication will include:

- All potentially impacted receivers should be informed, reasonably ahead of time, of the nature of works to be carried out, the expected noise impacts from noisier activities and their duration, and the measures being taken to minimise noise from the construction.
- Effective channels of communication must be established between the contractor, Local Authority and affected receivers.
- A site representative responsible for all matters relating to noise should be appointed and contact details of this representative be readily available. A site information board should be installed in front of the construction site with the name and contact details for the site representative.
- Acknowledge that some activities are predicted to generate high noise and/or vibration levels and may result in disturbance for short periods.

Once construction has begun, ongoing communication is important. Regular communication during the works should include:

- Public site signage that includes contact details
- Details of upcoming activities that may result in disturbance
- Any changes to scheduled timing and duration of activities
- Notification to occupants of surrounding buildings as to when demolition and excavation works will commence.

Specific consultation with Bayanami Public School is recommended. Current predictions have assumed classroom windows will be open during construction works. However, all available photos of the school show the exposed windows on the southern facade as being closed. In the instance that these classrooms operate with windows closed the acoustic impacts would be lower than currently assumed. Consultation should also establish the schedule of the school, including start, finish and break times, school holiday periods, exam periods etc.

6.5.7 Complaint response

All construction noise and/or vibration complaints should be recorded in a complaints file that is available to affected parties and the regulator on request. For each complaint, an investigation should be undertaken as soon as practicable using the following steps:

- Acknowledge receipt of the concern or complaint and record:
  - The name, address and contact details of the complainant (unless they elect not to provide)
  - Time and date the complaint was received and who received it
  - Time and date of the activity that caused the complaint (estimated where not known)
  - The complainant's description of the activity and its effects
  - Any relief sought by the complainant (e.g. scheduling of the activity).
- Identify the relevant activity and review the activity log to verify the complaint (or otherwise).
- If a complaint relates to building damage, inform the on-duty site manager as soon as practicable and stop the relevant works pending an investigation. In most cases, stopping the activity will provide immediate relief. But in some cases, this may not be practicable for safety or other reasons, in which case the complainant will be kept updated regularly during the time it takes to stop the activity.
- Review data from monitoring (if available) to identify the time in question and, if possible, verify exceedance.

- Review the predicted noise and/or vibration levels to determine if the activity was identified. Consider attended monitoring to verify the underlying reference level assumptions.
- Review the mitigation and management measures in place to ensure they have been applied. Review the relief sought by the complainant. Adopt further mitigation and management measures as appropriate.
- Review the potential residual effects if predicted to continue to exceed the relevant performance standards.
- Report the findings and recommendations to the Project Manager, implement changes and update the CNVMP as appropriate.

Report the outcomes of the investigation to the complainant, identifying where the relief sought by the complainant has been adopted or the reason(s) otherwise.

6.5.8 Monitoring

The need for and extent of noise and vibration monitoring will need to be considered in the CNVMP. Noise and/or vibration monitoring may be required for a range of reasons including:

- In response to a reasonable noise complaint
- To compare predicted impacts to levels measured on site, in order to determine accuracy of modelling and effectiveness of mitigation
- Where intensive works are to take place which are predicted to exceed the Highly Noise Affected levels with all mitigation measures in place

6.6 Construction vibration assessment

Vibration propagation through the ground is complex and depends on several factors including damping, reflection and impedance in ground conditions. Therefore, detailed vibration propagation assessment is considered to be a site-specific assessment and often require a combination of empirical (site measurements) and analytical methods.

Table 21 shows indicative safe working distances from vibration intensive plant indicating the minimum distance at which vibration levels from intensive vibration activities are not predicted to exceed the cosmetic damage targets. It is noted that these safe working distances are not to be applied to structures sensitive to vibration (e.g. heritage items).

Table 21: Safe working distances – Cosmetic damage limits

Plant Items	Safe working distance, (m)
Hydraulic Impact Hammer – Small (300 kg – 5-12t excavator)	2
Hydraulic Impact Hammer – Medium (900 kg – 12-18t excavator)	7
Hydraulic Impact Hammer – Large (1,600 kg – 18-34t excavator)	22
Pile Boring	2
Jackhammer	1*

* Avoid contact with receiver structure.

