



221-291 Crown Street, Wollongong

SSD Noise and Vibration Impact Assessment

Wollongong Development No. 8 Pty Ltd

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1 INTRODUCTION

This Noise and Vibration Impact Assessment prepared by Pulse White Noise Acoustic Pty Ltd on behalf of Wollongong Developments No.8 Pty Ltd ('the Applicant') supports a State Significant Development Application (SSDA) for an Infill Affordable Housing Development, SSD-76440958, for the site at 221-291 Crown Street, 216-238 Keira Street and 86-90 Burelli Street, Wollongong (the site).

Specifically, consent is sought for the following development in this SSDA:

- Demolition of existing structures on the site, retention of heritage facades, tree removal and site excavation for new basement.
- Construction of a new mixed-use development consisting of:
 - Four residential towers, ranging from 16 to 38 storeys and comprising 546 apartments including:
 - Approx. 414 market apartments.
 - Approx. 132 affordable apartments.
 - Residential lobbies and podium.
 - Communal open space.
 - 10-storey commercial office building, comprising 7,256 sqm of GFA.
 - 8-storey, 166 room hotel, including restaurant and conference floorspace comprising 8,793 sqm of GFA.
 - Lower ground, ground and first floor retail spaces totalling 5,291 sqm of GFA (including 1,510 sqm supermarket).
- Car, motorcycle and bicycle parking for residents, workers and visitors across two basement levels, mezzanine, lower ground and levels 1 and 2 including 775 car parking spaces.
- New public open space including a new public plaza.
- Associated landscaping and public domain works.

This report has been undertaken in response to the SSD-76440958 SEARS, which includes item 12 regarding noise and vibration as detailed below.

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.

- Noise and Vibration Impact Assessment

Specific items addressed in this report include the following:

1. EPA noise emission assessment – Included in Section 4.2
2. Operation noise assessment – Included in Section 4.4.
3. Construction noise and vibration assessment – Included in Section 5.

A list of acoustic terminology used in this report has been included in Appendix A of this report.

2 SITE DESCRIPTION AND SURROUNDING RECEIVERS

The site is situated at 221-291 Crown Street, 216-238 Keira Street and 86-90 Burelli Street, Wollongong, within the Wollongong Local Government Area (LGA).

The site forms part of the Wollongong City Centre Precinct, as identified in the Wollongong Local Environmental Plan 2009 (WLEP). It is well located, being approximately 280m from Wollongong Train Station which provides services within Wollongong and to the Sydney CBD. It is adjacent to Wollongong Central shopping centre, a major regional retail hub. The site has ample access to public open space being less than 50m from MacCabe Park.

The site comprises a significant landholding of approximately 13,088m² with frontages to Crown Street, Keira Street, Burelli Street and Atchison Street. The site is owned by Wollongong Developments No.8 Pty Ltd.

The site is bounded by roadways and is located within the typically commercial area of the Wollongong central area including Crown Street to the north with commercial/retail outlets, Keira Street to the east with commercial/shopping outlet, Burelli Street to the south include carparking and retail outlets and Atchinson Street to the west with commercial buildings.

The nearest receiver to the proposed project site are detailed below:

Receiver 1: Commercial properties located to the east of the street on Keira Street

Receiver 2: The carpark located to the south of the site, including that included as part of Wollongong Central.

Receiver 3: Commercial receiver located to the south of the site, including the restaurant at 1-5 Atchinson Street.

Receiver 4: Commercial properties including the restaurant and retail occupancies located to the west of the site at 2 Atchinson Street and 293 Crown Street.

Receiver 5: Commercial properties including those located to the north opposite on Crown Street.

A site map has been provided above which identifies the site, the surrounding receivers and monitoring locations, see the above figure.

2.1 Proposed Development

A site map has been included below to identify the proposed development and surrounding receivers. the location of both the unattended and attended monitoring positions onsite have been included in Figure 1 below and the proposed site layout is included in Figure 2.

11/11/2019

□ □ □ □ □

Figure 2 **Proposed Site Plan**





2.2 Relevant Guidelines

Acoustic criteria that have been adopted in this assessment include requirements from the following guidelines or legislative documents:

- NSW State
- NSW State Environmental Planning Policy 2021.
- NSW EPA Noise Policy for Industry (NPI) 2017.
- NSW EPA Road Noise Policy (RNP) 2011.
- NSW EPA Interim Construction Noise Guideline (ICNG) 2009.
- Australian Standard AS/NZS 2107:2016 'Acoustics – Recommended design sound levels and reverberation times for building interiors'.
- The Department of Planning *Development Near Rail Corridor and Busy Roads – Interim Guideline (DNRCBR)* references to "*Assessing Vibration – A Technical Guideline*".
- NSW EPA (formerly, Department of Environment and Climate Change) *Assessing Vibration: a technical guideline* 2006 (AV-TG).
- Australian Standard AS 2670.2 1990 - Evaluation of Human Exposure to Whole Body Vibration - Part 2: Continuous and Shock Induced Vibration in Buildings (1 Hz to 80 Hz).
- British Standard BS 6472 - 2008 - Evaluation of Human Exposure Vibration in Buildings (1 Hz to 80 Hz).
- German DIN 4150: Part 3 – 1999 "Effects of Vibration on Structure" (DIN 1999).

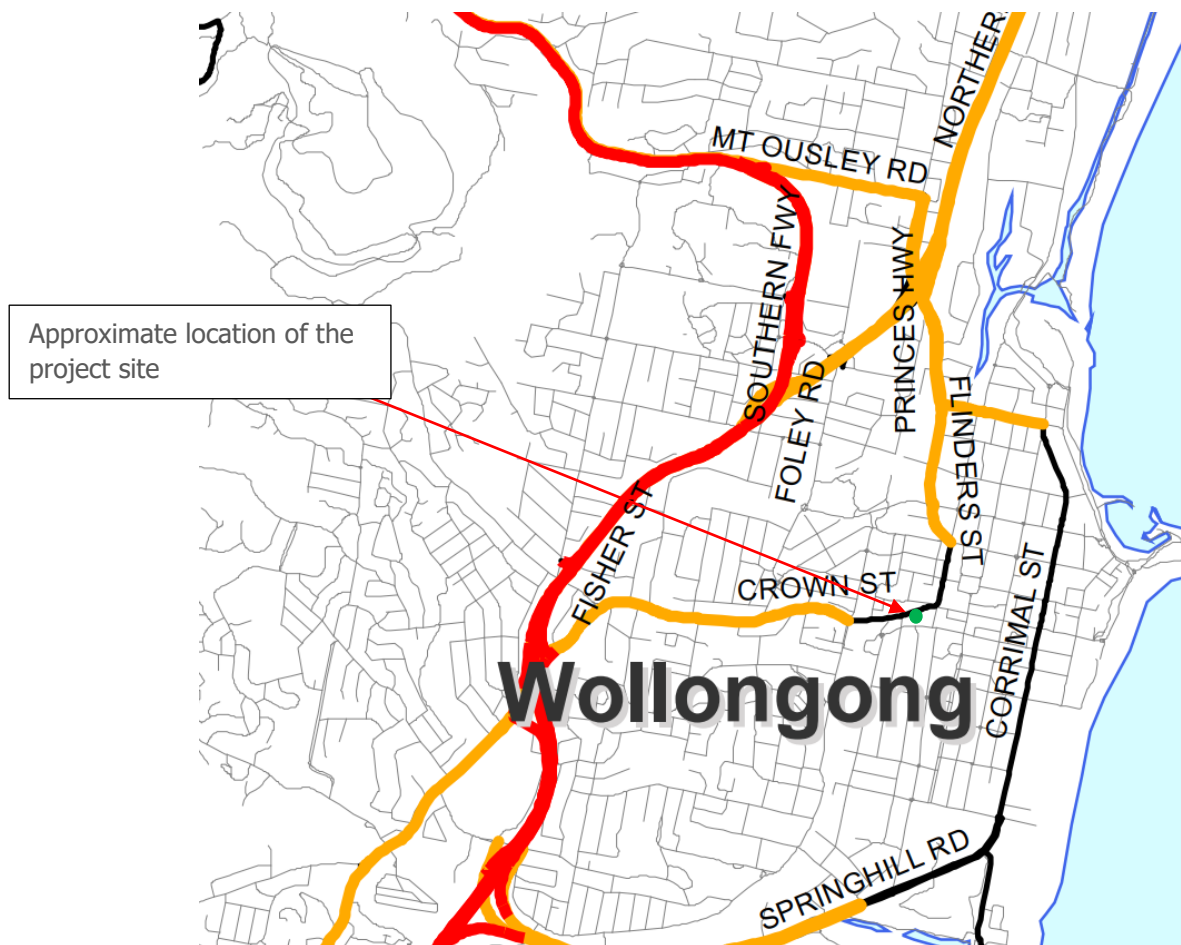
3 EXISTING NOISE ENVIRONMENT

The 221-291 Crown Street, Wollongong site is located with an area which is classified as Suburban residential area as defined by the NSW EPA *Noise Policy for Industry*. The exiting noise levels at the site are predominantly as a result from traffic noise within the vicinity of the site on surrounding roadways and the train line which is located to the west of the site.

The site is located on Crown Street, Keira Street, Burelli Street and Atchinson Street all of which are roadways which do not carry over 200,000 Annual Average Daily Traffic (AADT) number as defined in Map 20 of the RTA's *Traffic Volume Maps for Noise Assessment for Buildings on Land Adjacent to Busy Roads*.

See the Figure below which includes the site location included on Map 20 of the RTA. Based on the location of the site the acoustic assessment is not required to include the requirements of the Department of Planning *Development Near Rail Corridor and Busy Roads – Interim Guideline (DNRCBR)* references to "Assessing Vibration – A Technical Guideline". The purpose of this assessment noise levels have been assessed such that compliance with the DNRCBR will be achieved.

Figure 3 Site Location of Map 20 of the RTA's Traffic Volume Maps for Noise Assessment for Buildings on Land Adjacent to Busy Roads





3.1 Noise Descriptors and Terminology

Environmental noise constantly varies in level with time. It is therefore necessary to measure environmental noise in terms of quantifiable time periods and statistical descriptors. Typically, environmental noise is measured over 15-minute periods and relevant statistical descriptors of the fluctuating noise are determined to quantify the measured level.

