NORTHROP

ACOUSTIC REPORT FOR STATE SIGNIFICANT DEVELOPMENT APPLICATION

Multi-storey Student Accommodation

90-102 Regent Street, Redfern NSW 2016

PREPARED FOR
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Acoustic Report for State Significant Development Application

Revision Schedule

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1. Executive Summary

Northrop Consulting Engineers (Northrop Acoustics) has been engaged by Wee Hur Holdings Ltd to provide a SSDA (State Significant Development Application) Acoustic Report for the proposed student accommodation development at 90-102 Regent Street, Redfern. NSW. The report is as per SEARs requirements dated 27 Nov 2019, and the application number is SSD-10382.

The SEARs requirements for the acoustics are presented partly in Assessment of Key Issues and partly in section 12 of the document. The key issues i.e. the baseline data include consideration of the acoustic separation, and acoustic amenity of the occupants and the environment.

Part 12 of the SEARS is specifically on Noise and Vibration and states that the EIS shall include a noise and vibration assessment prepared in accordance with the relevant EPA guidelines. The assessment shall:

- *Detail construction and operational noise impacts on nearby noise sensitive receivers and outline proposed noise mitigation and monitoring procedures (for details see Section 3 and 4)*
- *Demonstrate compliance with the noise standards including the Noise Policy for Industry (NSW EPA 2017) (See Section 3)*
- *Include a Demolition, Construction Noise & Vibration Management Plan (see Section 4)*
- *Address the acoustic privacy between the residential rooms and the communal areas which share floors (see Section 3.5 & 3.6)*
- *Provide details for noise and vibration related to the Metro line (see Section 3.9)*

A noise survey was conducted on site to measure the ambient and traffic noise. Based on the acoustic requirements of Department of Planning, City of Sydney Council and relevant Australian standards and guidelines, the noise criteria were established. Considering the traffic noise levels of Regent Street, the façade elements were considered, and a window schedule has been prepared (see Table 9). In addition, a Construction Noise & Vibration Management Plan (CNVMP) is submitted in the report (Section 4).

The assessment provides recommendations for compliance with the set criteria as follows:

For the operational noise impact assessment:

- To attenuate ingress of traffic and ambient noise, a glazing schedule has been recommended
- For the Communal areas, acoustically rated walls and floors were recommended. An operational noise management plan is recommended to be implemented for management of student activity noise. The hours of use for outdoor areas should be limited to the following:
    - 8 am to 10 pm Sunday to Thursday
    - 8 am to 12 midnight on Friday, Saturdays and any day immediately before a public holiday
- Further advice to be sought for isolation of the building against future train vibration and ground-borne noise.

For the CNVMP:

- All “feasible and reasonable work practices” should be implemented to reduce the construction noise
- Suitable hoardings to be erected around the site
- Noise and vibration generating equipment to be replaced by quieter and less severe operations
- A system for community liaison including complaint handling to be put in place

- For the neighbouring building over the south boundary, a dilapidation report to be prepared before the start of work
- Prior to the start of construction works, attended vibration measurements to be conducted at the tunnel to measure construction vibration levels. The results will indicate if the vibration levels are close to the criteria and if vibration monitoring is required.

At this stage the noise data from the mechanical services and the tenancies is not available therefore a noise impact assessment is not possible. At the CC stage when the equipment is finalised and nature and work of tenancies is known, a detailed assessment of the mechanical and operational noise should be conducted. In addition, at the CC stage acoustic details of the partitions and floors should be detailed. The following are generally considered at the CC stage:

- All internal walls/partitions which need acoustic raring to be designed/specified.
- All floors which need acoustic and impact treatment to be designed/ specified.
- An assessment to be conducted to assess and control mechanical and operational noise in accordance with the EPA and other regulatory requirements.

Providing our recommendations are implemented, the development with comply with the acoustic requirements of NSW Dept. of Planning, Council requirements and relevant Australian standards and guidelines.

1.1 Structure of the Report

This report addresses the acoustic requirements of SEARS dated 27 Nov 2019, application number SSD-10382.

The report addresses the two main areas as follows.

1. The assessment of operational noise impacts (see Section 3)
2. Construction Noise and Vibration Management Plan (see Section 4)

2. Site Location

The proposed development is located at 90-102 Regent Street, Redfern (the Site). The Site is bound by Regent Street to the east, Marian Street to the north, William Lane to the west, a commercial building leading to a service station on the south. The Site and the immediate vicinity is shown in Figure 1.

Figure 1: *Site location and position of noise monitors*

The acoustic environment of the Site is dominated by traffic noise of Regent Street and general hum of the area.

The nearest sensitive receivers which have potential for noise impact from construction or operation of the development are:

- C1 – commercial building adjacent to the south boundary. This two-storey building is part of the service station and is used as a shop and office.
- R1 – residential buildings across William Lane at the corner of Marian Street. Accessed via Gibbons Street. The boundary is 5 m and the building is located 11 m from the Site boundary.
- R2 – residential apartments on the east side of the service station, accessed via Gibbons Street. The boundary is 10 m and the building is located approx. 25 m away from the Site boundary.
- W1 – the church to the south, located further down Regent Street on the corner of Regent and Margaret Streets, 55 m from the Site boundary
- C2 – commercial buildings across Regent Street, including a flower shop and a cafe, located 19 m from the Site boundary

- R3 – residential buildings across Regent Street. Residences are located on the upper levels of commercial buildings C2, and are located 19 m from the Site boundary

Location of nearest receivers are shown in Figure 2.

Figure 2: *Location of nearest potentially noise affected receivers*

2.1 Sydney Metro Tunnel

The proposed Sydney Metro (Chatswood to Sydenham line) tunnel passes under the Site. It is understood that the closest edge of the tunnel lies approximately 25 m from the existing surface level at the Site. The proposed development is required to take this tunnel into consideration. Approximate location shown in Figure 3.

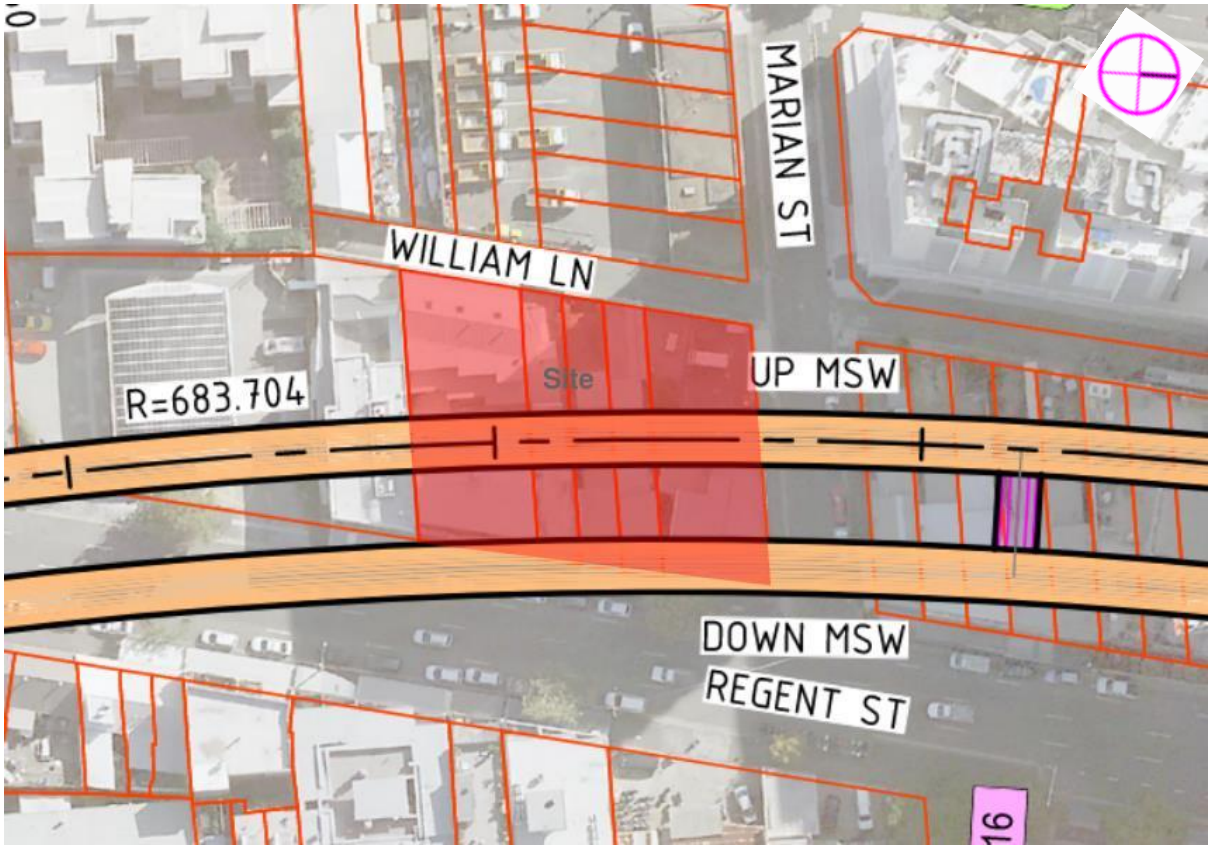


Figure 3: *Location of Sydney Metro Tunnel relative to the Site, shown in orange.*

3. Operational Noise Impact Assessment

3.1 Project appreciation

The proposed development will provide student accommodation services. The building will comprise the following:

- 1 Level of Basement – for bike parking and plant
- Ground Level – comprising of retail, student's common area, bike store, waste room, loading dock, switch and meter rooms, office and laundry, study rooms
- Level 2 – to include a terrace and outdoor areas, gym, common area, two music rooms, indoor cinema
- Level 3-18 – student accommodation rooms
- Level 9 and 15 – student accommodation and communal areas
- Rooftop plant

The street elevation from Regent Street is shown in Figure 4.

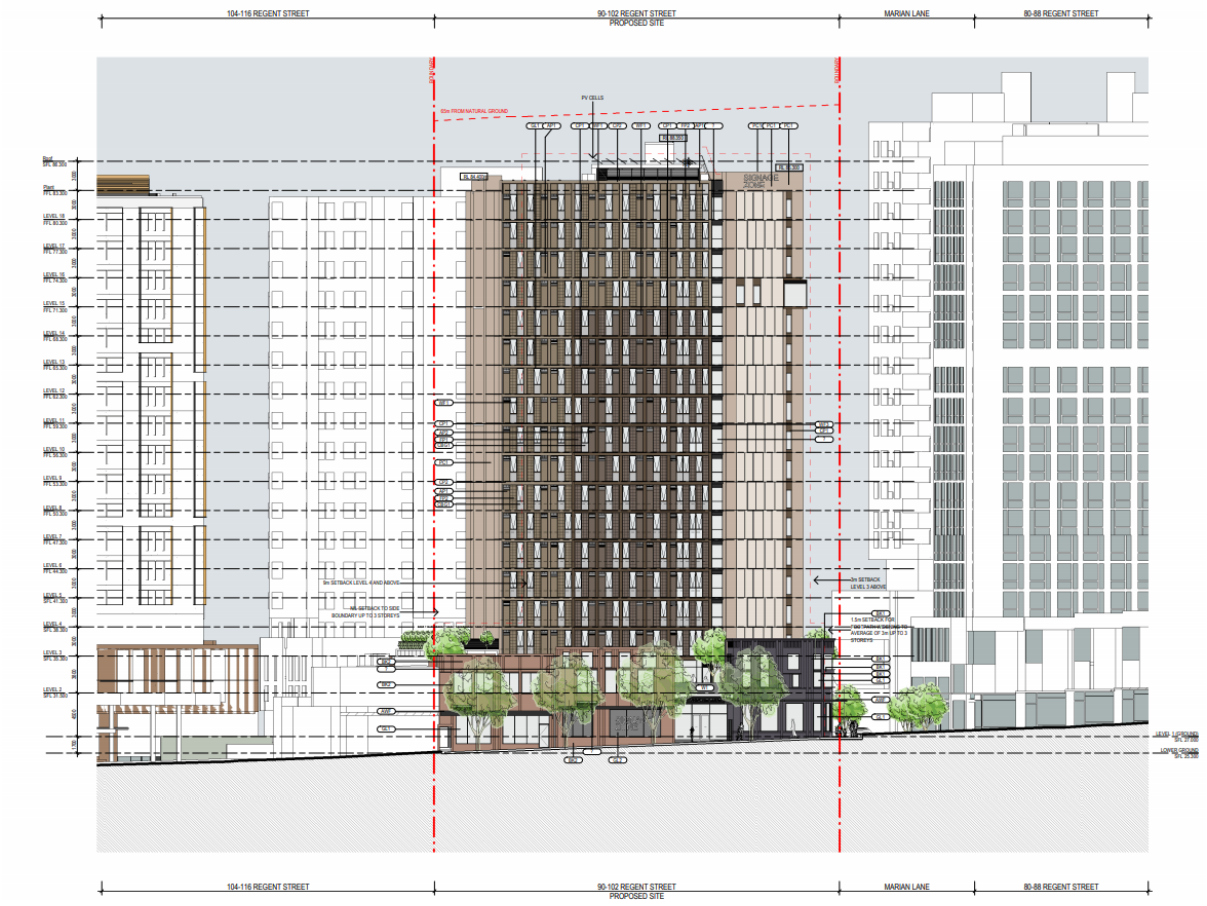


Figure 4: *Street elevation*

3.2 Noise criteria

The following noise criteria / standards are applicable to this project and were used in the assessment.