It is recommended that once a detailed construction methodology is known and specific equipment items are selected, a detailed review of proposed plant locations, close working zones, equipment selections and work activities for these receivers is conducted. Baseline vibration measurements for vibration generating works to develop site-specific exclusion zones should be considered. Detailed vibration impact assessment for works near potentially sensitive receivers, such as the Lennox

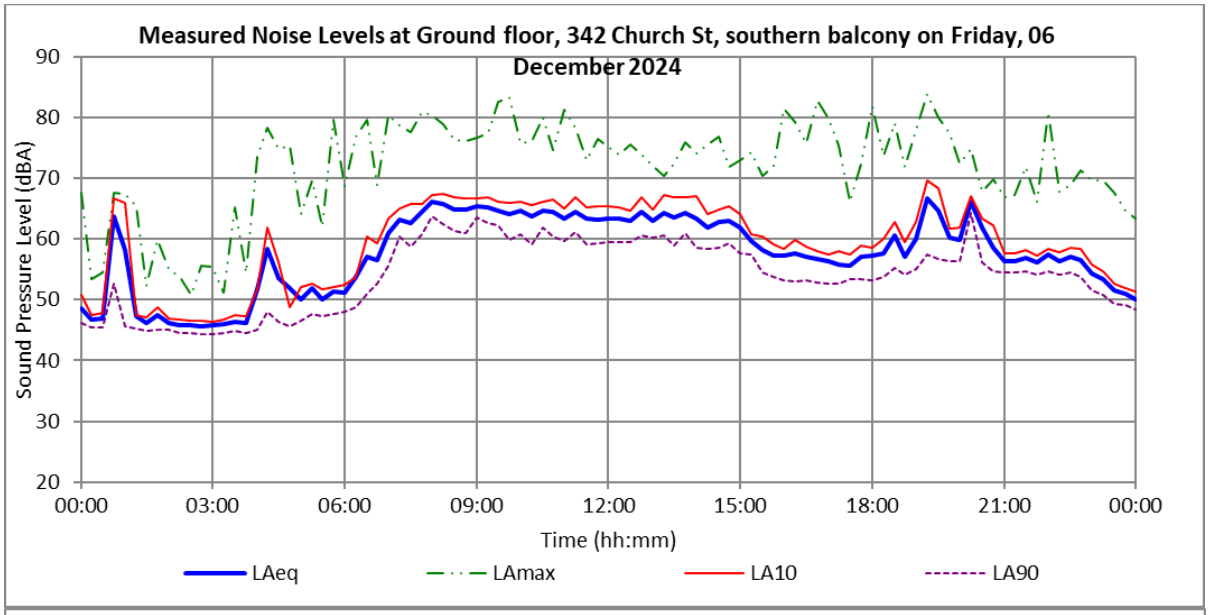
Bridge, may be required to be prepared as part of the full CNVMP. The vibration criteria detailed in Section 4.7.2 would govern these work types.