Noise (or sound) consists of minute fluctuations in atmospheric pressure capable of detection by human hearing. Noise levels are expressed in terms of decibels, abbreviated as dB or dB(A), the A indicating that the noise levels have been frequency weighted to approximate the characteristics of normal human hearing. Because noise is measured using a logarithmic scale, 'normal' arithmetic does not apply, e.g. adding two sources of sound of an equal value results in an increase of 3dB (i.e. 60 dBA + 60 dBA = 63 dBA). A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB – 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change roughly corresponds to a doubling or halving in loudness.

The most relevant environmental noise descriptors are the LAeq, LA1, LA10 and LA90 noise levels. The LAeq noise level represents the "equivalent energy average noise level". This parameter is derived by integrating the noise level measured over the measurement period and is equivalent to a level that would have been experienced had the fluctuating noise level remained constant during the measured time period.

The LA1, LA10 and LA90 levels are the levels exceeded for 1%, 10% and 90% of the sample period. These levels are sometimes thought of as the typical maximum noise level, the average repeatable maximum and average repeatable minimum noise levels, respectively.

Specific acoustic terminology is used in this assessment report. An explanation of common acoustic terms is included as Appendix A.

3.2 Noise Survey Results

As part of this assessment an acoustic survey of the existing acoustic environment at the site was undertaken. The survey included attended noise level measurements at the site, during various times of the day on the 20th September 2024 as well as long term unattended noise logging which was undertaken between the 20th of September and the 1st October 2024.

All testing was carried out in accordance with the requirements of the Australian Standard AS1055.

During the testing periods there was no inclement weather periods.

3.2.1 Unattended Noise Monitoring

An unattended noise survey was conducted between the 20th of September and the 1st October 2024 as shown in the above figure. All data in the graphs presented in Appendix B have not been corrected (i.e., raw data presented).

Instrumentation for the survey comprised one Rion NL42 sound level meters. Calibration of the logger was checked prior to and following the measurements. Drift in calibration did not exceed ± 0.5 dB. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

Charts presenting summaries of the measured daily noise data are attached in Appendix B. The charts present each 24-hour period and show the LA1, LA10, LAeq and LA90 noise levels for the corresponding 15-minute periods. This data has been filtered to remove periods affected by adverse weather conditions based on weather information.

Based on the unattended noise measurements, the results of the survey have been presented below.

3.2.1.1 Unattended Noise Logging Results

In order to assess the acoustical implications of the development at nearby noise sensitive receivers, the measured background noise data of the logger was processed in accordance with the NSW EPA's Noise Policy for Industry (NPI, 2017).

The Rating Background Noise Level (RBL) is the background noise level used for assessment purposes at the nearest potentially affected receiver. It is the 90th percentile of the daily background noise levels during each assessment period, being day, evening and night. RBL LA90 (15minute) and LAeq noise levels are presented in Table 1.

Data affected by adverse meteorological conditions and by spurious and uncharacteristic events have been excluded from the results, and also excluded from the data used to determine the noise emission criteria. Meteorological information has been obtained from the Sydney Observatory weather station (ID 066214).

Table 1 Measured Ambient Noise Levels corresponding to the NPI's Assessment Time Periods

Measurement Location	Daytime ¹ 7:00 am to 6:00 pm		Evening ¹ 6:00 pm to 10:00 pm		Night-time ¹ 10:00 pm to 7:00 am	
	LA90 ² (dBA)	LAeq ³ (dBA)	LA90 ² (dBA)	LAeq ³ (dBA)	LA90 ² (dBA)	LAeq ³ (dBA)
Noise Monitoring Location	47	59	43	57	39	55
<i>Note 1 For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am</i> <i>Note 2 The LA90 noise level is representative of the "average minimum background sound level" (in the absence of the source under consideration), or simply the background level.</i> <i>Note 3 The LAeq is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.</i>						

Note: In addition to the monitoring above, additional attended measurements were undertaken around the site to supplement the unattended noise monitoring.

3.2.2 Attended Noise Measurements

In addition to the unattended noise survey, an attended noise survey was carried out to establish levels at key locations within and surrounding the site. These are summarised below.

The attended noise measurements were conducted using a Brüel & Kjær Type 2250 sound level meter (serial number 2709757). Calibration of the sound level meter was checked prior to and following the measurements using a Brüel & Kjær Type 4231 sound calibrator (serial number 3009148). The calibrator emitted a calibration tone of 94 dB at 1 KHz. The drift in calibration did not exceed ± 0.5 dB. All equipment carries appropriate and current NATA (or manufacturer) calibration certificates.

Attended noise measurements were undertaken on the 20th September 2024 between 9.30am and 2pm. Results of the attended noise measurements are outlined in Table 2 below.

**Table 2 Measured Results of the Attended Noise Survey**

Measurement Location	Date and Time	Measured Noise Level (dBA)		Comments
		LA90 (15-min) ¹	LAeq (15-min) ²	
Crown Street	9.30am to 9.45am	68	51	Noise dominated by traffic noise
Keira Street	9.50am to 10.05am	67	49	Noise dominated by traffic noise
Burelli Street	10.10am to 10.25am	66	50	Noise dominated by traffic noise
Atchinson Street	10.30am to 10.45am	66	49	Noise dominated by traffic noise

Note 4 The LA90 noise level is representative of the "average minimum background sound level" (in the absence of the source under consideration), or simply the background level.

Note 5 The LAeq is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

4 ACOUSTIC CRITERIA

The acoustic criteria which have been adopted for this assessment are outlined below. All criteria have been separated into the relevant assessment type, these are; Noise Intrusion Criteria (Assessment of building envelope), Noise Emission Criteria (Assessment of noise to surrounding receivers) and Acoustic Separation Criteria (Assessment of acoustic privacy within the building).

4.1 Noise Intrusion Criteria

External noise intrusion into the building will generally be via the building envelope (External wall, glazing or external roof). The design of the building envelope should be such that the requirements listed below are achieved.

4.1.1 Wollongong City Council Development Control Plan (DCP) 2009

In the absence of any criteria in the DCP, we have adopted the recommended noise levels as set out below.

4.1.2 NSW Government Legislation – State Environmental Planning Policy (Transport and Infrastructure)

In 2021 the NSW Government Legislation including the SEPP infrastructure requirements includes the following:

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

1. This section applies to development for any of the following purposes that is on land in or adjacent to the road corridor for a freeway, a tollway or a transitway or any other road with an annual average daily traffic volume of more than 20,000 vehicles (based on the traffic volume data published on the website of TfNSW) and that the consent authority considers is likely to be adversely affected by road noise or vibration—
 - a) residential accommodation,
 - b) a place of public worship,
 - c) a hospital,
 - d) an educational establishment or centre-based child care facility
2. Before determining a development application for development to which this section applies, the consent authority must take into consideration any guidelines that are issued by the Planning Secretary for the purposes of this section and published in the Gazette.
3. If the development is for the purposes of residential accommodation, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded—
 - a) in any bedroom in the residential accommodation—35 dB(A) at any time between 10 pm and 7 am,
 - b) anywhere else in the residential accommodation (other than a garage, kitchen, bathroom or hallway)—40 dB(A) at any time.

As noted in Section 3 above, the site is not located on roadways which carry over 20,000 AADT, however the acoustic assessment has been undertaken such that the project noise levels will comply with the requirements of the SEPP 2021.

4.1.3 NSW Department of Planning and Environments Development Near Rail Corridors and Busy Roads – Interim Guideline 2008

NSW Department of Planning's document DNRCBR adopts the same internal noise criteria outlined in the SEPP infrastructure (previous 2008, now updated 2021) see below. However, table 3.1 from the policy states:

Figure 4 Extract - DRCBR - Table 3.1

Table 3.1: Noise criteria		
Residential Buildings		
Type of occupancy	Noise Level dBA	Applicable time period
Sleeping areas (bedroom)	35	Night 10 pm to 7 am
Other habitable rooms (excl. garages, kitchens, bathrooms & hallways)	40	At any time
Non-Residential Buildings		
Type of occupancy	Recommended Max Level dBA	
Educational Institutions including child care centres	40	
Places of Worship	40	
Hospitals	- Wards	35
	- Other noise sensitive areas	45

Note: airborne noise is calculated as L_{eq} (9h) (night) and L_{eq} (15h)(day). Groundborne noise is calculated as L_{max} (slow) for 95% of rail pass-by events.

4.1.4 Australian Standard AS/NZS 2107:2016

In relation to design internal noise levels, standard AS/NZS 2107:2016 recommends a range with lower and upper levels (rather than "satisfactory" and "maximum" internal noise levels) for building interiors based on room designation and location of the development relative to external noise sources. This change has occurred due to the fact that sound levels below 'satisfactory' could be interpreted as desirable, but the opposite may in fact be the case. Levels below those which were listed as 'satisfactory' can lead to inadequate acoustic masking resulting in loss of acoustic isolation and speech privacy.

The levels for areas relevant to this development are given in 5 below. In this report we will confine our recommendations to dBA levels, however, where the background noise appears to be unbalanced, standard AS/NZS 2107:2016 provides direction in terms of suitable diagnostic tools that can be used to assess the spectrum distribution of the background noise.



Section 6.18 of standard AS/NZ 2107:2016 notes that the presence of discrete frequencies or narrow band signals may cause the sound level to vary spatially within a particular area and be a source of distraction for occupants. Where this occurs, the sound level shall be determined as the highest level measured in the occupied location(s).

The Table below includes the recommended internal noise levels included within AS2107:2016 for various spaces.

Table 3 Recommended design sound levels as per standard AS/NZS 2107:2016

Type of Occupancy/Activity	Design sound level range ($L_{Aeq,t}$)
Retail Areas	45 - 55
Commercial Areas	35 - 40
Reception Areas	40 - 45
General Office Areas / Open plan office areas	40 - 45
Corridors and Lobbies	45 - 50
Apartment common areas (e.g., foyer, lift lobby)	45 - 50
Residential – Living/working areas	35 - 45
Residential - Sleeping areas (night-time)	35 - 40

Generally, where the final noise levels are within ± 2 dB of the specified level given above, the design criteria will be considered met. Both the upper and lower limits will need to be satisfied especially where privacy is important or where noise intrusion to be avoided.