3.2.1 NSW State Environmental Planning Policy SEPP – Developments near rail corridors and busy roads

The NSW State Environmental Planning Policy– Developments near rail corridors and busy roads document (SEPP) provides internal noise level criteria for residential buildings near rail corridors or busy roads, including the rail regenerated noise, which are tabulated in Table 1 below.

Table 1: *NSW DoP SEPP- Developments near rail corridors and busy roads- Internal noise criteria*

Type of Occupancy/activity	Noise Level (dBA)	Applicable Time Period
Residential Buildings:		
Sleeping areas (Bedrooms)	35	10 pm – 7 am
Other habitable rooms (Excl garages, kitchens, bathrooms, & hallways)	40	At any time

The SEPP recommends using the preferred and maximum weighted rms values for continuous and impulsive vibration acceleration (m/s^2) for 1-80Hz upon residences located above a rail corridor or within 25m horizontal distance from a rail corridor from "Assessing Vibration: a technical guideline" (published by the NSW Department of Environment and Conservation, 2006)". These values are shown in Table 2.

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

Location	Assessment period[1]	Preferred values (m/s^2)		Maximum values (m/s^2)	
		z axis	x & y axis	z axis	x & y axis
Continuous vibration					
Residences	Day time (7am-10pm)	0.010	0.0071	0.020	0.014
	Night time (10pm-7am)	0.007	0.005	0.014	0.010
Impulsive vibration					
Residences	Day time (7am-10pm)	0.30	0.21	0.60	0.42
	Night time (10pm-7am)	0.10	0.071	0.20	0.14

3.2.2 City of Sydney Council

Part "4.2.3.11 Acoustic privacy" of the Sydney City Council Development Control Plan (DCP) 2012 requires the following:

(1) A Noise Impact Assessment prepared by a suitably qualified acoustic consultant may be required when submitting a development application for commercial and retail uses which may affect the acoustic privacy of the adjacent residential use.

(2) Where necessary, a residential development is to include acoustic measures to reduce the impact of noise from existing or planned external sources (for example busy roads, adjoining industries, live music venues and public parks and plazas in which people may congregate or host live music or events).

(3) Development is to incorporate measures that reduce the entry of noise from external sources into dwellings.

(4) Where possible, the attenuation of noise at its source is preferred. Where this option is adopted, the applicant will need to demonstrate that the measures to be undertaken:

(a) have the consent of relevant parties associated with that noise source; and

(b) last for the life of the development proposal.

(7) The repeatable maximum $L_{Aeq\ (1\ hour)}$ for residential buildings and serviced apartments must not exceed the following levels:

(a) for closed windows and doors:

(i) 35dB for bedrooms (10pm-7am); and

(ii) 45dB for main living areas (24 hours).

(b) for open windows and doors:

(i) 45dB for bedrooms (10pm-7am); and

(ii) 55dB for main living areas (24 hours).

(8) Where natural ventilation of a room cannot be achieved, the repeatable maximum LAeq (1hour) level in a dwelling when doors and windows are shut and air conditioning is operating must not exceed:

(a) 38dB for bedrooms (10pm-7am); and

(b) 48dB for main living areas (24 hours).

(9) These levels are to include the combined measured level of noise from both external sources and the ventilation system operating normally.

(10) To limit the transmission of noise to and between dwellings, all floors are to have a weighted standardised impact sound level ($L'_{nT,w}$) less than or equal to 55 where the floor separates a habitable room and another habitable room, bathroom, toilet, laundry, kitchen, plant room, stairway, public corridor, hallway and the like.

(11) The overall design and layout of dwellings, where appropriate, is to include:

(a) a limit on window size and number where oriented towards an intrusive noise source;

(b) seals at entry doors to reduce noise transmission from common corridors or outside the building;

(c) minimisation of the number of shared walls with other dwelling units;

(d) storage, circulation areas, and non-habitable rooms to buffer noise from external sources;

(e) double or acoustic glazing; and

(f) operable acoustic screens to balconies.

(12) Mixed-use development which includes two or more dwellings is to provide separate lift access and a separate entrance for use exclusively for the dwellings.

The Sydney City Council Development Guidelines: Boarding Houses (including student accommodation) 2013 requires that the development meets the design requirements of the BCA "Class 3 – residential buildings".

3.2.3 Australian Standard AS2107: 2016 "Acoustics – Recommended design sound levels and reverberation times for building interiors"

Australian Standard 2107:2016 provides recommended noise level and reverberation times for different areas of occupancy in buildings. The recommended noise levels are given in terms of an equivalent continuous A-weighted noise level (L_{Aeq}). The AS 2107 recommended values for the internal background noise levels and reverberation times are shown in Table 3 below.

Table 3: *Excerpt from Table 1 of AS 2107 – recommended design background noise levels*

Type of Occupancy/Activity Residential	**Recommended Design Sound Level range - L_{Aeq} dBA**
Sleeping Area	30 - 40
Living area	35 - 45
Work areas	35 - 45
Enclosed carpark	< 65

3.2.4 NSW EPA Noise Policy for Industry (2017)

The NSW Environment Protection Authority (EPA) Noise Policy for Industry (2017) sets out noise criteria to control the noise emission from industrial noise sources. Mechanical, building services and operational noise from the development shall be addressed following the guideline in the NSW EPA Noise Policy for Industry.

The determination of the criteria is based on the results of the ambient and background noise unattended monitoring, addressing two components:

- Controlling intrusive noise into nearby residences (Intrusiveness Criteria)
- Maintaining noise level amenity for particular land uses (Amenity Criteria)

Once both criteria are established the most stringent for each considered assessment period (day, evening, night) is adopted as the Project Noise Trigger Level (PNTL). The project noise trigger level becomes the benchmark for assessing the noise impact from the proposed site upon the surrounding noise-sensitive receivers for the external noise emissions from the development. The assessment periods are:

- Day: 7am – 6pm Monday – Saturday, 8am – 6pm Sunday
- Evening: 6pm – 10pm Monday – Sunday
- Night: 10pm – 7am Monday – Saturday, 10pm – 8am Sunday

The applicable parts of Table 2.2: Amenity noise levels from the Noise Policy for Industry which are relevant to the project are reproduced in Table 4 below:

Table 4: *Amenity criteria for external noise levels*

Receiver	**Noise amenity area**	**Time of day**	**Recommended amenity noise level – L_{Aeq} dBA**
Residential	Urban	Day	60
		Evening	50
		Night	45

3.2.5 Sydney Metro Requirements and Guidelines

Part 8.6 of the guidelines is on Noise and Vibration and requires the following:

The effects of Noise and Vibration on existing metro infrastructure and on the development must be considered as part of the design and construction of the developments.

The construction of the development must be carried out such that the effects of noise and vibration on nearby metro structures and facilities are minimised. Prior to construction, an acoustic and vibration assessment including a vibration monitoring plan must be prepared by a qualified person and submitted to TfNSW. This assessment must cover acoustic and vibration levels arising from the proposed development during construction and its operation after completion (including any machinery causing heavy vibration levels). The assessment must also determine the effects of noise and vibration on the metro infrastructure and its operations.

3.3 Measured Noise Levels and Environmental Noise Criterion

Two noise monitors were installed on site for a period of 10 days from 3 to 13 July 2020 to measure the ambient and traffic noise as follows:

- Monitor 1 – at the rear on William Lane to measure ambient noise
- Monitor 2 – on the boundary of Regent Street to measure ambient and traffic noise

Monitor 1 was installed at a rear courtyard on William Lane boundary. Monitor 2 was installed outside the window of the existing vacant building, on Level 1. The microphone was installed on a long pole and was extended 1.2 m out of the window.

The following instruments were used in the measurements:

- ARL noise monitor type NL-42, serial number 184111
- ARL noise monitor type NL-42, serial number 410151

The equipment calibrations were checked before and after the measurements and there was no deviation between the two. All equipment carry traceable calibration certificates.

During the monitoring the weather was generally calm and dry. For those periods where adverse weather conditions prevailed, the data was disregarded.

At the time of monitoring, there was construction activity at the rear, at 11 Gibbons Street affecting daytime values of Monitor 1. For Monitor 1, we have deleted the noise data from 8 am to 4 pm on weekdays to exclude the construction noise. Hence the daytime figure is based on daytime hours outside that period and based on Saturday and Sunday readings over two weekends. The evening time and night time readings were not adjusted as they were not affected.

The noise data were used in conjunction with the noise requirements of the EPA NSW Noise Policy for Industry to establish the Project Noise Trigger Levels (noise criteria). The following Tables 5-8 present the measured noise data and the criterion.

Table 5: *Unattended noise measurement results*

Location	**Equivalent Continuous Noise Level – $L_{Aeq,\ 15\ minute}$ dB(A)**			**Background Noise Level – RBL values $L_{A90,\ 15\ minute}$ dB(A)**		
	Day	Evening	Night	Day	Evening	Night
Monitor 1-William Lane	59	55	51	53	49	45
Monitor	67	66	63	59	52	45

2-Regent Street						

Table 6: *EPA Noise Policy for Industry 2017 – Project trigger levels-William Lane–All values in dBA*

Period	Intrusiveness Noise Level – $L_{Aeq, 15\ minute}$ dB(A)	Project Amenity Noise Level – $L_{Aeq, 15\ minute}$ dB(A)	Project Noise Trigger Level – $L_{Aeq, 15\ minute}$ dB(A)
Day	58 (53+5)	58 (60-5+3)	58
Evening	54 (49+5)	48 (50-5+3)	48
Night	50 (45+5)	43 (45-5+3)	43

Table 7: *EPA Noise Policy for Industry 2017 – Project trigger levels-Regent St – All values in dBA*

Period	Intrusiveness Noise Level – $L_{Aeq, 15\ minute}$ dB(A)	Project Amenity Noise Level – $L_{Aeq, 15\ minute}$ dB(A)	Project Noise Trigger Level – $L_{Aeq, 15\ minute}$ dB(A)
Day	64 (59+5)	58 (60-5+3)	58
Evening	57 (52+5)	48 (50-5+3)	48
Night	50 (45+5)	43 (45-5+3)	43

Table 8: *Noise monitor results for traffic noise measurements – Monitor 2*

Time of Day	$L_{Aeq, period}$ dB(A)	$L_{Aeq, 1\ hour}$ dB(A)-Noisiest	L_{A90} dB(A)
Day (7 am- 10 pm)	67	68	56
Night (10 pm – 7 am)	63	65	45

From observations, the acoustic environment is highly dominated by traffic noise of Regent Street.

3.4 External Noise Intrusion

The outer envelope of the building will need to be designed to reduce noise impacts on occupants to achieve the following internal noise levels:

- Bedrooms: 35 dBA
- Living rooms: 40 dBA

R_w rating is the weighted sound reduction index of a building element. It describes the sound-proofing effectiveness of a partition or glazing depending on its material and construction. Each increment in R_w is equivalent to 1 dB of noise reduction. In general, partitions with higher R_w ratings will attenuate more sound. R_w however, is a rating determined in a laboratory - a highly controlled environment - and should only be used as an indicative value for design purposes. Spectrum adaptation terms C and C_{tr} are often added to the measured R_w result to account for low frequency noise.

Using traffic noise levels from Regent Street, calculations were made to obtain the interior noise levels within the living spaces. The outer walls will be masonry for which the value of R_w 45 has been considered in the calculations.

Traffic noise was measured in front of the building on Regent Street hence the figures include 2.5 dBA for façade reflections.

For night time the traffic noise figures have a value of $L_{Aeq\ (night)}$ 63 dBA and $L_{Aeq\ (1\ hr)}$ 65 dBA (as noisiest 1 hour). As the values are close, we have based our glazing calculation on 65 dBA, hence the results will comply with acoustic requirements of both DoP and City of Sydney Council.

The glazing schedule is presented in the following Table 9.