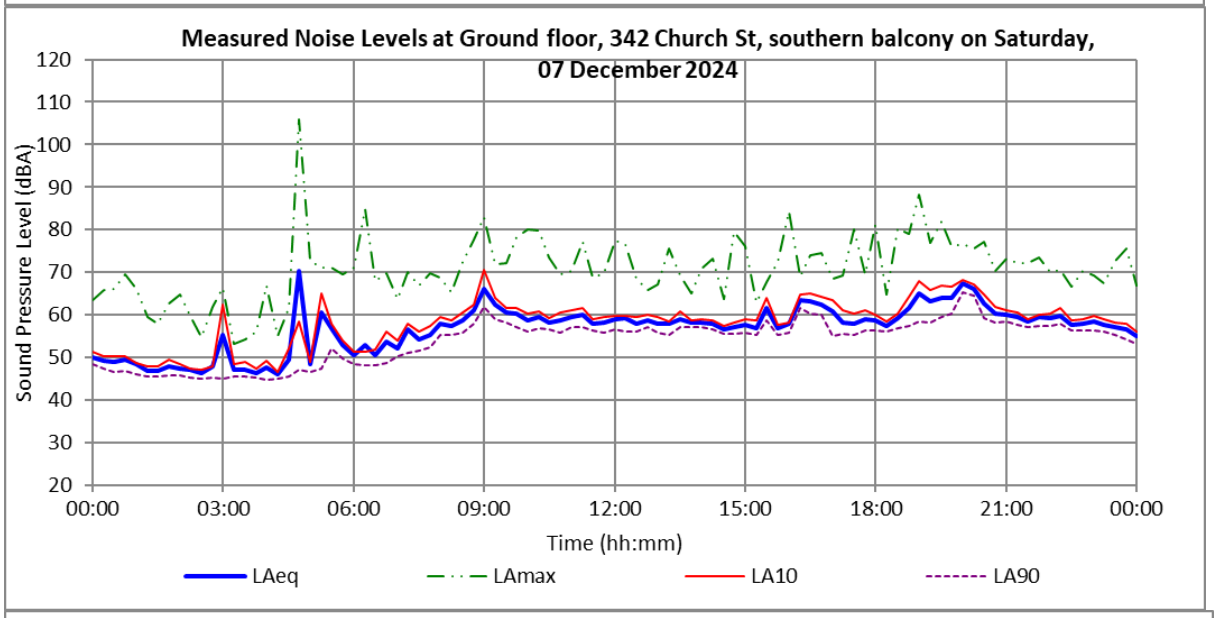
APPENDIX A GLOSSARY OF TERMINOLOGY

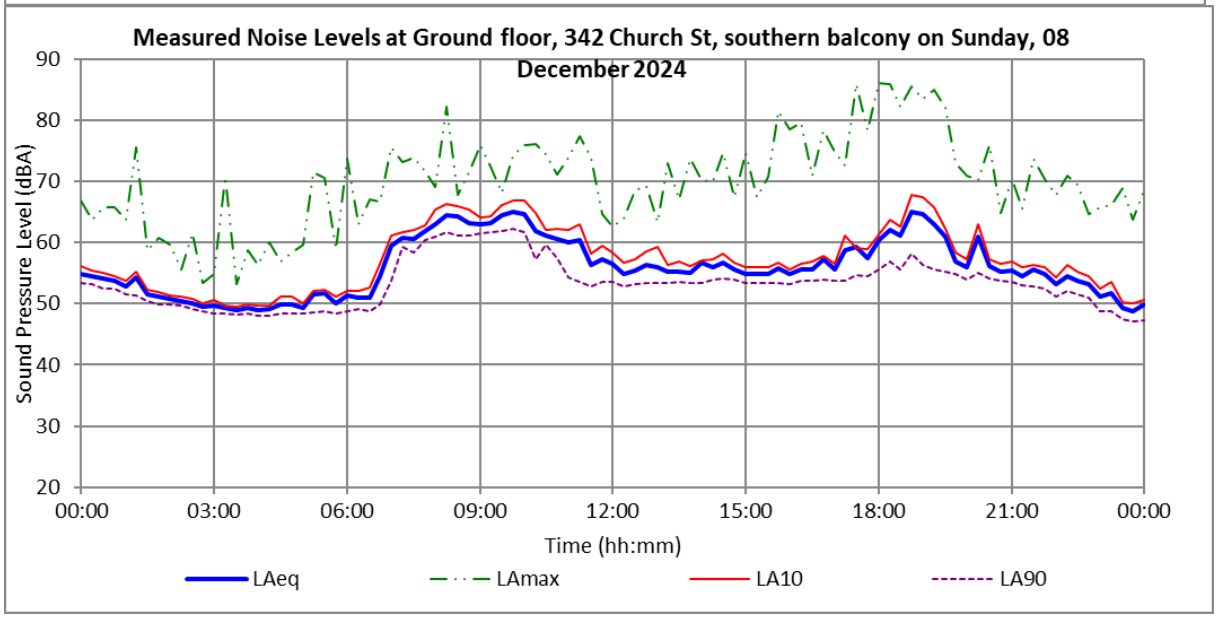
Background sound	The sound that is continuously present in a room our outdoor location. Often expressed as the A-weighted sound level exceeded for 90 % of a given time period i.e. L_{A90}.
Emission	Sound that is generated by, and propagates away from a source.
Frequency	Sound occurs over a range of frequencies, extending from the very low (e.g. thunder) to the very high (e.g. mosquito buzz). Measured in units of Hertz (Hz). Humans typically hear sounds between 20 Hz and 20 kHz. High frequency acuity naturally reduces with age most adults can hear up to 15 kHz.
Hertz (Hz)	The unit of frequency, named after Gustav Hertz (1887-1975). One hertz is one pressure cycle of sound per second. One thousand hertz – 1000 cycles per second – is a kilohertz (kHz).
Noise	A subjective term used to describe sound that is unwanted by, or distracting to, the receiver.
Octave band	The interval between one frequency and its double. Sound is divided into octave bands for analysis. The typical octave band centre frequencies are 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz and 4 kHz.
Reference time interval	The time interval over which the time average A-weighted sound pressure levels is determined. Typically 15 minutes. This definition is from NZS 6802:2008.
A-weighting	A set of frequency-dependent sound level adjustments that are used to better represent how humans hear sounds. Humans are less sensitive to low and very high frequency sounds. Sound levels using an "A" frequency weighting are expressed as dB L_A. Alternative ways of expressing A-weighted decibels are dBA or dB(A).
C-weighting	A frequency weighting used to approximate the response of the human ear to sounds with strong low frequency components (typically between 25 and 125 Hz) at high noise levels (typically greater than 85 decibels).
dB	Decibel. The unit of sound level.
L_{A90}	The A-weighted sound level exceeded for 90 % of the measurement period, measured in dB. Commonly referred to as the background noise level.
L_{Aeq}	The equivalent continuous A-weighted sound level. Commonly referred to as the average sound level and is measured in dB.
L_P	Sound pressure level. The sound level measured at distance from a source. Distinctly different from sound power level (L_W)
L_w	Sound Power Level. The calculated level of total sound power radiated by a sound source. Usually A-weighted i.e. L_{WA}.
Impact sound	Sound produced by direct contact with a building structure, such as footfall noise, chairs scraping on a floor or a door banging shut.
R_w	Weighted Sound Reduction Index. A single number system for quantifying the transmission loss through a building element. The measured transmission loss, in third octave bands from 100 Hz to 3.15 kHz, is compared to a standard reference