4.1.5 PWNA Recommended Acoustic Criteria

Noise levels within the open communal corridors within the centre of the floorplate, PWNA recommend a 55 dBA L_{Aeq} 15 hours (7am - 10pm) requirement in the absence of any applicable requirements for external open corridors.

4.1.6 Summary of Project Requirements

Based on the details included in the sections above, the project internal noise levels requirements are summarised in the table below.

Table 4 Summary of Internal Noise Level Criteria

Room Type	Project Internal Environmental Noise Level Requirements (Traffic and Train Noise)
Bedrooms	35 dBA $L_{Aeq, Fast 9 \text{ hour}}$ (10pm - 7am)
Habitable Spaces	40 dBA $L_{Aeq, Fast 9 \text{ hour}}$ (7am - 10pm)
Hotel Rooms	Nighttime - 35 dBA $L_{Aeq, Fast 9 \text{ hour}}$ (10pm - 7am) Day time - 40 dBA $L_{Aeq, Fast 9 \text{ hour}}$ (7am - 10pm)
Retail Areas	50 dBA L_{Aeq} 15 hours (7am - 10pm)
Commercial Areas	45 dBA L_{Aeq} 15 hours (7am - 10pm)
Reception/Common Areas	45 dBA L_{Aeq} 15 hours (7am - 10pm)
General Office Areas / Open plan office areas	45 dBA L_{Aeq} 15 hours (7am - 10pm)
Corridors and Lobbies	
Fully enclosed corridors or lobbies (an internal area)	50 dBA L_{Aeq} 15 hours (7am - 10pm)
Apartment common areas (e.g. foyer, lift lobby)	50 L_{Aeq} 15 hours (7am - 10pm)

4.2 Noise Emission Criteria (Operational Criteria)

Noise emissions from the operation of the site impacting on the adjacent land uses are outlined below. Noise emissions expected from the use of the site include, basement carpark and associated driveway, mechanical services and communal areas.

4.2.1 Wollongong City Council Development Control Plan (DCP) 2009

In the absence of any objective criteria in the DCP, we have adopted the recommended external noise levels as set out in NSW EPA Noise Policy for Industry (NPI) 2017. See below.

4.2.2 NSW EPA Noise Policy for Industry (NPI) 2017

In NSW, the control of noise emissions is the responsibility of Local Governments and the NSW Environment Protection Authority (NSW EPA).

The NSW EPA has recently released a document titled Noise Policy for Industry (NSW NPI) which provides a framework and process for determining external noise criteria for the assessment of noise emission from industrial developments. The NSW NPI criteria for industrial noise sources have two components:

- Controlling the intrusive noise impacts for residents and other sensitive receivers in the short term; and
- Maintaining noise level amenity of particular land uses for residents and sensitive receivers in other land uses.

4.2.2.1 Intrusive Noise Impacts (Residential Receivers)

The NSW NPI states that the noise from any single source should not intrude greatly above the prevailing background noise level. Industrial noises are generally considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (LAeq), measured over a 15-minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB(A). This is often termed the Intrusiveness Criterion.

The 'Rating Background Level' (RBL) is the background noise level to be used for assessment purposes and is determined by the methods given in the NSW NPI. Using the rating background noise level approach results in the intrusiveness criterion being met for 90% of the time. Adjustments are to be applied to the level of noise produced by the source that is received at the assessment point where the noise source contains annoying characteristics such as tonality or impulsiveness.

4.2.2.2 Protecting Noise Amenity (All Receivers)

To limit continuing increase in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.2 of the NSW NPI. That is, the ambient LAeq noise level should not exceed the level appropriate for the particular locality and land use. This is often termed the 'Background Creep' or Amenity Criterion.

The amenity assessment is based on noise criteria specified for a particular land use and corresponding sensitivity to noise. The cumulative effect of noise from industrial sources needs to be considered in assessing the impact. These criteria relate only to other continuous industrial-type noise and do not include road, rail or community noise. If the existing (measured) industrial-type noise level approaches the criterion value, then the NSW NPI sets maximum noise emission levels from new sources with the objective of ensuring that the cumulative levels do not significantly exceed the criterion.



Project amenity noise level for industrial developments is specified as the recommended amenity noise level (Table 2.2 of the NPI) minus 5 dB(A). To standardise the time periods for the intrusiveness and amenity noise levels, this policy assumes that the $LA_{eq,15min}$ will be taken to be equal to the $LA_{eq,period} + 3$ decibels (dB).

Where the resultant project amenity noise level is 10 dB or more lower than the existing traffic noise level, the project amenity noise levels can be set at 15 dB below existing traffic noise levels (i.e. $LA_{eq,period(traffic)} - 15$ dBA).

4.2.2.1.3 Area Classification

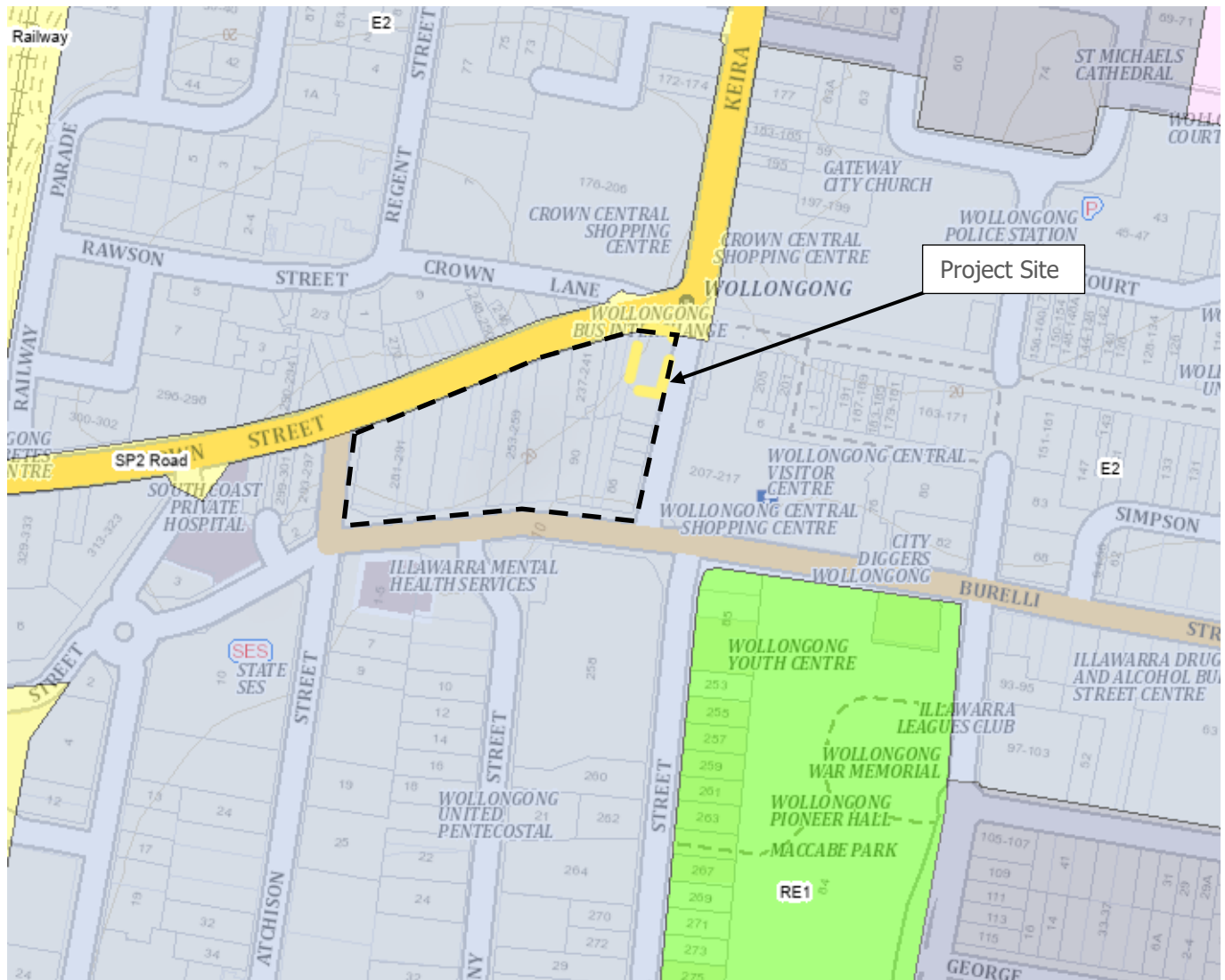
The NSW NPI characterises the "Suburban Residential" noise environment as an area that has the following characteristics:

An acoustical environment that:

- is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable, mostly traffic and/or industrial related sound sources.
- has through-traffic with characteristically heavy and continuous flows during peak periods.
- is near commercial districts or industrial districts.
- has any combination of the above.

Figure 5 has been is obtained from the NSW Planning ePlanning Spatial Viewer Zoning Maps and shows the land zoning map of the proposed development and the nearest sensitive receivers.

Figure 5 NSW ePlanning Spatial Viewer Zoning Maps



classification tool outlined in the NSW EPA NPI, PWN A believe the most appropriate zoning is an suburban residential.

For residential and non-residential receivers in an urban residential area, the recommended amenity criteria are shown in Table 5 below.

**Table 5 NSW NPI – Recommended LAeq Noise Levels from Noise Sources**

Type of Receiver	Indicative Noise Amenity Area	Time of Day ¹	Recommended Amenity Noise Level (LAeq, period) ² (dBA)
Residence	Suburban	Day	60
		Evening	50
		Night	45
Commercial		When in use	65

Note 1 For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am.

Note 2 The LAeq is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

4.2.2.2 Project Trigger Noise Levels

The intrusive and amenity criteria for industrial noise emissions, derived from the measured data, are presented in Table 6. These criteria are nominated for the purpose of determining the operational noise limits for mechanical plant associated with the development which can potentially affect noise sensitive receivers.