Table 9: *Glazing schedule*

Level	Space	Facing	Recommendations		Can use natural ventilation?
			R_w glass + frame	Glazing type	
Ground	Retail	Regent	32	6.38mm laminated	No
2-6	Student Bedrooms ensuites, studios and twins	East – Regent	36	10.38mm laminated	No
		North & south	32	6.38mm laminated	No
		West – William Lane	30	6mm monolithic	No
2	Spaces of communal area	Regent St, Marian St and William Lane	32	6.38mm laminated	No
7-11	Student Bedrooms ensuites, studios and twins	East – Regent	32	6.38mm laminated	No
		North & south	30	6mm monolithic	No
		West – William Lane	25	5mm monolithic	Yes
9 and 15	Communal rooms	Regent St, Marian St and William Lane	32	6.38mm laminated	No
12-18	Student Bedrooms ensuites, studios and twins	East – Regent	30	6mm monolithic	No
		North & south	30	6mm monolithic	No
		West – William Lane	25	5mm monolithic	Yes

On Regent Street façade, level 2 podium has solar access windows to maximise sunlight to the communal space. The required glazing for those windows is 6.38 laminated glass.

The above glazing thicknesses are the minimum required for acoustics. Glazing thicknesses can be increased for the reason of fire, safety, etc.

3.4.1 General Glazing Considerations

Glazing is generally the weakest component of the façade, and if not designed or installed properly would be a major transmission path.

Sometimes different glass configurations have the same R_w rating but they have different sound transmission loss characteristics at each frequency band. Our recommendations for glazing have been based on glass performance across frequency spectrum.

All windows / doors should be well sealed when closed with good seals such as Q-LON acoustic seals along the top and bottom sliders. Special attention should be given to balcony or slider doors to have good quality acoustic seals all around them. Any airgap will significantly reduce the acoustic performance or the ability to reduce noise. Mohair seals are not considered to be acoustic seals.

For service rooms such as toilets, kitchen or laundries where the glazing is not specified in the glazing schedule, a 5 mm standard glass and frame with R_w 25 is considered sufficient.

3.5 Sound Insulation Provisions

The walls and floors separating the occupancy units should be designed to achieve the acoustic performance requirements of the NCC. This requires further assessment during detailed design/ construction certificate stage to ensure appropriate separating elements are documented.

For details of walls and floors and noise requirements of other ancillaries the requirements of NCC BCA 2019 Part F5 are presented below. NCC 2019 sound insulation performance requirements for intertenancy walls of NCC Part F5 for Class 3 buildings are summarised in the following Table 10.

Table 10: *BCA sound insulation criteria*

Building element separating:			**Required acoustic performance**
Floors	Sole-occupancy unit (including ensuite)	Sole-occupancy unit (SOU), plant room, lift shaft, stairway, public corridor, public lobby or the like; parts of a different classification.	Min. $R_w + C_{tr}$ 50 Max. $L_{n,w} + C_I$ 62
Walls	Sole-occupancy unit	Sole-occupancy unit	Min. $R_w + C_{tr}$ 50
		Stairway, public corridor, public lobby or the like; parts of a different classification.	Min. R_w 50, with min. R_w 30 door
		Plant room, lift shaft	Min. R_w 50 Discontinuous construction
	Habitable room (other than a kitchen)	Bathroom, sanitary compartment, laundry or kitchen in an adjoining unit	Min. $R_w + C_{tr}$ 50 Discontinuous construction
Services	Habitable room in a sole-occupancy unit	Duct, soil pipe, waste pipe, water supply pipe, storm water pipe, including a duct or pipe that is located in a wall or floor cavity, serves or passes through more than one SOU	Min. $R_w + C_{tr}$ 40
	Non-habitable room or kitchen in a sole-occupancy unit		Min. $R_w + C_{tr}$ 25

**Discontinuous construction definition: Minimum 20 mm cavity between 2 separate leaves, and for masonry, where wall ties are required to connect leaves, the ties are of the resilient type; for other than masonry, there is no mechanical linkage between leaves except at the periphery.*

In addition, the Council DCP requires to limit the transmission of noise to and between dwellings. All floors are to have a weighted standardised impact sound level ($L'_{nT,w}$) less than or equal to 55 where the floor separates a habitable room and another habitable room, bathroom, toilet, laundry, kitchen, plant room, stairway, public corridor, hallway and the like.

3.6 Noise Emissions from the Communal Areas

The communal areas are located on Levels 2, 9 and 15. We haves assessed those as follows:

3.6.1 Outdoor Communal Areas – Level 2

There are two outdoor areas on Level 2, one on the eastern side and one on the northern and western side of the building (see Figure 5). These areas will be used for small gatherings for residents' recreational use only.

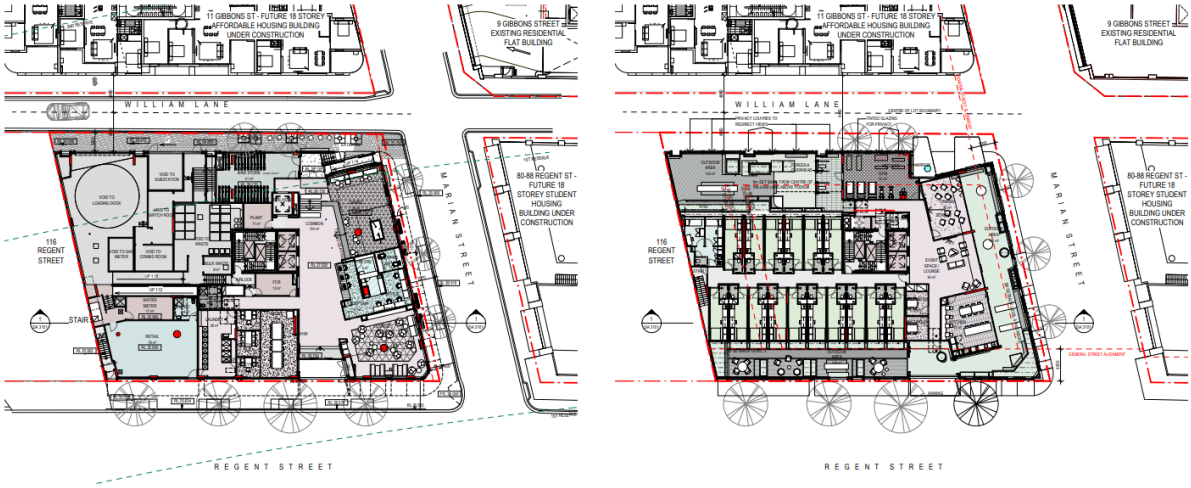


Figure 5: *Level 2 outdoor terraces*

3.6.1.1 The Office of Environment & Heritage POEO Act – Offensive Noise

Noise emissions from the outdoor terraces can be considered as "recreational" and therefore is not covered under Noise Policy for Industry. Hence, for this assessment we will consider the "Offensive Noise" criteria as defined in POEO Act 1997 (Protection of Environment Operations Act). The Office of Environment & Heritage defines offensive noise in the POEO Act as noise:

(a) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:
  (i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or
  (ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or

(b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances, prescribed by the regulations.

In NSW, there are restrictions on noise from musical instruments and sound systems which are commonly used at parties. Noise from music that can be heard in any habitable rooms of a neighbouring residence must cease during certain times: midnight to 8am on Friday, Saturday or any day preceding a public holiday and 10pm to 8am on any other day. An offence occurs if the noise continues after a warning has been given by a council or police officer.

3.6.1.2 Recommendations

It is recommended that an Operation Noise Management Plan is prepared with the following management controls for the outdoor terraces:

- Limiting the hours of use to the following:
  - 8 am to 10 pm Sunday to Thursday
  - 8 am to 12 midnight on Friday, Saturdays and any day immediately before a public holiday

- No external speakers will be permitted in external common areas
- Display signage in the outdoor terrace areas for noise management, reading for example: “Please respect our neighbours and keep noise to a minimum” or similar

3.6.2 Indoor Communal Areas – Levels 2, 9 and 15

The common areas on level 2 will be used for different activities such as meetings, gatherings, etc. The common rooms on Levels 9 and 15 will be used for as breakout study space and can hold small gatherings. These areas can be used at anytime during day or night. Low level background music will be permitted in the internal common areas.

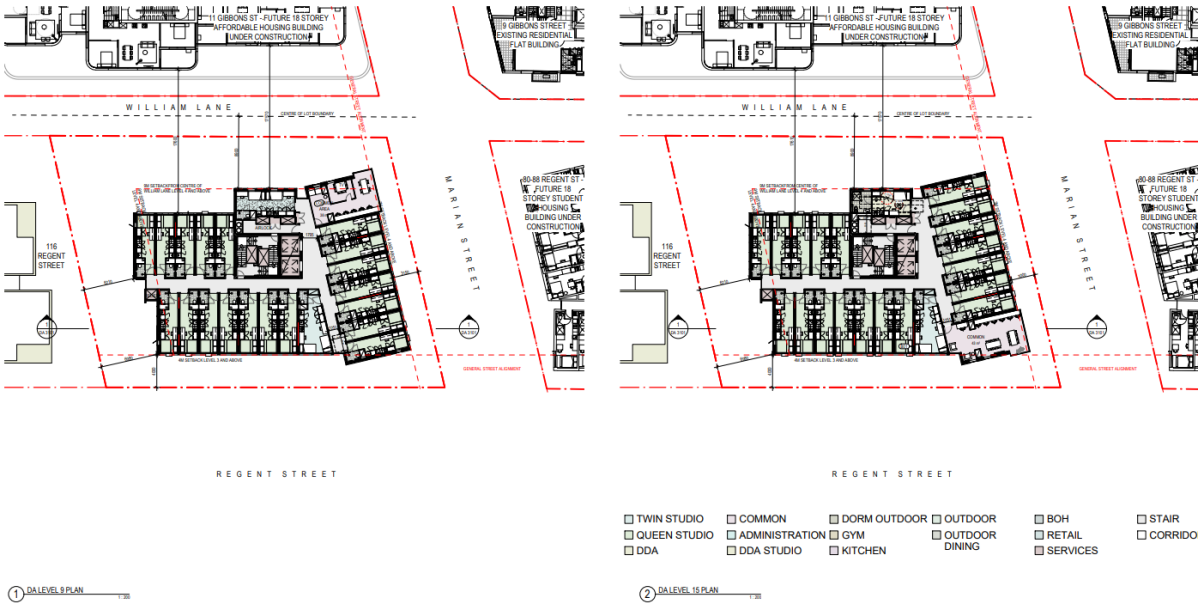


Figure 6: *Level 9 & 15 communal areas*

The communal areas are enclosed, and the minimum recommended glazing for these spaces is 6.38mm laminated glass. Considering the acoustic performance R_w 32 for the 6.38mm laminated glass, noise breakout from small gatherings or background music is expected to be attenuated adequately, therefore there will be no impact upon the nearest neighbouring buildings from those spaces.

The communal spaces are adjacent to the student bedrooms sharing a common wall. There are other student bedrooms below the communal spaces. Noise attenuation should be considered for the common walls and floors. The following is recommended:

- The common walls to have acoustic performance $R_w + C_{tr}$ 50
- The floors to have airborne noise insulation of $R_w + C_{tr}$ 50 and a maximum weighted standardised impact sound level ($L'_{nT,w}$) less than or equal to 55.

The construction of walls and the floors of the building including those of the communal spaces will be finalised at the CC stage.

All acoustic treatment for walls of various spaces such as the wall between SOU and adjacent music / meeting rooms, or cinema wall treatments will be specified at detailed design or CC stage.

3.7 Noise Emissions from Retail

Noise emissions from retail tenancy should be such that it complies with Project Noise Trigger Levels as shown in Tables 6 & 7.

At this stage the retail tenancy type of activity is not known therefore assessment of noise emissions is not possible. An assessment may be required at the CC stage at the discretion of the planner or the regulating authority.

It is anticipated that if retail activities are all inside and do not have outdoor areas, noise impact upon the neighbours is not likely to occur.

3.8 Mechanical Services Noise Control

At this stage, the mechanical plant is not finalised therefore a mechanical noise assessment is not possible. External mechanical plant areas are proposed to be located on the podium (Level 2) and Roof Level. It is anticipated that in principle typical engineering controls can be implemented to ensure compliance with external noise criteria.

Design and selection of mechanical equipment such as air conditioning units or rooftop plant, should be such that total noise emissions comply with the criteria set out in Table 6 and Table 7 so that adjacent properties are not adversely affected.

Following the approval of the proposed SSDA, at construction certificate stage a detailed acoustic assessment of the mechanical plant including the amelioration measures should be conducted to ensure compliance with the set criteria.