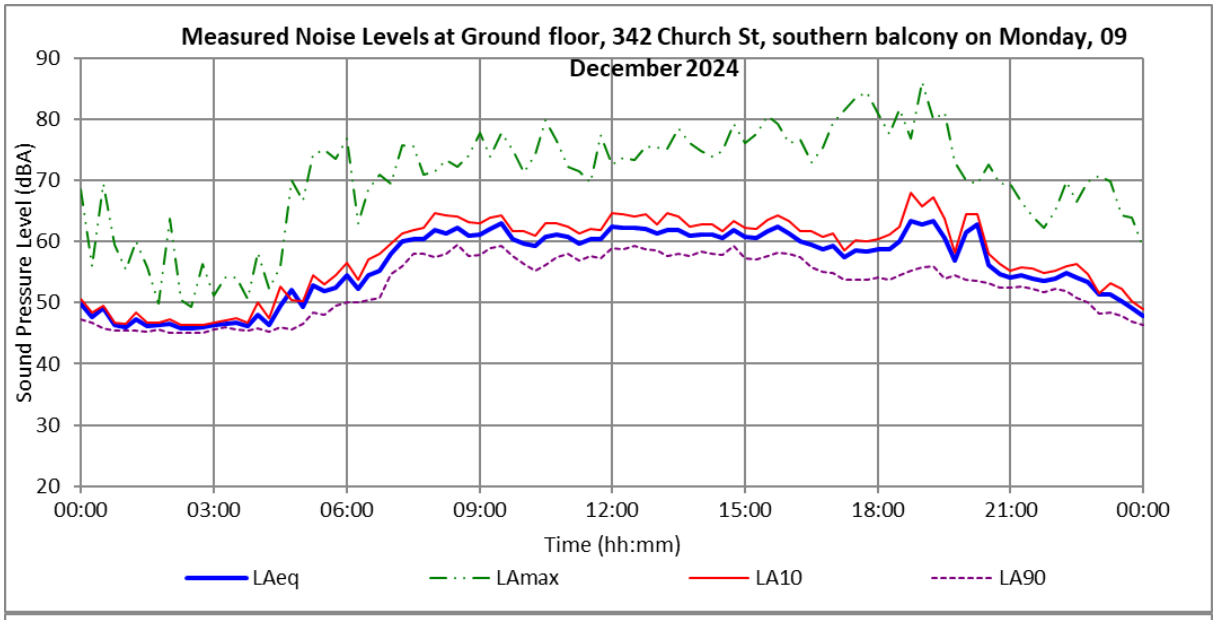
	contour to determine the single number value. Can only be measured in laboratory conditions
Sound insulation	The ability of a material or construction to reduce sound travelling through it.
Transmission loss (TL)	The reduction in sound level resulting from sound passing through a material or construction.
RT	Reverberation Time. Describes how quickly sound decays within a room and is dependent on its volume and sound absorption. Measured in seconds – the more reverberant the room, the higher the RT.
PPV	Peak Particle Velocity. The measure of the vibration aptitude, zero to maximum. Used for building structural damage assessment.
RMS velocity	For most applications where there is continuous vibration, vibration is measured in terms of root mean square RMS velocity (mm/sec), measured in any direction. Used for vibration annoyance.
Spectrum	The spectrum is the result of transforming a time domain signal to the frequency domain. Spectrum analysis is the procedure of doing the transformation, and it is most commonly performed using an FFT analyzer.
Vibration	When an object vibrates, it moves rapidly up and down or from side to side. The magnitude of the sensation when feeling a vibrating object is related to the vibration velocity. Vibration can occur in any direction. When vibration velocities are described, it can be either the total vibration velocity, which includes all directions, or it can be separated into the vertical direction (up and down vibration), the horizontal transverse direction (side to side) and the horizontal longitudinal direction (front to back).