For each assessment period, the lower (i.e., the more stringent) of the amenity or intrusive criteria are adopted, which are shown in bold text in Table 6.

Table 6 External noise level criteria in accordance with the NSW NPI

Location	Time of Day ¹	Project Amenity Noise Level, LAeq, period ² (dBA)	Measured LA90, 15 min (RBL) ³ (dBA)	Measured LAeq, period Noise Level (dBA)	Intrusive LAeq, 15 min Criterion for New Sources (dBA)	Amenity LAeq, 15 min Criterion for New Sources (dBA)
Residential Receivers	Day	55	47	59	52	58
	Evening	45	43	57	48	48
	Night	40	39	55	44	43
Commercial Receivers	When in use	60	-	-	-	63

Note 1 For Monday to Saturday, Daytime 7:00 am – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 10:00 pm; Night-time 10:00 pm – 8:00 am.

Note 2 Project amenity noise level are shown as

Note 3 LA90 Background Noise or Rating Background Level.

Note 4 Project Noise Trigger Levels are shown in bold and underline.

Note 5 Resulting amenity noise levels are calculated as per below in accordance with section 2.4.1 of the NSW EPA NPI.

4.2.3 NSW DECCW – NSW Road Noise Policy (RNP) 2011

For existing residences and other sensitive land uses affected by additional traffic on existing roads, the NSW Road Noise Policy states that for noise associated with increased road traffic generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB during both day and night-time periods. An increase of 2 dB represents a minor impact that is considered barely perceptible to the average person. Acoustic Assessment

4.3 Building Envelope Assessment

Preliminary façade acoustic treatments based on the external levels from surrounding roads as discussed in the above are provided below.

4.3.1 Glazing Constrictions

The recommended sound transmission loss requirement required to satisfy the specified internal noise level criteria is outlined in the following section.

Façade Orientation	Occupancy Area	Acoustic Performance Requirement ($R_{w(C,CTR)}$)	Indicative Construction
All Façade Orientations	Bedrooms	35 _(0,-3)	10.38mm laminated glazing
	Living Spaces	35 _(0,-3)	10.38mm laminated glazing
	Hotel Rooms	35 _(0,-3)	10.38mm laminated glazing
	Toilet/Ensuites	30 _(0,-3)	6.38mm laminated glazing
	Common areas	30 _(0,-3)	6.38mm laminated glazing
	Retail Aeras	30 _(0,-3)	6.38mm laminated glazing
	Commercial Areas	30 _(0,-3)	6.38mm laminated glazing

Note 1: The acoustic performance of the external façade includes the installed glazing and frame including (but not limited to) the façade systems seals and frame. All external glazing systems are required to be installed using acoustic bulb seals.

Note 2: Detailed constructions included in the table above are consistent for all levels of the project.

Please note for windows, this performance is not only subject to the glazing selection but also to the construction of the window frame and the frame seal selection. Therefore, it is recommended that the window manufacturer should confirm that the required sound insulation can be achieved. It is anticipated that the window system should comprise Q-Lon (or equivalent) or fin seals with deep C channels as part of the window track (i.e., Performance levels outlined above need to be achieved with glazed panels + frame + seals).

4.3.2 External Wall Construction

External wall constructions will be constructed either from masonry/concrete or lightweight cladding system is proposed. For the external walls which are constructed from a masonry/concrete construction, no further acoustic upgrading is required. However, for the external walls constructed from lightweight cladding system, the following construction is recommended.

Table 7 Recommended Light Weight External Wall Construction

Façade Orientation	Occupancy Area ¹	Acoustic Performance	Proposed Construction
Western All Façade Orientation	All Room Types	Rw 45	External Cladding, Metal or Timber framing with a minimum 75mm air cavity and insulation (similar to 75mm thick 14kg/m ³ . 13mm internal lining; OR
All other façade orientation			Masonry construction.

Any penetrations through any external skin which are required must ensure all gaps remaining in the penetration are filled with an acoustic grade sealant which provides an equal or better performance to the system being penetrated.



4.3.3 External Roof Construction

External roof constructions which are constructed from a concrete or masonry construction will be acoustically sufficient and no further acoustic upgrading is required.

If penetrations through any external skin are required, all gaps remaining in the penetration are to be filled with an acoustic grade sealant which provides an equal or better performance to the system being penetrated.

4.3.4 Alternative Ventilation Requirements

The internal design sound levels detailed above are achieved with external operable building openings closed. As internal noise levels with windows open will result in noise levels which are greater than 10 dB(A) with windows open to 5% of the floor area for ventilation an alternative method of providing outside air ventilation will be required to all units within the development.

As part of the proposed development internal noise level within the project will comply with the design noise level + 10 dB(A) with external windows open for ventilation.

4.4 Operational Acoustic Assessment

This section of the report details the assessment of potential noise generated as part of the proposed development.

The assessment of potential noise impacts from various sources of noise on the site are detailed in the following sections.

4.4.1 Mechanical Services Equipment

Detailed selections of the proposed mechanical plant and equipment to be used on the site are not available at this time. All future plant and equipment are to be acoustically treated to ensure the noise levels at all surrounding receivers comply with noise emission criteria detailed within this report. Experience with similar projects indicated that it is both possible and practical to treat all mechanical equipment such that the relevant noise levels are achieved. Examples of the possible acoustic treatments to mechanical equipment includes the following:

- Supply and Exhaust Fans – location of fans within the building and treated using internally lined ductwork or acoustic silencers.
- General supply and exhaust fans – general exhaust and supply fans such as toilet, kitchen, lobby and other small mechanical fans can be acoustically treated using acoustic flex ducting or internal lined ducting.

Details of the required mechanical services equipment and acoustic treatments to ensure the relevant noise level criteria is achieved will be provided as part of the CC submission of the project.

Experience with similar projects indicates that the acoustic treatment of the proposed mechanical equipment to be installed on the project is both possible and practical.



4.4.2 Waste and Garbage Collections

Noise resulting from the removal of waste and garbage from the site, including garbage trucks and the like will be undertaken in accordance with council's waste management requirements.

Noise resulting from the collection of waste from the site will include intermittent collection using approved waste collection vehicles. The resulting noise impact resulting from the site will be similar to noise levels currently experienced by exiting receivers from exiting waste collection services, train noise and vehicle movements on surrounding roadways.

The recommended acoustic treatments to the building facade detailed in this report include those required to ensure internal noise levels within the future dwellings of the project from the collection of waste will be acoustically acceptable and compliant with the recommended internal noise levels.

4.4.3 Retail Tenancy Assessment

At this stage the proposed use of the ground level retail tenancy is envisaged to be a "Retail" tenancy. It is recommended that all operational noise and services associated with the tenancy comply with the Project Trigger Noise Levels outlined in this report.

However, based on the location of the retail tenancies within the project and surrounding land uses it is unlikely noise impacts associated with the tenancy would affect the existing acoustic amenity of the surrounding residential receivers.

4.4.4 Noise Impacts on Surrounding Roadways

Noise impacts from the increase in vehicle movements on surrounding roadways are to be assessed in accordance with the NSW EPA Road Noise Policy (RNP) 2011.

A peak hour increase proposed for the number vehicles associated with the development will not exceed a 2dBA increase at a residential receiver as summarised in the NSW EPA RNP to be barely perceptible to the average person and therefore considered acoustically acceptable.

5 CONSTRUCTION NOISE AND VIBRATION MANAGEMENT PLAN

This section of the report details the construction noise and vibration impacts and the required mitigations and management controls required to be implemented as part of the construction of the building. The assessment of construction noise and vibration has been undertaken in accordance with the EPA's *Interim Construction Noise Guideline*.

5.1 Construction Noise

This section of the report details the assessment of noise associated with the proposed construction activities associated with the development. The assessment has been undertaken to assess the potential noise impacts from construction and demolition on surrounding receivers to the site.

The proposed construction and demolition activities to be undertaken on the site include the strip out of the existing areas of the existing building and limited external demolition of the existing building on the site. The development will then be constructed using normal construction processes.

The assessment of construction noise impacts generated from the site has been undertaken in accordance with the requirements of the EAP Interim Construction Noise Guideline.

The EPA's Interim Construction Noise Guideline defines normal day time hours as the following:

2.2 Recommended standard hours

The recommended standard hours for construction work are shown in Table 1; however, they are not mandatory. There are some situations, as described below, where construction work may need to be undertaken outside of these hours. The likely noise impacts and the ability to undertake works during the recommended standard hours should be considered when scheduling work.

Table 1: Recommended standard hours for construction work

Work type	Recommended standard hours of work*
Normal construction	Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays
Blasting	Monday to Friday 9 am to 5 pm Saturday 9 am to 1 pm No blasting on Sundays or public holidays

* The relevant authority (consent, determining or regulatory) may impose more or less stringent construction hours.

5.1.1 Proposed Appliances

The proposed construction appliances which will be used as part of the demolition and construction of the project are detailed in the table below.

Table 8 Noise Level from Expected Demotion Appliances

Tasks	Equipment	Sound Power Levels per task dB(A) L ₁₀	Aggregate Sound Power Level per Task dB(A) L ₁₀
Site Demolition works	Jack hammer mounted on excavator	118	122
	Excavators and bulldozers	115	
	Hand held jack hammer	111	
	Concrete saw	119	
	Skid steer	110	
	Power hand tools	109	
	Materials Movements	105	
Site Ground Works	Jack hammer mounted on excavator	118	122
	Saw cutting	119	
	Excavators and bulldozers	115	
	Materials Movements	105	
	Bulldozers	115	
	Trucks	109	
Construction Works	Piling	115	120
	Welder	101	
	Saw cutter	109	
	Dump truck	109	
	Concrete saw	119	
	Power hand tools	109	
	Cranes	110	

Note: Noise levels of proposed equipment to be used on the site based on the Australian Standard AS2436-2010 and noise level measurements previously undertaken of similar equipment on construction sites.



5.1.2 Construction Noise Criteria

This section of the report details the relevant construction noise criteria which is applicable to the site including the EPA's *Interim Construction Noise Guideline* (ICNG).