In general, based on previous experience for such developments a number of amelioration measures can be implemented to control mechanical noise emissions. Typical such measures can be:

- Construction of acoustic enclosures for plant equipment and acoustic louvers for ventilation openings
- The extraction system to be designed such that the equipment is shielded from the noise receivers or is at an angle at least 90-degree angle to the noise receptors
- There should be no direct line of sight path between the nearest noise sensitive receiver and all the major plant equipment and extraction system
- Isolation of vibration of the equipment to prevent structure born noise.

3.9 Sydney Metro Rail Tunnel Vibration & Ground-Borne Noise Impact

NSW Sydney Metro is currently constructing a tunnel that will form the Sydney Metro City & South West Metro line, which will be located approximately 30 m below the subject building. The Metro line is planned to be operational in 2024. For consideration of vibration issues from the development to the Metro line and vice versa our assessment and recommendations are as follows:

1- Vibration impact from the development to the train tunnel:

The construction work of the subject building (demolition, excavation and construction) is proposed to commence in 2021 (indicative). At that time, if the tunnel is at a stage where vibration measurements can be conducted within the tunnel, we recommend attended vibration measurements to be conducted prior to the start of construction work. The tests will require access to the tunnel at a point below the subject Site. This will indicate whether vibration levels at the tunnel are likely to exceed the criteria and if vibration monitoring will be necessary throughout the construction of the building.

After the construction phase, the subject building will not have any vibration-generating equipment or activity therefore there will be no vibration issue from the operation of the building.

2- Vibration impact from the train line to the subject building:

There are two main phases where vibration from Metro tunnel could have an impact upon the subject site/building, during tunnel boring and during operation of the Metro (from train pass-by events).

It is anticipated that tunnel boring activities will be complete by the time the subject building is constructed therefore there will be no vibration impact from tunnel boring. However, when the Metro is operational in 2024, there is potential for ground-borne noise and vibration impact from the operation of Metro line (from train pass by events). It is recommended that specialist advice is sought for vibration/structural isolation of the building at the design stage of the project, so that relevant vibration isolation treatments can be incorporated, if required.

4. Construction Noise Impact Assessment

The existing buildings on Site are proposed to be demolished to construct a new 18-level student accommodation with ground level retail and basement car park.

The proposed construction work will consist of the following stages:

- Demolition
- Excavation
- Construction

The nearest neighbouring buildings which can potentially be impacted by construction noise are shown in Figure 2.

4.1 Acoustic Criteria

City of Sydney Council has specific Construction Noise Guidelines applicable to Sydney CBD. As this Site is outside the CBD the applicable guidelines will be those of EPA NSW.

4.1.1 NSW EPA Interim Construction Noise Guidelines

Construction noise is a major environmental noise issue in NSW, and it is well accepted that this activity can adversely affect, sleep, concentration and learning performance and mental and physical health. While construction noise is temporary in nature, its impacts need to be controlled.

The EPA NSW Interim Construction Noise Guideline (ICNG) is specifically aimed at managing noise from construction works. From a regulatory perspective, the local Council is the appropriate regulatory authority for non-scheduled construction activities.

The ICNG criteria for control of construction noise is presented in Table 11.

Table 11: *ICNG noise criteria at residences, using quantitative assessment, L_{Aeq}*

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

Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for work 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 dBA above the noise affected level, the proponent should negotiate with the community For guidance on negotiating agreements see Section 7.2.2 (NSW Interim Construction Noise Guideline)

For other receiver types subjected to construction noise, the ICNG provides the following noise criteria as presented in Table 12.

Table 12: *Noise criteria for receivers other than residential*

Receiver type	Criteria
Commercial offices, retail outlets	External $L_{Aeq\ (15\ min)}$ 70 dBA
Place of worship	Internal noise level 45 dBA

Noise monitoring results are presented in the following Table 13 and are used to establish the criteria.

Table 13: *Ambient noise levels – Site specific measurements*

Monitor	Location	Measured noise level. dBA	
		$L_{Aeq\ (15\ min)}$	$L_{A90\ (15\ min)}$ (RBL)
1	William Lane	59	53
2	Regent Street	67	59

Considering the measured daytime RBL background noise levels in William Lane and Regent Street are 53 and 59 dBA, the Noise Affected Level criteria will be **63** and **69** dBA respectively (RBL + 10).

The Highly Noise Affected Level criterion has a value of 75 dBA and is independent of the background level.

4.1.2. Road noise Policy

Noise from the vehicles associated with the development will be assessed using NSW Road Noise Policy. Table 14 presents the noise assessment criteria for land use developments with potential to create additional traffic on existing local and sub-arterial roads.

Table 14: *Noise levels- Road Noise Policy*

Road category	Type of project/Land use	Assessment criteria, dBA	
		Day	Night
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use development	$L_{Aeq,1hr}$ 55 (External)	$L_{Aeq,1hr}$ 50 (External)
Freeway/arterial/sub-arterial roads	Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use	$L_{Aeq,15hr}$ 60 (External)	$L_{Aeq,9hr}$ 55 (External)

	development		

- RNP recommends that “Where feasible, existing noise levels should be mitigated to meet the noise criteria. In this regard, the RNP states that for existing roads there is limited potential for noise control as the development is not linked to road improvements. It does however advise that applicable strategies include appropriate location of private access roads, regulating time of use, using clustering, and using barriers and acoustic treatments”.
- Section 3.4.1 of the RNP specifies a limit of 2 dB for vehicular noise level increase over existing noise level of local roads for such developments/projects.

4.1.3 Construction Vibration Limits

Construction vibration levels depend on several factors. These include the activity, the equipment being used, the ground geology and the distance between the building and the source. In Australia there is no current specific standard for construction vibration. The methodology is equivalent to the guidelines issued in current international standards and described in *‘AS 2670:2001 Vibration and shock - Guide to the evaluation of human exposure to whole body vibration’*.

This methodology is equivalent to the guidelines issued in current international standards and described in *‘AS 2670:2001 Vibration and shock - Guide to the evaluation of human exposure to whole body vibration’*, as shown below in Figure 7.

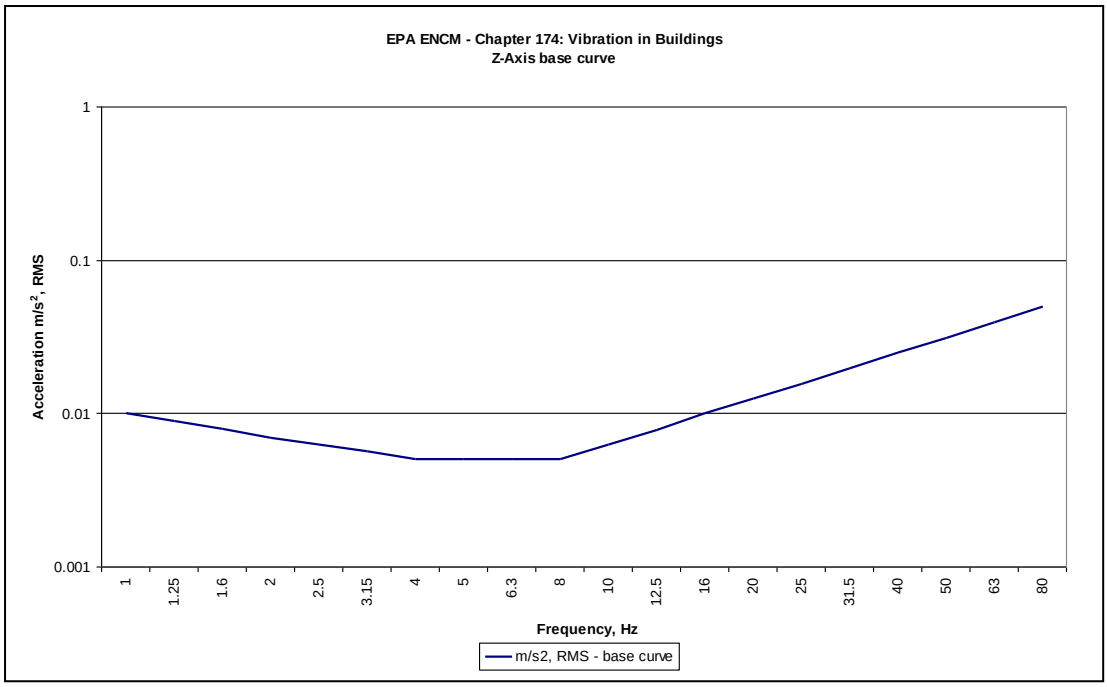


Figure 7: *AS2670 Base Vibration Criteria*

The NSW Office of Environment and Heritage (OEH) does not directly relate to damage levels to buildings. The German DIN4150 and NSW OEH/British Standard BS6472 provide guidelines relevant to this assessment. These criteria are summarised below in Table 15.

Table 15: *Typical vibration limit criteria (mm/s)*

Criterion	Typical vibration velocity	Standard
Disturbance to persons (day: 7am – 10pm)	0.3 – 0.6 peak	BS6472
Disturbance to persons (night: 10pm – 7am)	0.2 peak	BS6472

Damage to dwellings	5 – 20 mm/s	DIN4150
Damage to heritage buildings	3 – 8 mm/s	DIN4150

The construction vibration assessment is usually conducted if the receivers are within a few meters from the source. In general, the vibration effects for larger distances are minimal or non-existent, for example train vibration assessments are required only if the residential buildings are within 25 m of the train line.

The following criteria are considered applicable when assessing vibration emission levels from the construction works.

The effects of ground vibration on buildings near construction sites may be broadly defined by the following three categories:

1. Disturbance to building occupants - Vibration in which the occupants or users of the building are inconvenienced or possibly disturbed,
2. Effects on building contents - Vibration where the building contents may be affected, and,
3. Effects on building structures - Vibration in which the integrity of the building or structure itself may be prejudiced.

In general, vibration criteria for human disturbance (1) are more stringent than vibration criteria for effects on building contents (2) and building structural damage (3). Hence, compliance with the more stringent limits dictated by Category 1, would allow for compliance to be achieved for the other two categories.

4.1.4 Construction Vibration Criteria for the Sydney Metro rail tunnel

Sydney metro and Transport for NSW (TfNSW) protects rail tunnel infrastructure by defining rail protection reserves around the tunnel. The 'first reserve' comprises the immediate surrounds of the tunnel and represents the area that shall not be encroached upon by any future construction or development. The 'second reserve' covers areas where future development works have the potential to impact on the performance of the tunnel support elements and operation of the tunnel.

Details regarding the rail reserves, along with general guidelines on allowed construction activities and required protection measures, are provided in the TfNSW document Sydney Metro – Technical Services – Sydney Metro Underground Corridor Protection – Technical Guidelines Revision 1 (issued 16th October 2017).

The following is an excerpt from the guideline detailing relevant vibration criteria and controls:

Any development that occurs within a screening distance of 25 m horizontally from first reserve must consider the vibration on the metro infrastructure with the following assessment criteria of maximum peak particle velocity (PPV):

- *15 mm/s for tunnel and cavern cast in situ concrete linings that are in good condition.*
- *20 mm/s at the running tunnels supported using a precast concrete segment lining.*

It is important to note that more stringent limits may apply if rail equipment, that is sensitive to vibration, has the potential to be affected by the development and its construction.

During development construction vibration monitoring may be required for the underground metro support, such as concrete linings. This monitoring must be conducted based on the selection of appropriate trigger levels.

If the vibration levels exceed tolerable limits, then the developer must modify the construction methodology in such a way that the vibration limits are satisfied

4.2 Construction Noise Assessment

At this stage, the proposed nature of construction works and activity has not been finalised as a contractor has not yet been appointed, therefore the equipment schedule is not available. The following typical plant involved in each phase / activity have been assumed:

- Demolition work: Excavator, jack hammer, concrete breaker, a loader and spoil removal trucks.
- Excavation work: Excavator, concrete breaker, loader, removal trucks
- Construction: Concrete mixer, crane, delivery trucks

Representative plant and associated noise power levels have been derived from the Australian Standard AS 2436 “Guide to noise and vibration control on construction, demolition and maintenance sites”. The following
Table 16 presents a summary of equipment noise levels.

Table 16: *AS2436 - Predicted construction noise from various works phases, $L_{Aeq\ (15min)}$*

Item	Plant Description	Sound Power Level (average), dBA	Sound Pressure Level at 10 m, dBA
1	Excavator	107	79
2	Jack hammer	121	93
3	Backhoe	104	76
4	Small compactor	113	85
5	Crane(mobile)	104	76
6	Compressor	101	73
7	Generator	99	71
8	Hand tools (Jack hammer)	121	93
9	Concrete pump truck	108	80
10	Welder	105	77
11	Angle grinder/ drill	108 / 105	80 / 77
12	Loader	113	85
13	Circular Saw (3 KW, petrol, cutting concrete)	107	79
14	Truck (20 T)	107	79

The Interim Construction Noise Guideline proposes that noise levels not exceeding measured background noise levels (day time RBL – see Table 5) by 10 dB are considered acceptable for construction works.