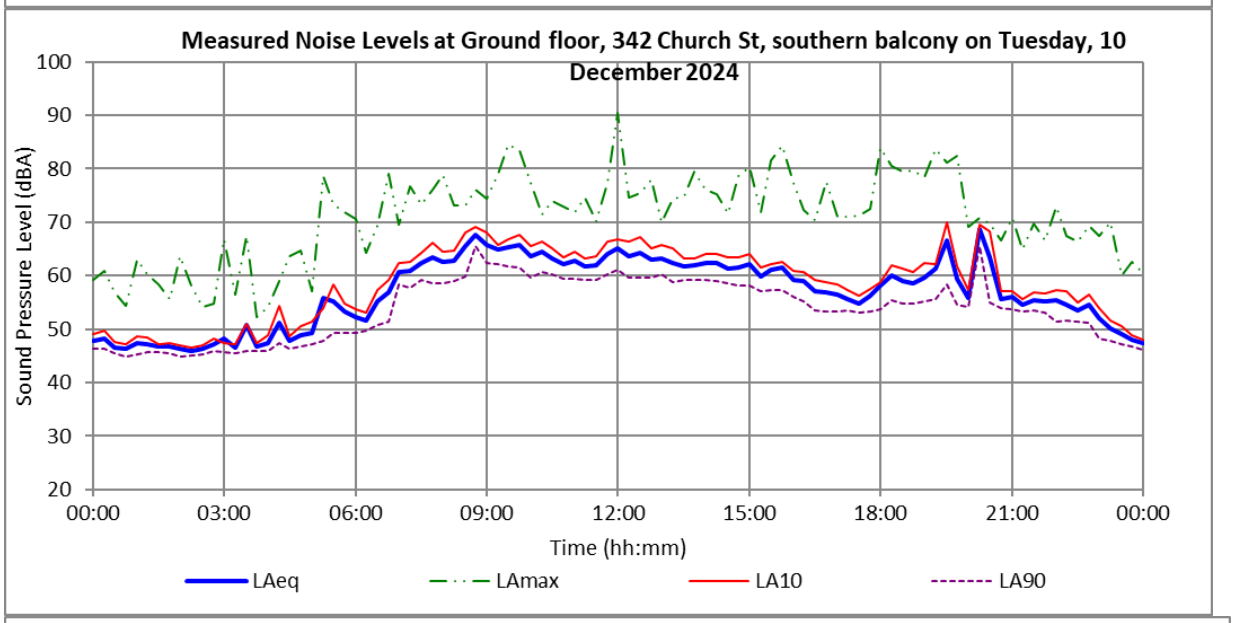
APPENDIX B NOISE LOGGING RESULTS – 342 CHURCH STREET

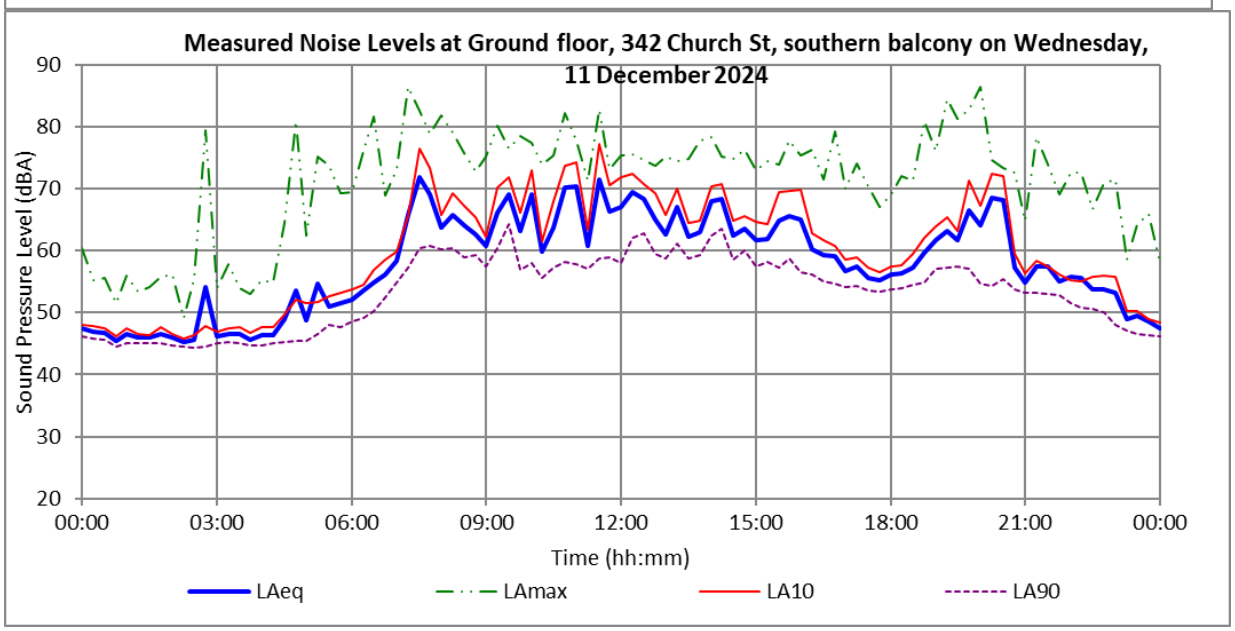