5.1.2.1 Interim Construction Noise Guideline

Noise criteria for construction and demolition activities are discussed in the *Interim Construction Noise Guideline* (ICNG). The ICNG also recommends procedures to address potential impacts of construction noise on residences and other sensitive land uses. The main objectives of the ICNG are summarised as follows:

- Promote a clear understanding of ways to identify and minimise noise from construction works;
- Focus on applying all "feasible" and "reasonable" work practices to minimise construction noise impacts;
- Encourage construction to be undertaken only during the recommended standard hours unless approval is given for works that cannot be undertaken during these hours;
- Streamline the assessment and approval stages and reduce time spent dealing with complaints at the project implementation stage; and
- Provide flexibility in selecting site-specific feasible and reasonable work practices in order to minimise noise impacts.

The ICNG contains a quantitative assessment method which is applicable to this project. Guidance levels are given for airborne noise at residences and other sensitive land uses.

The quantitative assessment method involves predicting noise levels at sensitive receivers and comparing them with the Noise Management Levels (NMLs). The NML affectation categories for receivers have been reproduced from the guideline and are listed in the table below.

**Table 9 Noise Management Levels from Construction**

Receiver Type	Time of Day	Noise Management Level $L_{Aeq(15minute)}^{1,2}$	How to Apply
Residential	Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15minute)}$ 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 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences. 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Receiver Type	Time of Day	Noise Management Level $L_{Aeq(15\text{minute})}^{1,2}$	How to Apply
	Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.
offices, retail outlets: external	When is use	$L_{Aeq(15\text{ min})}$ 70 dB(A)	During construction, the proponent should regularly update the occupants of the commercial and industrial premises regarding noise levels and hours of work.

Note 6 Note 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.

Note 7 Note 2 The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW Industrial Noise Policy (EPA 2000).

Based on the table above the suitable construction noise management levels for works undertaken on the site is detailed in Table 10 below.

Table 10 Site Construction Noise Management Levels

Noise Source	Time Period	Receiver Type	Construction Noise Management Level ¹	'High Noise Affected' Level ¹
Construction Noise	During period of approved hours of works	Residential Receivers	57 dB(A) L_{Aeq} (15min)	75 dB(A) L_{Aeq} (15min)
		Commercial and Retail Receivers	70 dB(A) L_{Aeq} (15min)	75 dB(A) L_{Aeq} (15min)

5.1.3 Construction Noise Management – Qualitative Assessment

Based on the assessment conducted of the expected construction noise levels generated from the site, levels are generally expected to require the building contractor to engage in management of activities on the site and engagement with the local community.

Notwithstanding, the following management controls are recommended to mitigate construction noise levels on the site:

1. Construction to be undertaken within the approved hours detailed within the projects *Conditions of Consent*.
2. All plant and equipment are to be maintained such that they are in good working order.
3. A register of complaints is to be recorded in the event of complaints being received, including location, time of complaint, nature of the complaint and actions resulting from the complaint.
4. If required a noise level measurement of the offending plant item generating complaints is to be conducted and noise mitigations undertaken to reduce noise levels to within Noise Management levels in the event magnitude of noise levels is found to be above suitable levels.
5. The use of percussive and concrete sawing should be undertaken behind a closed façade when possible.
6. The use of percussive equipment including hydraulic hammering should be limited such that they are not undertaken prior to 7.30am on weekdays and prior to 8.30am on Saturdays.
7. Where possible any excavation to be undertaken on the site is to include ripping of material where possible.

In addition to the recommended mitigations above details of the proposed construction (including demolition) works to be conducted on the site, including type of activities to be conducted as well as the expected duration of activities should be provided to the neighbouring receivers.

In the event noise levels are found to require additional noise reduction then all possible and practical mitigations are required to be included in the construction of the project. Possible acoustic treatments and controls may include the following:

1. Use of alternative appliances to complete the required works which result in reduced noise impacts on surrounding neighbours.
2. Period when noisy appliances are undertaken, such as undertaking noisy works on locations with the greatest distance to residential receivers during morning periods if possible.
3. Construction of acoustic screening to permanently located high noise generating equipment such as pumps and generators.
4. Scheduling of high noise generating works outside of noise sensitive periods if possible.
5. Other site specific treatments and controls which may become possible once works commence.

5.1.4 Construction Noise Assessment – Quantitative Assessment

A quantitative assessment of the construction noise levels resulting from the proposed works to be undertaken as part of the project on surrounding receivers has been undertaken.

The assessment has been based on the expected noise levels to be generated on the site including those detailed in Section 5.1.1 above. Calculations of the resulting construction noise levels of the receivers within proximity to the site is detailed in the table below.

**Table 11 Quantitative Assessment of Construction Noise to Neighboring Recivers**

Source Noise	Equipment	Sound Power Levels dB(A) L ₁₀	Site Cumulative Sound Power Level dB(A) L ₁₀	Calculated Construction Noise Level – Residential Receivers
Site Demolition works	Jack hammer mounted on excavator	118	122	Up to 75 dB(A) when items used externally
	Excavators and bulldozers	115		
	Hand held jack hammer	111		
	Concrete saw	119		
	Skid steer	110		
	Power hand tools	109		
	Materials Movements	105		
Site Excavations	Jack hammer mounted on excavator	118	122	Up to 75 dB(A) when items used externally
	Saw cutting	119		
	Excavators and bulldozers	115		
	Materials Movements	105		
	Bulldozers	115		
	Trucks	109		
Construction Works	Piling	115	120	Up to 75 dB(A) when items used externally
	Welder	101		
	Saw cutter	109		
	Dump truck	109		Up to 52 dB(A) once items used internally within the building structure
	Concrete saw	119		
	Power hand tools	109		
	Cranes	110		

Note 8 Note 1: Calculated qualitative noise levels are based on the overall Aggregate Sound Power Level for the expected demolition and construction works to be undertaken in the site.

Based on the qualitative assessment of construction noise suitable management controls and community notifications are required to be conducted.

The required management of construction noise impacts are included in Section 5.1 above and the Community Consultation included in Section 5.4 of this report.

5.2 Construction Vibration Assessment

This section of the report details the assessment of construction vibration impacts on surrounding receivers.

Effects of ground borne vibration on buildings may be segregated into the following three categories:

- Human comfort – vibration in which the occupants or users of the building are inconvenienced or possibly disturbed. Refer to further discussion in Section 5.2.1.
- Effects on building contents – where vibration can cause damage to fixtures, fittings and other non-building related objects. Refer to further discussion in Section 5.2.2.
- Effects on building structures – where vibration can compromise the integrity of the building or structure itself. Refer to further discussion in Section 5.2.3.

5.2.1 Vibration Criteria – Human Comfort

Vibration effects relating specifically to the human comfort aspects of the project are taken from the guideline titled *"Assessing Vibration – A Technical Guideline"*. (AVTG) This type of impact can be further categorised and assessed using the appropriate criterion as follows:

- Continuous vibration – from uninterrupted sources (refer to Table 12).
- Impulsive vibration – up to three instances of sudden impact e.g. dropping heavy items, per monitoring period (refer to Table 13).
- Intermittent vibration – such as from drilling, compacting or activities that would result in continuous vibration if operated continuously (refer to Table 14).

Table 12 Continuous vibration acceleration criteria (m/s²) 1 Hz-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	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
		0.04	0.029	0.080	0.058
Workshops	Day or night-time	0.04	0.029	0.080	0.058

**Table 13 Impulsive vibration acceleration criteria (m/s^2) 1 Hz-80 Hz**

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	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
Workshops	Day or night-time	0.64	0.46	1.28	0.92

Table 14 Intermittent vibration impacts criteria ($\text{m/s}^{1.75}$) 1 Hz-80 Hz

Location	Daytime		Night-time	
	Preferred Values	Maximum Values	Preferred Values	Maximum Values
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

5.2.2 Vibration Criteria – Building Contents and Structure

The vibration effects on the building itself are assessed against international standards as follows:

- For transient vibration: British Standard BS 7385: Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration" (BSI 1993); and
- For continuous or repetitive vibration: German DIN 4150: Part 3 – 1999 "Effects of Vibration on Structure" (DIN 1999).

5.2.3 Standard BS 7385 Part 2 - 1993

For transient vibration, as discussed in standard BS 7385 Part 2-1993, the criteria are based on peak particle velocity (mm/s) which is to be measured at the base of the building. These are summarised in

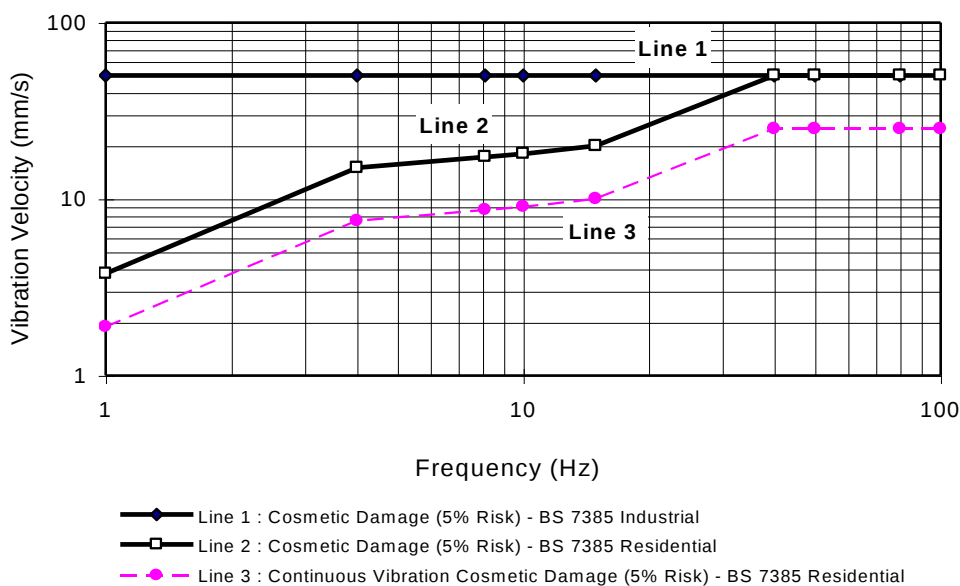
and illustrated in the Figure below.