The nearest noise sensitive receivers are the commercial building C1 on the south boundary and residential buildings R1 and R2 across William Lane. Other residential and commercial buildings are further away, on the other side of Regent Street. There is also a place of Worship further down the south across Margaret Street.

Most mobile equipment such as the excavator will be moving all over the Site. The calculation considers the location where the mobile equipment are nearest to the noise receivers. The position of truck loading area is not finalized but it is likely to be within the boundary at the corner of William Lane

and Marion Street. The loader may move all over the Site but will be mainly working in this area to load the trucks.

Typical noise levels from the activities have been calculated to the nearest receiver buildings. The attenuation effects of distance and directivity were considered in the calculations. The following Table 17 provides a summary of the results.

Table 17: *Predicted construction noise levels, $L_{Aeq\ (15min)}$*

Noise receiver	Average distance (m)	Noise Level $L_{Aeq\ (15\ min)}$ dBA		
		Demolition phase	Excavation phase	Construction phase
R1	5	85 (excavator)	85 (excavator)	86 (concrete truck & pump)
		99 (jack hammer)	85 (loader & truck)	43 (grinder & drill, inside)
		82 (backhoe)	82 (backhoe)	82 (mobile crane)
R2	10	79 (excavator)	79 (excavator)	80 (concrete truck & pump)
		93 (Jack hammer)	79 (loader & truck)	40 (grinder & drill, inside)
		76 (backhoe)	76 (backhoe)	76 (mobile crane)
R3	19	73 (excavator)	73 (excavator)	74 (concrete truck & pump)
		87 (jack hammer)	73 (loader & truck)	37 (grinder & drill, inside)
		69 (backhoe)	69 (backhoe)	69 (mobile crane)
C1	< 5	79 (excavator)	79 (excavator)	80 (concrete truck & pump)
		93 (jack hammer)	79 (loader & truck)	37 (grinder & drill, inside)
		76 (backhoe)	76 (backhoe)	76 (mobile crane)
W1	55	64 (excavator)	64 (excavator)	65 (concrete truck & pump)
		78 (jack hammer)	64 (loader & truck)	<30 (grinder & drill, inside)
		61 (backhoe)	61 (backhoe)	70 (mobile crane)

The above noise levels were assessed against the criteria. A summary of results is presented in Table 18.

Table 18: *Noise levels and compliance status*

Receiver	Phase	Noise level at receiver, dBA	Criteria		Does it comply with?	
			Noise Affected	Highly Noise Affected	Noise Affected	Highly Noise Affected

			Level – dBA	Level – dBA	Level – dBA	Level – dBA
R1	Demolition	82-85	63	75	No	No
	Excavation	82-85	63	75	No	No
	Construction	43-86	63	75	Yes	No
R2	Demolition	76-79	63	75	No	No
	Excavation	76-79	63	75	No	No
	Construction	40-80	63	75	Yes	No
R3	Demolition	69-73	69	75	Yes	No
	Excavation	69-73	69	75	Yes	No
	Construction	37-74	69	75	Yes	Yes
C1	Demolition	76-79	External level 70 dBA		No	
	Excavation	76-79	External level 70 dBA		No	
	Construction	37-80	External level 70 dBA		Yes for some activities	
W1	Demolition	30-35	Internal noise level 45 dBA		Yes	
	Excavation	30-33	Internal noise level 45 dBA		Yes	
	Construction	<30	Internal noise level 45 dBA		Yes	

The above summary results indicate that for residential receivers, noise emissions from most activities, demolition, excavation and construction exceed the Noise Affected Level criteria and in some cases comply with Highly Noise affected Level. Due to the close proximity of the residential buildings and high level of equipment noise, exceedances are likely to occur and at times the Highly Noise Affected Criteria will also be exceeded. At times when two or three pieces of equipment work simultaneously (e.g. excavator and loader could be working simultaneously) the accumulated noise will be even higher; hence the exceedances will be higher.

For exceedances above the Noise Affected Level, ICNG requires reduction of the noise to meet the level as follows (see Table 11):

The noise affected level represents the point above which there may be some community reaction to noise.

Where the predicted or measured $L_{Aeq\ (15min)}$ 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.

For exceedances above the Highly Noise Affected Level of 75 dBA, there will be a strong community reaction. In such cases, to reduce the noise impact and its effects the following recommendations are given (See Table 11).

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, regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account:

Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences)

If the community is prepared to accept longer period of construction in exchange for restrictions on construction times

To meet the required noise levels (Noise Affected Level), all “feasible and reasonable work practices” should be implemented. These will reduce the noise impact and could be in the form of semi-enclosures around stationary noise sources or using trucks fitted with proper silencers. To reduce the above noise impact the following is recommended:

- Due to large noise levels and exceedances installation of a hoarding around the Site periphery is recommend. The required hoarding height is ideally 3m, however in some cases this is not practical therefore contractors prefer a smaller height of around 2m. This will still shield the noise receivers against low level activities such as excavation. The recommended hoarding will not provide any shielding to the high level noise sources such as demolishing or construction of the upper levels. The hoarding which acts as an acoustic barrier should be constructed of solid material such as 9 mm fibre cement sheet or 20mm plywood and should be free from gaps and openings. The hoarding should also enclose the truck loading area.
- Where possible, the use of noisy equipment should be avoided. These should be replaced by quieter equipment/operations for example a circular saw or ripping should be used as an alternative to jack hammering.
- Managerial measures including Community Liaison and Complaint Handling will be an important part of the mitigation measures. Please see the following sections.

We understand that few neighbouring buildings are undergoing construction and the construction of the subject building may occur at the same time or with some time overlap. These include the building at 11 Gibbons Street and 13-23 Gibbons Street. At times where the construction noise adds up, the above exceedances will be higher. To alleviate the noise levels, the mitigation measures should also be applied to the neighbouring buildings.
The amount of addition or cumulative noise depends on many factors, some of which are as follows:

- Distance of noise receivers from each source.
- Noise level of the two sources (or the level difference) received at the receivers. If the two sources are of the same level, noise will be increased by 3 dBA. If the level difference is 10 dBA or more, there will be no addition, only the louder noise will be heard.
- The construction noise is intermittent and the peaks may not occur at the same time. Noise additions only occur if the peaks are close or occur at the same time.

4.3 Truck Noise Assessment

Truck loading will take place within the Site boundary at the corner of William Lane and Marion Street. Truck noise emissions should be considered in two separate parts as follows:

1. Truck noise impact upon the neighbouring buildings
2. Truck noise impact upon the surrounding road network

Truck noise for trucks arriving and for activities on Site, and emissions upon the neighbouring buildings have been included in our assessment in Section 5.1 above in accordance with ICNG requirements.

For trucks travelling on the surrounding road network the noise impact will be assessed against the requirements of NSW Road Noise Policy (RNP). At this stage a contractor is not appointed therefore the truck numbers and truck routes are not known. Trucks will travel to Site via Regent Street and then turn into Marion Street. The main impact on the surrounding and nearby road network will be on Regent Street therefore this location has been considered for the assessment.

For generated traffic associated with such developments the RNP allows 2 dBA increase on local and collector roads. In order for a road noise level to increase by 2 dBA, a significant increase in traffic volume would be needed. A 2 dBA increase in noise levels will require a 66% increase in traffic

volume (note: the addition of noise is on logarithmic basis. A doubling in traffic volume corresponds to a noise increase of 3 dBA).

From experience with similar projects, it is estimated that the number of trucks travelling to Site will be approximately 10-15 per day. Assuming that the truck movements are spread evenly during the day, there will be 1-2 truck entering or leaving the Site in each hour.

Considering the high volume of traffic on Regent Street, the addition of 1-2 truck/hour, is well below 66% volume increase hence will not result in a perceptible difference in noise level. The resulting noise increase will be well within the 2 dBA limit increase, hence will comply with RNP noise requirements.

In general, residences along the route will be subject to passing truck noise. To minimize any noise impact the contractor should train and instruct the truck drivers to exercise caution to keep the noise to a minimum. Trucks should be properly maintained and have proper silencers fitted to control engine and brake noise. The drivers should avoid unnecessary idling and switch off engines during loading/unloading of the trucks.

4.4 Construction noise mitigation recommendations

4.4.1 Scheduling, Standard Hours for Construction Work

The recommended standard hours for construction (including demolition and excavation) work are as follows. These hours should be strictly adhered to.

- Monday to Friday 7 am to 6 pm
- Saturday 8 am to 1 pm
- No work on Sundays or public holidays

Section 2.2 of the “Interim Construction Noise Guideline” specifies categories of work that might be taken outside the standard hours. A strong justification is required for work outside the standard hours. The categories which may be relevant are:

- The delivery of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads.
- Emergency work to avoid loss of life or damage to property, or to prevent environmental harm.
- Maintenance and repair of public infrastructure where disruption to essential services may occur.

4.4.2 Noise Mitigation Measures (General)

Detailed construction timelines and methodologies are not available at this stage. Typically, detailed construction plans including equipment schedule are prepared once relevant contractors have been appointed and specific details of work are finalised. Our analysis indicates that at the nearest residential and commercial buildings, noise from subject work will exceed the “Noise Affected Level” and in some cases it will also exceed the “Highly Noise Affected Level”. The mitigation measures (“How to apply” column of Table 11) should be strictly observed. While this may vary for the actual plant the following provides a general guide and list of our recommendations for control of such noise and reduction of noise impact. All feasible and reasonable work practices should be applied to meet the “Noise Affected Level” criteria and to reduce the noise impact.

Where exceedances occur, our general recommendations are as follows:

- Installation of hoarding to the appropriate height (or maximum possible / practical height) on the periphery of the Site. For the hoarding to act as an acoustic barrier it should be

constructed of solid panels such as 20 mm plywood or 9mm fibre cement sheets, should have proper overlap and be free from any gaps and openings.

- The above hoarding should have appropriate height such that there is no line of sight between the equipment and the noise receiver. Most hoardings should have a minimum height of 2 m, to be effective. For this Site, the use of hoarding will shield low level work such as excavation but will not be effective for the work at higher levels such as demolition work. In such cases management mitigation measures such as the use of “all feasible and reasonable solutions” should be fully considered.
- Where possible, noisy operation/equipment should be replaced by a quieter method for example in demolition, jaw crushers and circular saws to be used instead of rock breakers or dozers. At close distances, hammering should be replaced by ripping. Where piling is required, use bored or auger piling instead of impact piling.
- Provide respite periods during noisy activities. Limiting noisy activities to when community is less sensitive to noise, e.g. between 9 and 12 am or between 2 and 5 pm.
- Selecting or treating equipment to lower their noise emissions, e.g. engines to be installed with proper exhausts or silencers or noise radiating surfaces to be damped.
- Any stationary noisy equipment such as generators to be kept as far possible from the residential receivers. Such equipment is recommended to be fitted with a purpose-built semi-enclosure.
- Using less annoying alternatives to audible movement alarms (e.g. broadband “quacker“ units) that provide a safe system of work or configuring the Site to maximize forward movement of the mobile plant.
- Liaising with affected residents, informing them when noisy works will occur and what methodologies are being implemented to minimize the noise impact.
- Implementing a formal system for community liaison and consultation (see below for details).
- All truck movements, loading/unloading should take place with minimum amount of noise emissions to the neighbours. The trucks should be selected to have minimum noise and a proper exhaust system. All drivers should be trained to keep the noise to a minimum. To eliminate the reversing beep, the route must be planned to minimize the reversing distance. Trucks should be switched off as soon as they arrive into position.

4.4.3 Construction Noise Management Recommendations

The Noise Affected Level represents the point above which there may be some community reaction to noise. The Highly Noise Affected Level represents the point above which there may be strong community reaction. The construction noise mitigation measures detailed above provide solutions to reduce the noise impact however further measures may be required to minimise the temporary loss of acoustic amenity on the nearest affected receivers and surrounding community.

Noise management can help to minimise the noise impact by planning and implementing the following:

- Scheduling
- Community engagement
- Operational practices

4.4.4 Community Consultation and Complaints Handling

As a project moves towards the construction phase more details normally become available on the planned work methods, location of plant and equipment, and scheduling. For the development construction works, contact with the nearest affected community is desirable once approval has been given to commence works and should be undertaken prior to any work beginning. The type of

community engagement should relate to the likelihood and extent of noise and vibration impacts from the construction works.