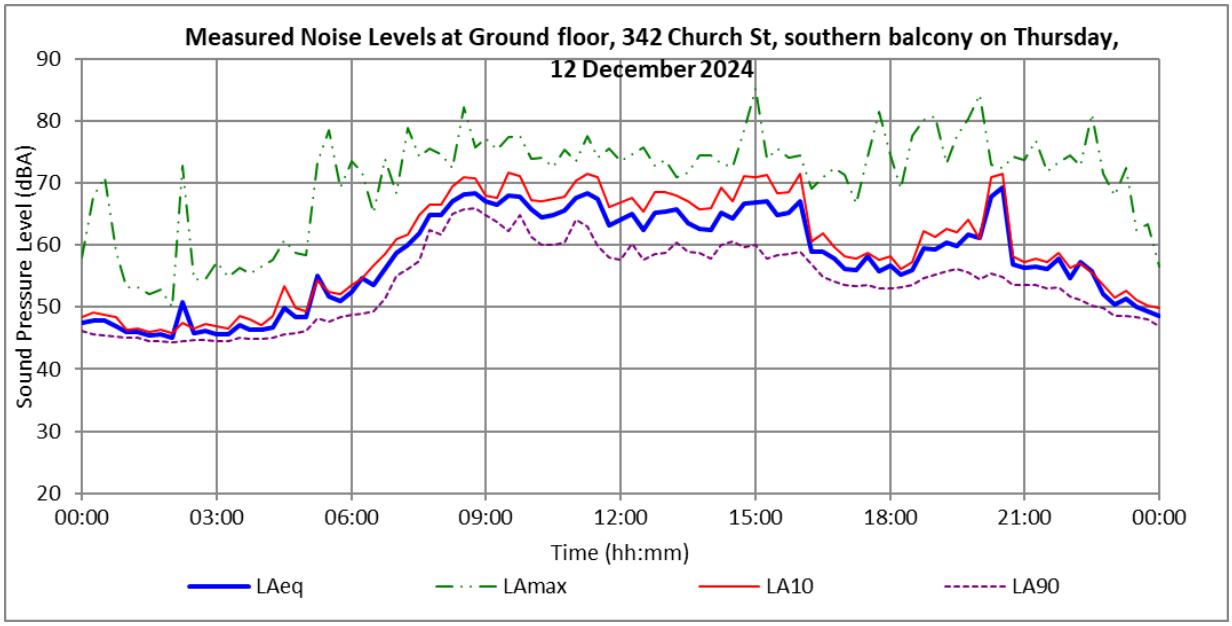












APPENDIX C NOISE LOGGING RESULTS – 12 PHILLIP STREET