Table 15 Transient vibration criteria as per standard BS 7385 Part 2 - 1993

Line in Figure 6	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Standard BS 7385 Part 2 – 1993 states that the values in the figure below relate to transient vibration which does not cause resonant responses in buildings.

Where the dynamic loading caused by continuous vibration events is such as that results in dynamic magnification due to resonance (especially at the lower frequencies where lower guide values apply), then the values in the figure below may need to be reduced by up to 50% (refer to Line 3 in the Figure below).

**Figure 6 BS 7385 Part 2 – 1993, graph of transient vibration values for cosmetic damage**

In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the recommended values corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.

The standard also states that minor damage is possible at vibration magnitudes which are greater than twice those given in Table 8, and major damage to a building structure may occur at values greater than four times the tabulated values.

5.2.4 Standard DIN 4150 Part 3 - 1999

For continuous or repetitive vibration, standard DIN 4150 Part 3-1999 provides criteria based on values for peak particle velocity (mm/s) measured at the foundation of the building; these are summarised in 10. The criteria are frequency dependent and specific to particular categories of structures.

Table 16 Structural damage criteria as per standard DIN 4150 Part 3 - 1999

Type of Structure	Peak Component Particle Velocity, mm/s			
	Vibration at the foundation at a frequency of			Vibration of horizontal plane of highest floor at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz ¹	
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
Structures that, because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

Note 9 Note 1: For frequencies above 100Hz, at least the values specified in this column shall be applied.

5.2.5 Project Vibration Criteria

Based on the details included in the sections above the project specific vibration criteria to protect the surrounding residential receivers from structural or architectural damage includes the following:

1. Project construction vibration criteria at all surrounding building structures – 8 mm/s



5.2.6 Construction Vibration Impacts

An assessment of the potential for vibration generated as part of the required construction activities on the project (including excavation, demolition and construction) has been undertaken.

As the proposed buildings to be demolished on the site are not attached to neighbouring structures and the proximity of neighbouring structures to the development site, the vibration levels generated from the proposed demolition and construction on the site are expected to comply with all vibration criteria detailed in this report.

In the event excavation is required on the site including removal of stone, the following management technique should be included in the excavation methodology:

- A saw cut at the perimeter of any excavation within rock on the excavation boundary adjacent neighbouring residential properties are required to include a saw cut to the rock prior to use of any excavation or ripping.

5.3 Noise and Vibration Measurements and Monitoring

As part of the management of noise from the proposed demolition, excavation and construction activities to be undertaken on the site the following noise and vibration measurements are recommended to be undertaken:

1. Noise – Attended noise level measurements of typical demolition, excavation and construction activities should be undertaken at site.
Attended construction noise surveys of the site and surrounding impacts on neighbours should be undertaken during the following as a minimum:
 - a. In response to any ongoing complaints received from neighbours.
2. Vibration – Based on the proximity of the surrounding receivers to the works attended vibration measurements of typical demolition, excavation and construction activities should be undertaken at site.
Attended construction vibration measurements at representative locations to the neighbouring building structures should be undertaken at the following times as a minimum:
 - a. Commencement of any hydraulic hammering required for demolition of construction on the site and required to be conducted within 30m of neighbouring buildings.
 - b. Commencement of any rock breaking or sawing on the site required to be conducted within rock during the excavation stage of the project and required to be conducted within 30m of neighbouring buildings.
 - c. In response to any ongoing complaints received from neighbours.

5.4 Community Engagement

During the proposed construction of the project (including excavation and construction) the building contractor is required to engage in community interaction. The community interaction and notification is required to include the following:

1. Notification of the proposed works to be undertaken on the site and the periods when works will be conducted, including information regarding the programme of works such as demolition and excavation. This should include the expected period when activities such as hydraulic hammering, rock breaking, concrete or rock sawing is required to be undertaken.
2. Details of the relevant site representative where complaints can be registered.
3. Details of the methodology to respond to complaints raised from the surrounding receivers.
4. A register of complaints, to be kept on site including record of time and nature of the complaint as well as the outcomes and comments regarding investigations resulting from the complaint.

6 CONCLUSION

Pulse White Noise Acoustics Consultancy Pty Ltd (Pulse White Noise Acoustics) has been engaged to undertake the Noise and Vibration Impact Assessment of the proposed mixed use development located at 221-291 Crown Street, Wollongong.

This report details the required acoustic constructions of the building's façade, including external windows, to ensure that the future internal noise levels comply with the relevant noise levels of the Australian Standard AS2107:2016 for environmental noise. Providing the recommended constructions detailed in this report are included in the construction of the project the required internal noise levels will be achieved.

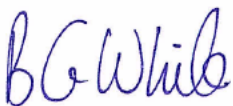
An assessment of the potential for noise and vibration impact from the operation of the railway line which is located to the north of the site has been undertaken and providing the recommendations in this report are included in the design and construction of the project compliance with the Department of Planning *Development Near Rail Corridors and Busy Roads – Interim Guideline* and the *Infrastructure SEPP* will be achieved.

External noise emissions from the site have been assessed and detailed in accordance with the NSW Environmental Protection Authorities *Noise Policy for Industry*. The future design and treatment of all building services associated with the project can be acoustically treated to ensure all noise emissions from the site comply with the EPA NPfI criteria including the following:

1. Operation of mechanical services on the site.
2. Removal of waste from the site.
3. Retail uses on the site.

An assessment of construction noise and vibration has also been undertaken and the required noise and vibration management and controls as well as community consultation required as part of the construction of the project, including those required to ensure works are undertaken in accordance with the EPA's *Interim Construction Noise Guideline*.

Regards

A handwritten signature in blue ink that reads "BG White".

Ben White
Director

Pulse White Noise Acoustics



7 APPENDIX A: ACOUSTIC TERMINOLOGY

The following is a brief description of the acoustic terminology used in this report.

<i>Sound power level</i>	The total sound emitted by a source																						
<i>Sound pressure level</i>	The amount of sound at a specified point																						
<i>Decibel [dB]</i>	The measurement unit of sound																						
<i>A Weighted decibels [dB(A)]</i>	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).																						
<i>Decibel scale</i>	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows: <table> <tr> <td>0dB(A)</td><td>Threshold of human hearing</td></tr> <tr> <td>30dB(A)</td><td>A quiet country park</td></tr> <tr> <td>40dB(A)</td><td>Whisper in a library</td></tr> <tr> <td>50dB(A)</td><td>Open office space</td></tr> <tr> <td>70dB(A)</td><td>Inside a car on a freeway</td></tr> <tr> <td>80dB(A)</td><td>Outboard motor</td></tr> <tr> <td>90dB(A)</td><td>Heavy truck pass-by</td></tr> <tr> <td>100dB(A)</td><td>Jackhammer/Subway train</td></tr> <tr> <td>110 dB(A)</td><td>Rock Concert</td></tr> <tr> <td>115dB(A)</td><td>Limit of sound permitted in industry</td></tr> <tr> <td>120dB(A)</td><td>747 take off at 250 metres</td></tr> </table>	0dB(A)	Threshold of human hearing	30dB(A)	A quiet country park	40dB(A)	Whisper in a library	50dB(A)	Open office space	70dB(A)	Inside a car on a freeway	80dB(A)	Outboard motor	90dB(A)	Heavy truck pass-by	100dB(A)	Jackhammer/Subway train	110 dB(A)	Rock Concert	115dB(A)	Limit of sound permitted in industry	120dB(A)	747 take off at 250 metres
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110 dB(A)	Rock Concert																						
115dB(A)	Limit of sound permitted in industry																						
120dB(A)	747 take off at 250 metres																						
<i>Frequency [f]</i>	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.																						
<i>Ambient sound</i>	The all-encompassing sound at a point composed of sound from all sources near and far.																						



<i>Equivalent continuous sound level [L_{eq}]</i>	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
<i>Reverberation</i>	The persistence of sound in a space after the source of that sound has been stopped (the reverberation time is the time taken for a reverberant sound field to decrease by 60 dB)
<i>Air-borne sound</i>	The sound emitted directly from a source into the surrounding air, such as speech, television or music
<i>Air-borne sound isolation</i>	The reduction of airborne sound between two rooms.
<i>Sound Reduction Index [R] (Sound Transmission Loss)</i>	The ratio the sound incident on a partition to the sound transmitted by the partition.
<i>Weighted sound reduction index [R_w]</i>	A single figure representation of the air-borne sound insulation of a partition based upon the R values for each frequency measured in a laboratory environment.
<i>Level difference [D]</i>	The difference in sound pressure level between two rooms.
<i>Normalised level difference [D_n]</i>	The difference in sound pressure level between two rooms normalised for the absorption area of the receiving room.
<i>Standardised level difference [D_{nT}]</i>	The difference in sound pressure level between two rooms normalised for the reverberation time of the receiving room.
<i>Weighted standardised level difference [$D_{nT,w}$]</i>	A single figure representation of the air-borne sound insulation of a partition based upon the level difference. Generally used to present the performance of a partition when measured in situ on site.
C_{tr}	A value added to an R_w or $D_{nT,w}$ value to account for variations in the spectrum.
<i>Impact sound isolation</i>	The resistance of a floor or wall to transmit impact sound.
<i>Impact sound pressure level [L_i]</i>	The sound pressure level in the receiving room produced by impacts subjected to the adjacent floor or wall by a tapping machine.
<i>Normalised impact sound pressure level [L_n]</i>	The impact sound pressure level normalised for the absorption area of the receiving room.
<i>Weighted normalised impact sound pressure level [$L_{n,w}$]</i>	A single figure representation of the impact sound insulation of a floor or wall based upon the impact sound pressure level measured in a laboratory.
<i>Energy Equivalent Sound Pressure Level [$L_{A,eq,T}$]</i>	'A' weighted, energy averaged sound pressure level over the measurement period T.
<i>Percentile Sound Pressure Level [$L_{Ax,T}$]</i>	'A' weighted, sound pressure that is exceeded for percentile x of the measurement period T.