The following community consultation and complaints handling procedures should be adopted for the Site:

- Contact neighbours who potentially may be affected at the earliest possible time before the Site work begins
- Inform potentially noise affected neighbours about the nature of the construction stages and duration of noisier activities
- Keep potentially noise affected neighbours up to date on progress
- Provide contact details including phone number on a Site board at the front of the Site and maintain a complaint register suited to the scale of works
- If a website exists, provide details and news of the construction progress. Provide contact details
- Any formal complaints received regarding noise and vibration matters at the construction Site shall be passed on to the Building Contractor for the complaints to be addressed and resolved.
- Once a complaint is received it should be followed up promptly, acted upon and the complainant contacted (if amenable) to inform them of the progress and check that the solution is satisfactory
- Ask about any concerns that potentially noise affected neighbours may have and discuss possible solutions

4.4.5 Operational Practices to Minimise Construction Noise Impacts

The EPA “Interim Construction Noise Guidelines” provides the operational suggestions to reduce noise impacts. The following general procedures can be adapted.

- Community consultation and notification should be carried out. Keep affected receivers informed of upcoming works and construction times.
- Complaints handling procedure should be established. This should include a readily accessible contact point for residences to contact the Site staff in charge of noise management, a clear complaint (and reporting process and establishment of a complaints register.
- Use quiet work methods and lower noise plant and equipment.
- Use quiet equipment where possible. Specified noise levels can be considered when selecting individual plant.
- Operate plant in a quiet and efficient manner. For example, reduce throttle setting and turn off equipment when not being used.
- Maintain equipment to ensure manufacturers design noise levels are achieved.
- Locate noisy plant away from sensitive receivers where possible. This may include locating construction vehicle entrances away from residential ends.
- Maximize noise shielding on Site. This may include the use of site sheds, material stockpile or natural landforms to provide acoustic shielding.
- Schedule activities to minimize noise impacts. Consultation should be undertaken with affected neighbours to minimise impacts.
- Organise deliveries and access to minimise noise impacts. This may include nomination of off-site truck parking areas away from residents, provision of on-site parking for trucks and staff and amalgamation of loads to minimise truck movement numbers.

The best management practices involve adopting particular operational procedures that minimise noise while retaining production efficiency. Some common noise reduction strategies include:

- Changing the activity to reduce the noise impact or disturbance (e.g. reorganising the way the activity is carried out).
- Choosing a suitable time — schedule noisy activity to less sensitive times of the day. There are sensitive times of the day and should be considered for different people, for example, schools during the day, times of religious services, and residences during evenings and night. Where several noisy pieces of equipment are used, their operation should be scheduled to minimise impacts.
- Keeping neighbours informed of a planned noisy activity, its duration and the reasons for the activity. Neighbours may be more accepting of temporary noise if they know when and why the noise is happening, and how long it will last.
- Educating staff and contractors about noise and quiet work practices. This could include signage, for example, some construction sites have signs reminding contractors to consider neighbours and be quiet, and to not start noisy work too early (e.g. before 7.30 am).

4.5 Vibration Assessment

The purpose of the vibration assessment is to limit potential vibration generated from construction activities on the Site so as to avoid building damage and human discomfort associated with the construction works. Vibration impacts on the nearby buildings and their occupants should be considered for the assessment of structural damage and human annoyance, respectively.

Typical vibration levels from construction plant equipment most likely to cause significant vibration are summarised in Table 19 below.

Table 19: *Typical ground vibration generated by construction plant*

Activity	Typical ground vibration
Bulldozers/ Excavators	Typical ground vibration from bulldozers range from 1mm/s to 2mm/s at distances of approximately 5m and at distances greater than 20m, vibration levels are usually below 0.2mm/s.
Jack Hammers	Typical ground vibrations from jack hammers are generally greater than 5mm/s at distances of 1m and no more than 2mm/s for distances of 5m or more.
Truck traffic	Typical vibration from heavy trucks passing over normal (smooth) road surfaces generate relatively low vibration in the range 0.01-0.2mm/s at the footings of buildings located 10-20m from a roadway. In general ground vibration from trucks is usually imperceptible in nearby buildings.

Therefore, vibration management strategies implemented on Site shall consider these items of plant and those construction activities involving these items of plant.

4.5.1 Buffer Distances for Vibration Control

The relationship between vibration and the probability of causing human annoyance or damage to structures is complex. This complexity is mostly due to the magnitude of the vibration source, the particular ground conditions between the source and receiver, the foundation-to-footing interaction and the large range of structures that exist in terms of design (i.e. dimensions, materials, type and quality of construction and footing conditions).

The intensity, duration, frequency content and number of occurrences of a vibration, all play an important role in both the annoyance caused and the strains induced in structures.

As the pattern of vibration radiation is very different to the pattern of airborne noise radiation, and is very Site specific, below are some indicative minimum ‘buffer’ distances determined for some

common construction plant with data available from recent projects, which assist to avoid human discomfort in terms of perceptible (or tactile) vibration during daytime construction hours:

Table 20: *Recommended Minimum Buffer Distances for Construction Plant*

Plant Item	Recommended Minimum Buffer Distance (m)
CFA (Continuous Flight Auger) Piling rig	10
Excavators	10
Jack hammers	5

A preliminary review has been carried out of typical construction equipment and levels using published formulae historical and measured data for major plant equipment expected to be used. Actual Site vibrations may vary from those shown in Table 21 below as there is dependence on ground type on Site.

Table 21: *Equipment vibration levels vs distance*

Activity/plant	Peak Particle velocity (mm/s)									
	Distance (m)									
	5	10	15	20	25	30	35	40	45	50
Loaded truck	3.6	1.3	0.7	0.5	0.3	0.2	0.2	0.2	0.1	0.1
Small excavator	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jack hammer	1.7	0.6	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.0
Rock hammer	4.5	3	-	1.5	-	0.4	-	0.3	-	0.3

The following Table 22 presents vibration levels and the criteria. The levels are based on the building being within 5 m and the truck within 10 m of the construction work.

Table 22: *Typical Vibration Levels*

Plant item	Distance	Vibration level PPV(mm/s)	Amenity criterion (mm/s)	Structural criterion (mm/s)
Loaded truck	10	1.3	0.28-0,56	5
Small excavator	5	0.1	0.28-0,56	5
Jack hammer	5	1.7	0.28-0,56	5

Other plant items such as generators or concrete pump will be less severe on vibration and may not be as critical as the above items.
The commercial building to the south boundary (C1) is in the immediate vicinity hence should be considered for possible vibration impact. Other neighbouring buildings R1, R2, R3 and C2 are not within the buffer distances therefore are not considered critical.

4.5.2 Specific Vibration Management measures

Due to close proximity of the commercial building C1, the building will be within the buffer zone of the equipment, therefore the following specific recommendations have been provided:

- Prior to the start of demolition work, a dilapidation report is recommended to be conducted on the south boundary commercial building C1.

- The equipment with high vibration levels such as the excavator or jack hammer should not be used close to the south boundary. For such work, those equipment to be replaced with alternatives with known lower vibration generation. For example, when work is close to the south boundary a backhoe is recommended to be used as an alternative to an excavator or a circular saw or ripper to be used as an alternative to a jack hammer.
- Building C1 is directly adjacent to the proposed construction work, therefore for any work at the south boundary extreme care should be taken. For example, when the south boundary wall is being demolished, the operation should be smooth such as layer by layer ripping or removal as an alternative to knocking down or impacts.
- During the course of all works/phases, specifically during demolition and excavation, vibration monitoring is recommended to be conducted at the boundary. The vibration monitor should also provide warnings to the Site manager when any exceedances in the vibration amenity criteria occur. The vibration monitor should have audible or visual warnings to warn the equipment operator when the operator is working close to the boundary and exceeds the vibration limit, so that he can stop and replace equipment/operation.

4.5.3 General Vibration Management Measures

Further to buffer distance considerations, to ensure vibration impacts are minimised during the construction period, the following vibration management control measures are recommended:

1. Implementation of a vibration management plan is required to avoid adverse vibration disturbance to affected occupancies. Consultation with occupants and property owners is recommended and should be aimed at providing a communication path directly to the Project Manager.
2. A management procedure will be implemented to deal with vibration complaints. Each complaint will be investigated and where vibration levels are established as exceeding the set limits, appropriate amelioration measures shall be put in place to mitigate future occurrences
3. Where vibration is found to be excessive, management measures shall be implemented to ensure vibration compliance is achieved. Management measures may include modification of construction methods such as using smaller units, establishment of safe buffer zones at the beginning of works and if necessary, time restrictions for the most excessive vibration activities. Time restrictions are to be negotiated with affected receivers.

4.5.4 Construction Vibration Impact on the Sydney Metro rail tunnel

Sydney Metro requires a noise and vibration impact assessment and vibration monitoring before and during the construction phase of the proposed development of the tunnels to assess and monitor the impact of the proposed development on the surrounding tunnels in accordance with the Sydney Metro Guideline. We recommend attended vibration measurements to be conducted prior to the start of construction work (See Section 3.9). This will measure the construction equipment vibration levels at the tunnel and will determine if the vibration levels are close to the criteria and if vibration monitoring will be required.

4.6 Monitoring program

As neighbouring buildings are close to the construction Site and noise and vibration impacts are likely to occur, it is recommended that regular noise and/or vibration monitoring and inspections are undertaken during the construction period. Where monitoring indicates that measured noise levels consistently exceed the predicted noise level by more than 3dB, additional mitigation measures will be implemented to reduce the noise levels.

Noise and vibration monitoring shall be undertaken by a suitably qualified acoustic consultant. Reports shall be provided stating the measurement methodology and results of monitoring, and any recommendations for mitigation. Long term noise monitoring data shall be acquired over a period of

minimum 10 days, excluding rain and excessive wind events using 15-minute A frequency weighted measurements and broadband levels for L_{Aeq}, L_{A10}, L_{A90}, L_{Amax} and L_{Amin}.

Spot checks using a hand-held Type 1 integrating sound level meter with octave band filters may be undertaken to check equipment noise levels against manufacturers specifications and to check worst-case noise impacts at the commencement of high noise generating activities. Operator attended measurements shall be 15-minute A frequency weighted measurements and record octave band levels for L_{Aeq}, L_{A10}, L_{A90}, L_{Amax} and L_{Amin}. Reports shall be provided stating the measurement methodology and results.

Table 23: *Recommended noise and vibration monitoring program*

Monitoring condition		**Frequency**	**Monitoring Location**
Noise monitoring	During high noise construction activities	Monthly	Nearest affected receiver
	Where a compliant has been received and monitoring is considered an appropriate response to determine whether noise levels are consistently exceeding predicted noise level by more than 3dB	As required	At address of complainant
Vibration monitoring	Vibration generating works undertaken at distances less than the buffer distances presented in Table 20	As required	At address of complainant or potentially affected buildings
	Where a compliant has been received and monitoring is considered an appropriate response to determine whether levels are consistently exceeding vibration criteria	As required	At address of complainant

5. Conclusion

The report is as per SEARs requirements dated 27 Nov 2019, and the application number is SSD-10382. The SEARs requirements for the acoustics are presented partly in Assessment of Key Issues and partly in section 12 of the document. The key issues ie the baseline data include consideration of the acoustic separation, and acoustic amenity of the occupants and the environment.

Part 12 of the SEARS is specifically on Noise and Vibration and states that the EIS shall include a noise and vibration assessment prepared in accordance with the relevant EPA guidelines. The assessment shall:

- *Detail construction and operational noise impacts on nearby noise sensitive receivers and outline proposed noise mitigation and monitoring procedures (for details see Section 3 and 4)*
- *Demonstrate compliance with the noise standards including the Noise Policy for Industry (NSW EPA 2017) (See Section 3)*
- *Include a Demolition, Construction Noise & Vibration Management Plan (see Section 4)*
- *Address the acoustic privacy between the residential rooms and the communal areas which share floors (see Section 3.5 & 3.6)*
- *Provide details for noise and vibration related to the Metro line (see Section 3.9)*

A noise survey was conducted on site to measure the ambient and traffic noise. Based on the acoustic requirements of Department of Planning, City of Sydney Council and relevant Australian standards and guidelines, the noise criteria were established. Considering the traffic noise levels of Regent Street, the façade elements were considered, and a window schedule has been prepared (see Table 9). In addition, a Construction Noise & Vibration Management Plan is submitted in the report (Section 4).

The assessment provides recommendations for compliance with the set criteria as follows:

For operational noise impacts:

- To attenuate ingress of traffic and ambient noise, a glazing schedule has been recommended.
- For the Communal areas, acoustically rated walls and floors were recommended. An operational noise management plan is recommended to be implemented for management of student activity noise. The hours of use for outdoor areas should be limited to the following:
    - 8 am to 10 pm Sunday to Thursday
    - 8 am to 12 midnight on Friday, Saturdays and any day immediately before a public holiday
- Further advice to be sought for isolation of the building against future train vibration and ground-borne noise.