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 "Acoustics – Glossary of terms and related symbols"



8 APPENDIX B: UNATTENDED NOISE LOGGING

291 Crown Street, Wollongong

Ambient noise monitoring report



Item	Information
Logger Type	SVAN 977A
Serial number	81344
Address	291 Crown Street, Wollongong
Location	291 Crown Street, Wollongong
Facade / free field	Free field
Environment	

Measured noise levels

Logging date	Rating Background Level			L _{Aeq,period}		
	Daytime 7am-6pm	Evening 6pm-10pm	Night-time 10pm-7am	Daytime 7am-6pm	Evening 6pm-10pm	Night-time 10pm-7am
Fri 20 Sep 2024	-	42	-	58	56	55
Sat 21 Sep 2024	45	44	38	58	56	54
Sun 22 Sep 2024	43	40	38	57	55	52
Mon 23 Sep 2024	47	42	38	59	56	52
Tue 24 Sep 2024	48	41	39	59	55	57
Wed 25 Sep 2024	47	42	37	57	56	54
Thu 26 Sep 2024	53	51	43	61	59	58
Fri 27 Sep 2024	51	47	45	60	58	58
Sat 28 Sep 2024	47	48	43	57	60	56
Sun 29 Sep 2024	41	43	40	57	58	55
Mon 30 Sep 2024	50	46	40	60	58	55
Tue 01 Oct 2024	-	-	-	57	-	55
Summary	47	43	39	59	57	55

Note: Results with a '-' identify that there were not enough measurements available to correctly calculate the level, in accordance with the Noise Policy for Industry. The data has been excluded either from weather or manual exclusions. See the charts for more information

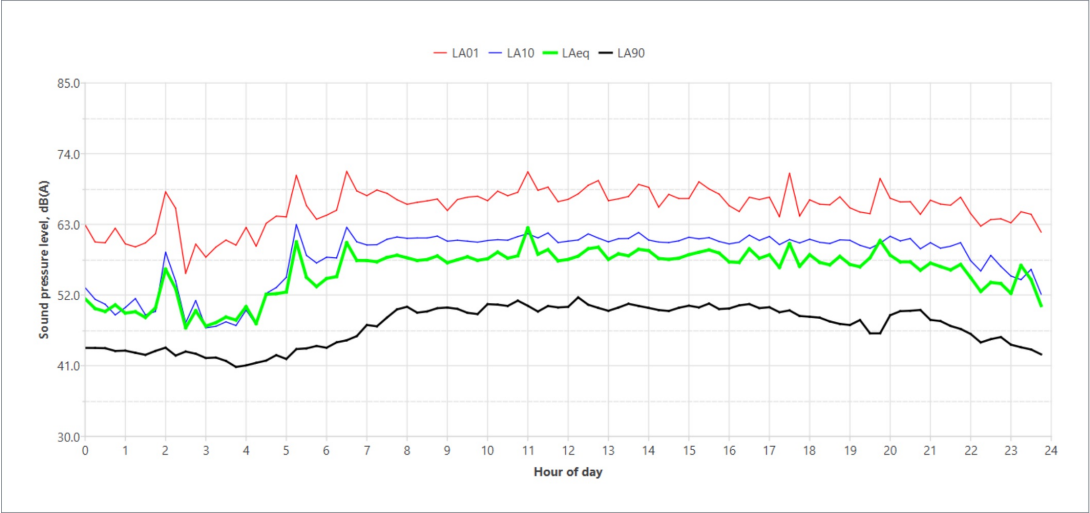
Logger location



Logger deployment photo



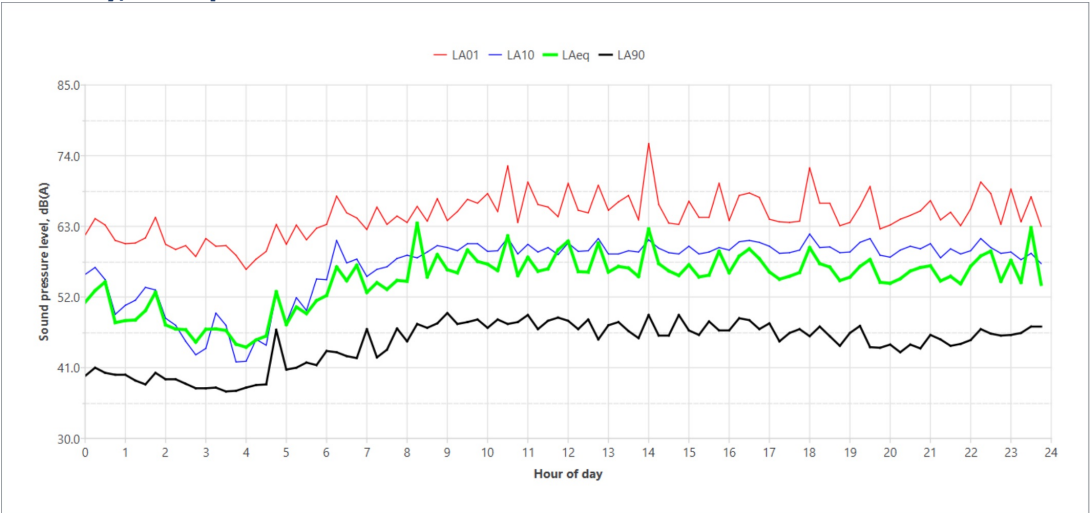
Typical Day



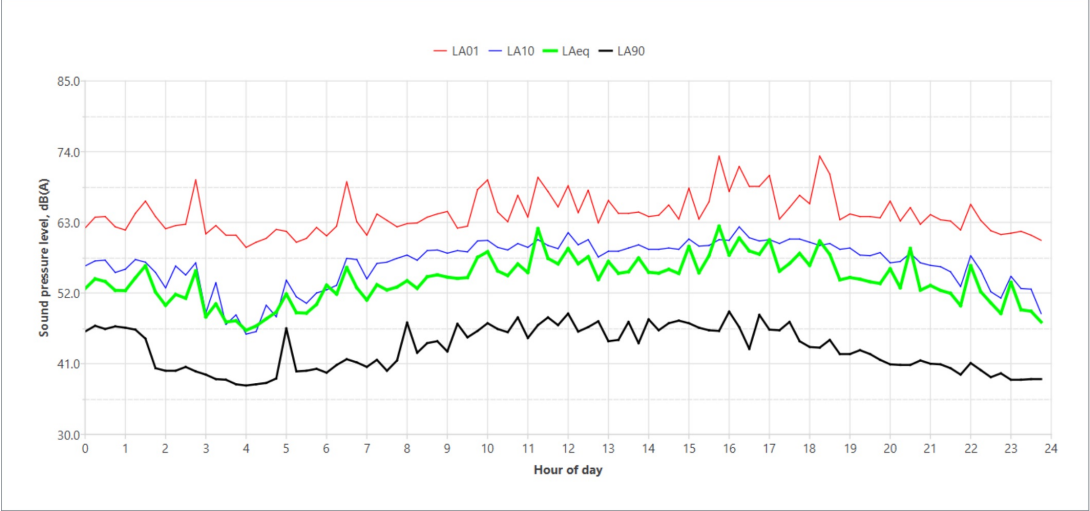
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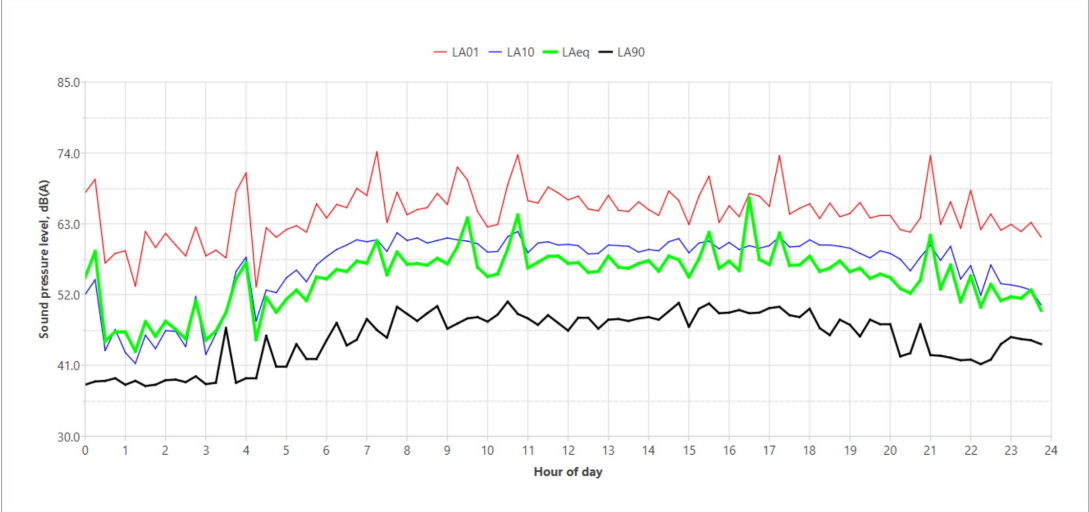
Saturday, 21 September 2024



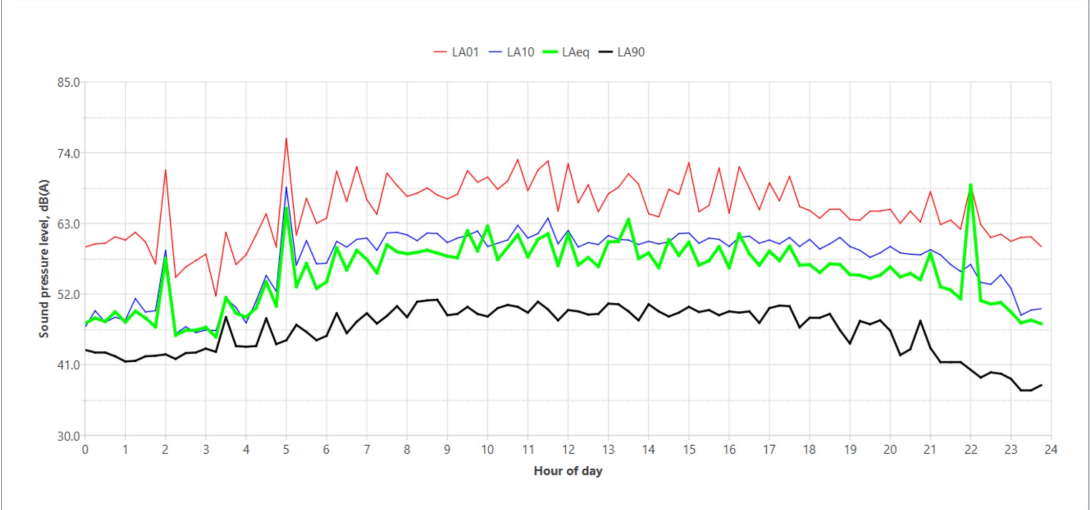
Sunday, 22 September 2024



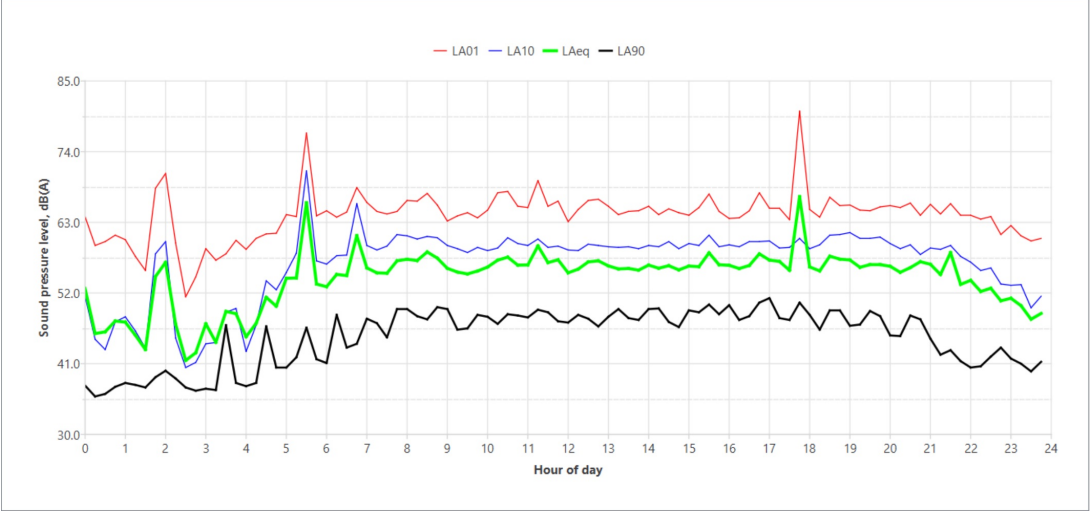
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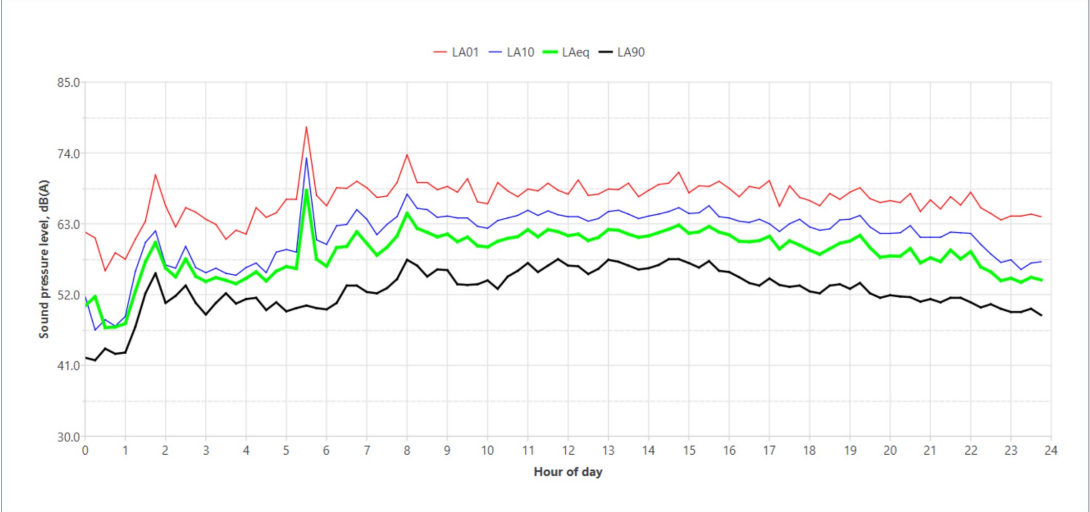
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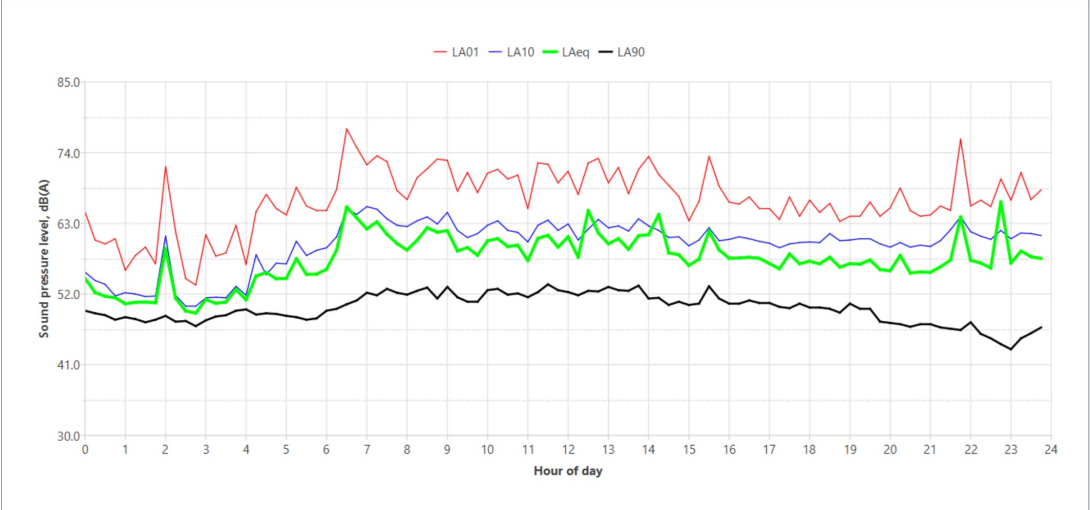
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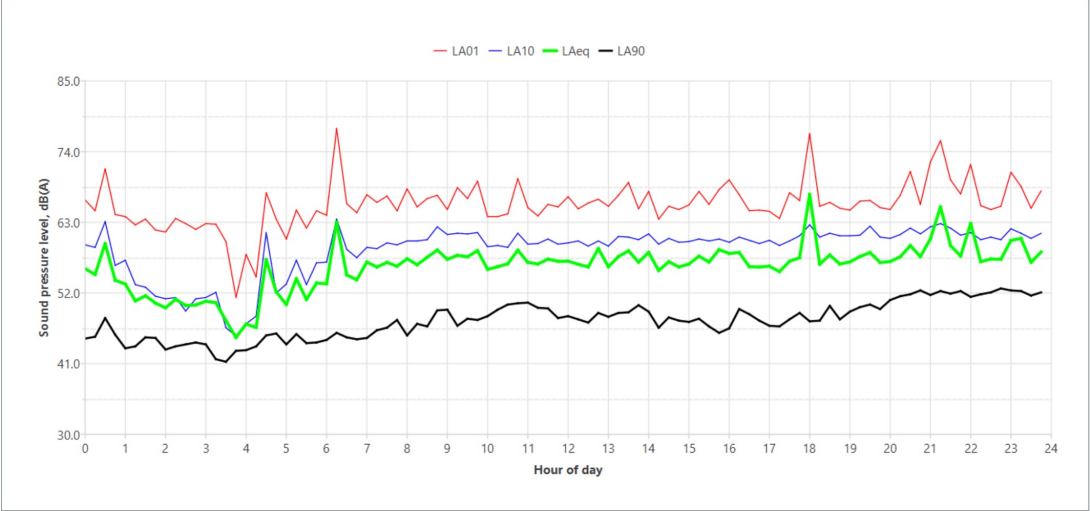
Thursday, 26 September 2024



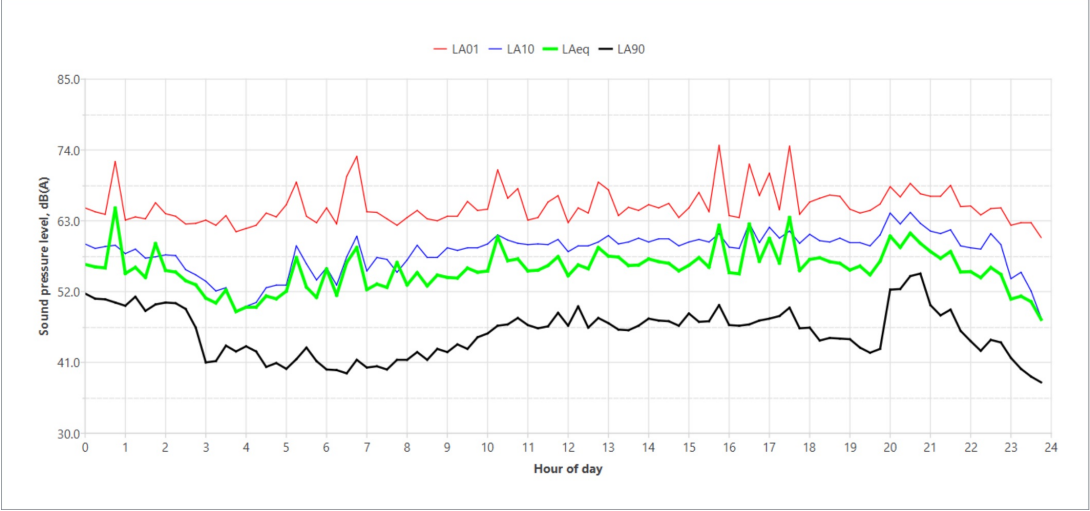
Friday, 27 September 2024



Saturday, 28 September 2024



Sunday, 29 September 2024



Monday, 30 September 2024