For the CNVMP:

- All “feasible and reasonable work practices” should be implemented to reduce the construction noise
- Suitable hoardings to be erected around the site
- Noise and vibration generating equipment to be replaced by quieter and less severe operations
- A system for community liaison including complaint handling to be put in place
- For the neighbouring building over the south boundary, a dilapidation report to be prepared before the start of work

- Prior to the start of construction works, attended vibration measurements to be conducted at the tunnel to measure construction vibration levels. The results will indicate if the vibration levels are close to the criteria and if vibration monitoring is required.

At this stage the noise data from the mechanical services and the tenancies is not available therefore a noise impact assessment is not possible. At the CC stage when the equipment is finalised and nature and work of tenancies is known, a detailed assessment of the mechanical and operational noise should be conducted. In addition, at the CC stage acoustic details of the partitions and floors should be detailed. The followings are generally considered at the CC stage:

- All internal walls/partitions which need acoustic raring to be designed/specified.
- All floors which need acoustic and impact treatment to be designed/ specified.
- An assessment to be conducted to assess and control mechanical and operational noise in accordance with the EPA and other regulatory requirements.

Providing our recommendations are implemented, the development with comply with the acoustic requirements of NSW Dept. of Planning, Council requirements and relevant Australian standards and guidelines.

Appendix A: Architectural drawings

The following drawings produced by AJ+C Architects were provided and were used in the assessment:

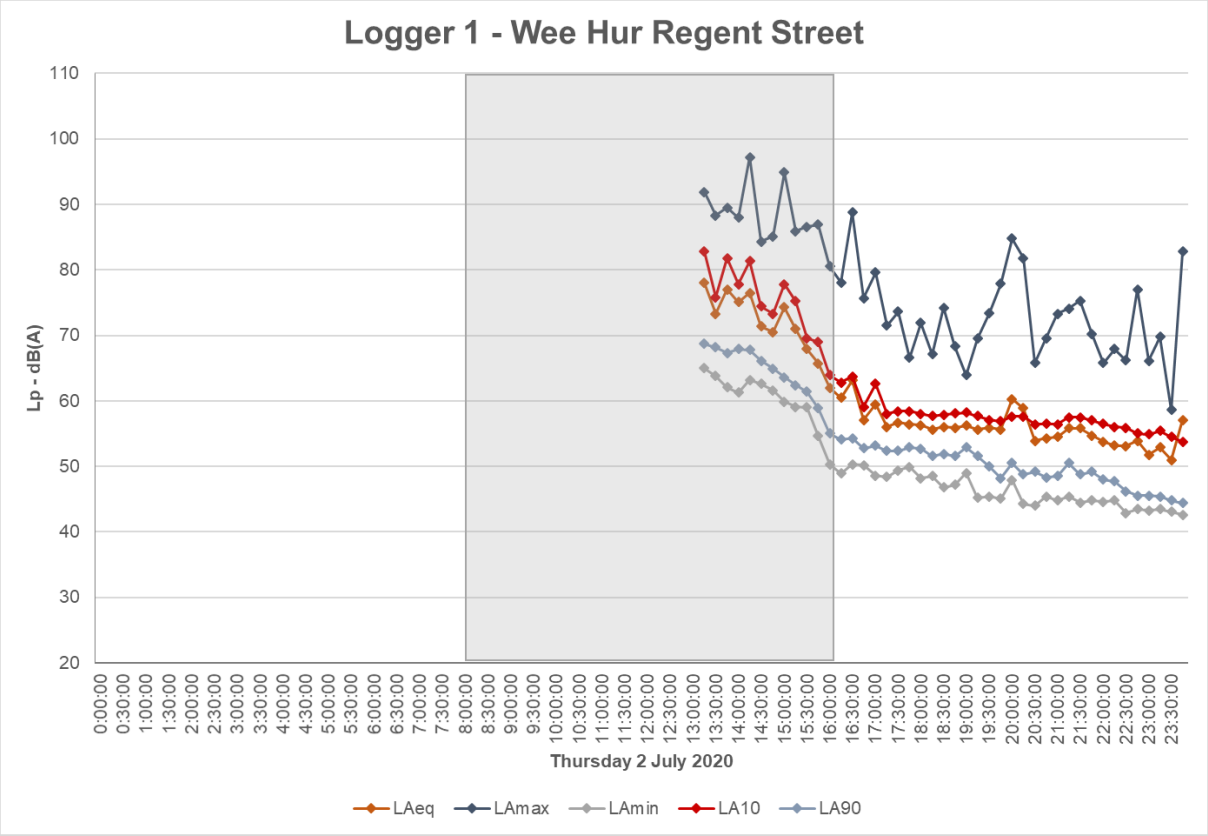
Drawing number	Issue	Drawing Title
DA1001	2	Site plan
DA1002	2	Site analysis
DA1007	2	Site coverage plan
DA2000	2	Basement & lower ground floor plan
DA2001	2	Ground & level 2 floor plan
DA2002	2	Level 3 & lower typical floor plan
DA2003	2	Level 9 & 15 communal floor plans
DA2004	2	Upper typical floor plan
DA2005	2	Plant & roof plan
DA3001	2	East elevation
DA3002	2	North elevation
DA3003	2	West elevation
DA3004	2	South elevation
DA3101	2	Section A
DA3102	2	Section B
DA3103	2	Section C
DA3104	2	Section D
DA3105	2	Section E

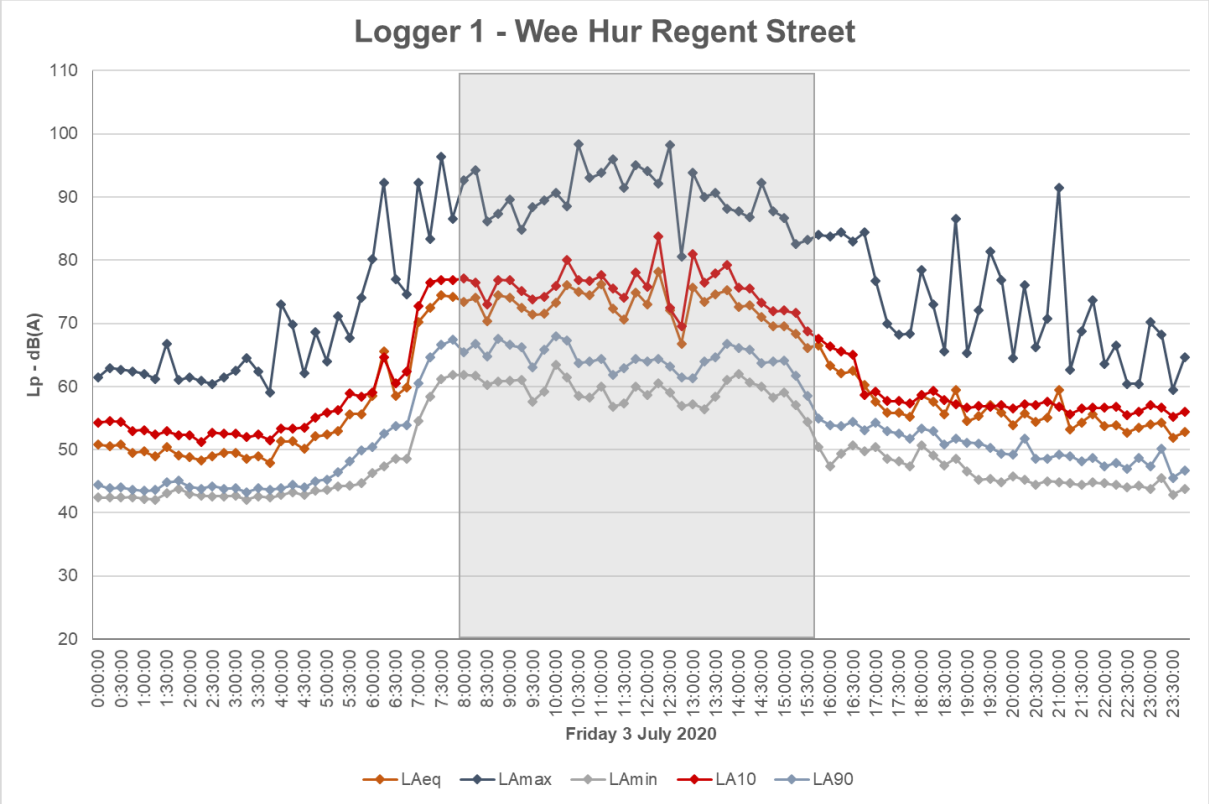
Appendix B: Glossary of Acoustic Terms

- Decibel – dB – Unit of Acoustic measurements for power, pressure and intensity. Expressed in dB relative to standard levels.
- A-weighted decibel – dBA – Unit of acoustic measurement weighted approximately to human hearing to sound.
- SPL – Sound Pressure Level – 20 times the logarithm to the base 10 of the ratio of r.m.s. sound pressure to the reference pressure of 20 micro Pascals, sound pressure level is measured using a microphone and a sound level meter and varies with distance from the source.
- SWL – Sound Power Level – 10 times the logarithm to base 10 of the ratio of the sound power of the source to the reference sound power of 1 Pico Watt. Sound power level cannot be directly measured using a microphone and a sound level meter, and it does not change with distance. The sound power of a machine will vary depending on the operation conditions or load.
- R_w – Weighted Sound Reduction Index – Measured sound reduction of a building element in a laboratory, corrected for room volume and reverberation time, the higher values correspond to better sound insulation.
- L_{Amax} – The Maximum Noise Level over a sample period is the maximum level, measured on fast response, during the sample period.
- L_{A10} – The noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The LA10 is a common noise descriptor for environmental noise and road traffic noise.
- L_{Aeq} – The equivalent continuous sound level is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.
- L_{A90} – The noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level or RBL.
- L_{Amin} – The Minimum Noise Level over a sample period is the minimum level, measured on fast response, during the sample period.

Appendix C: Noise data

The noise measurement data is presented below in the graphical form. Sections in grey have been removed from the assessment due to construction noise, sections in blue have been removed due to rainfall.

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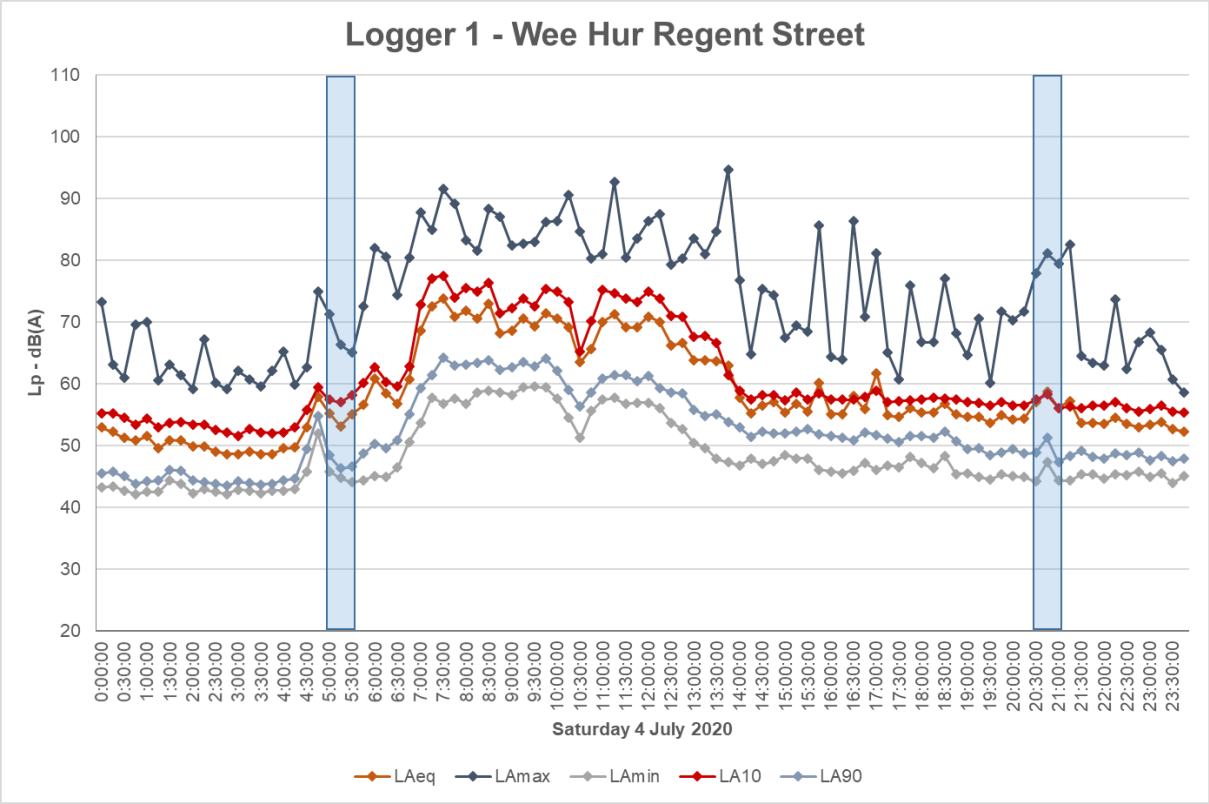
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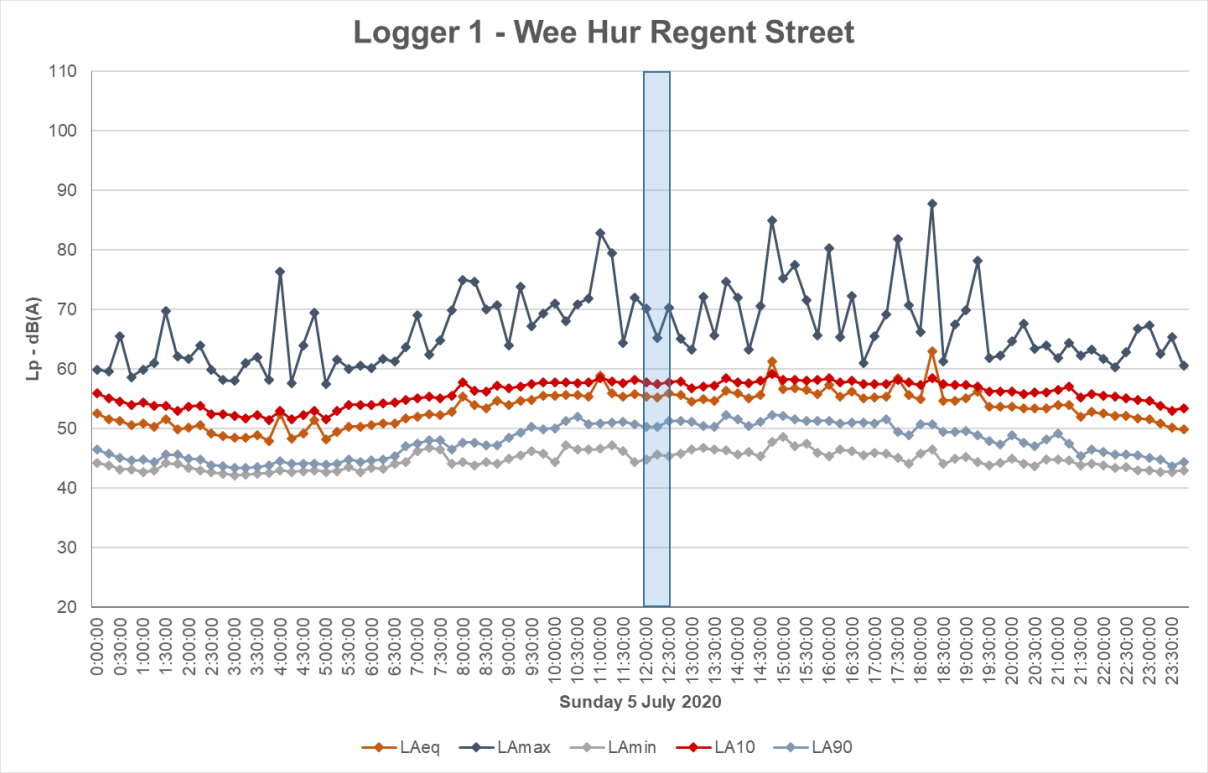
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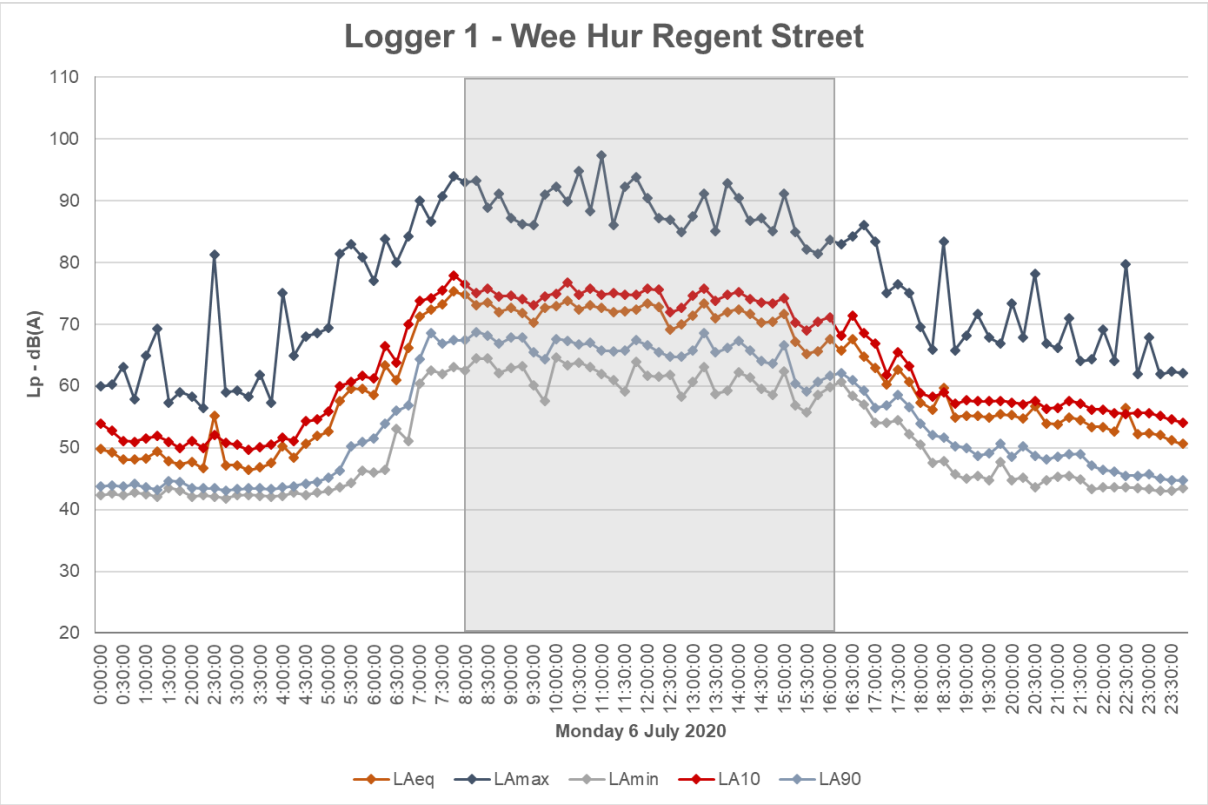
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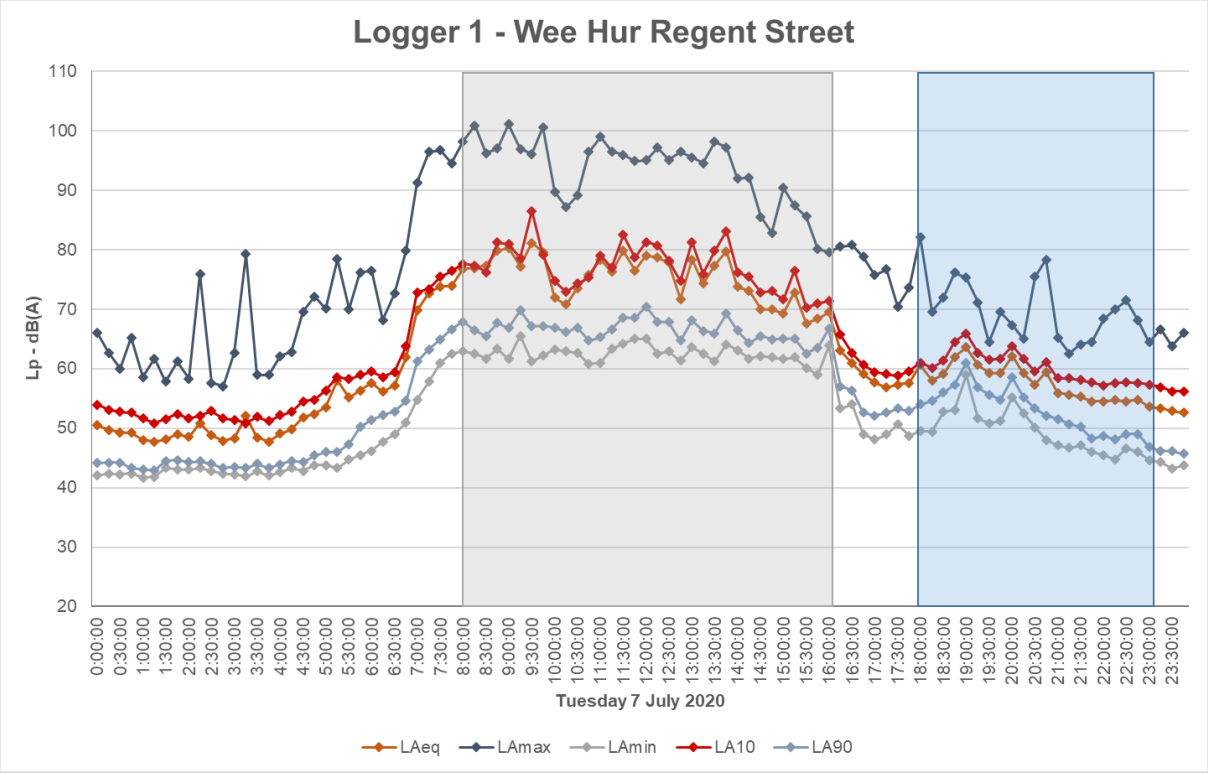
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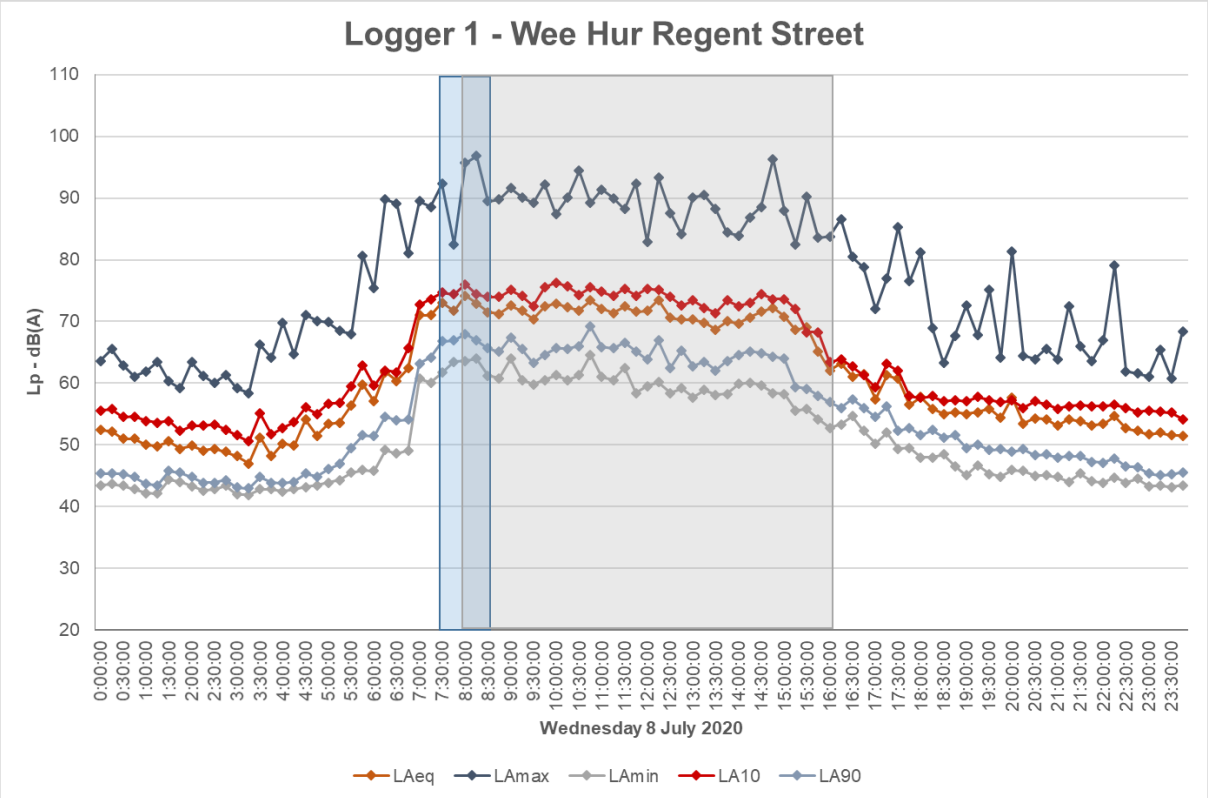
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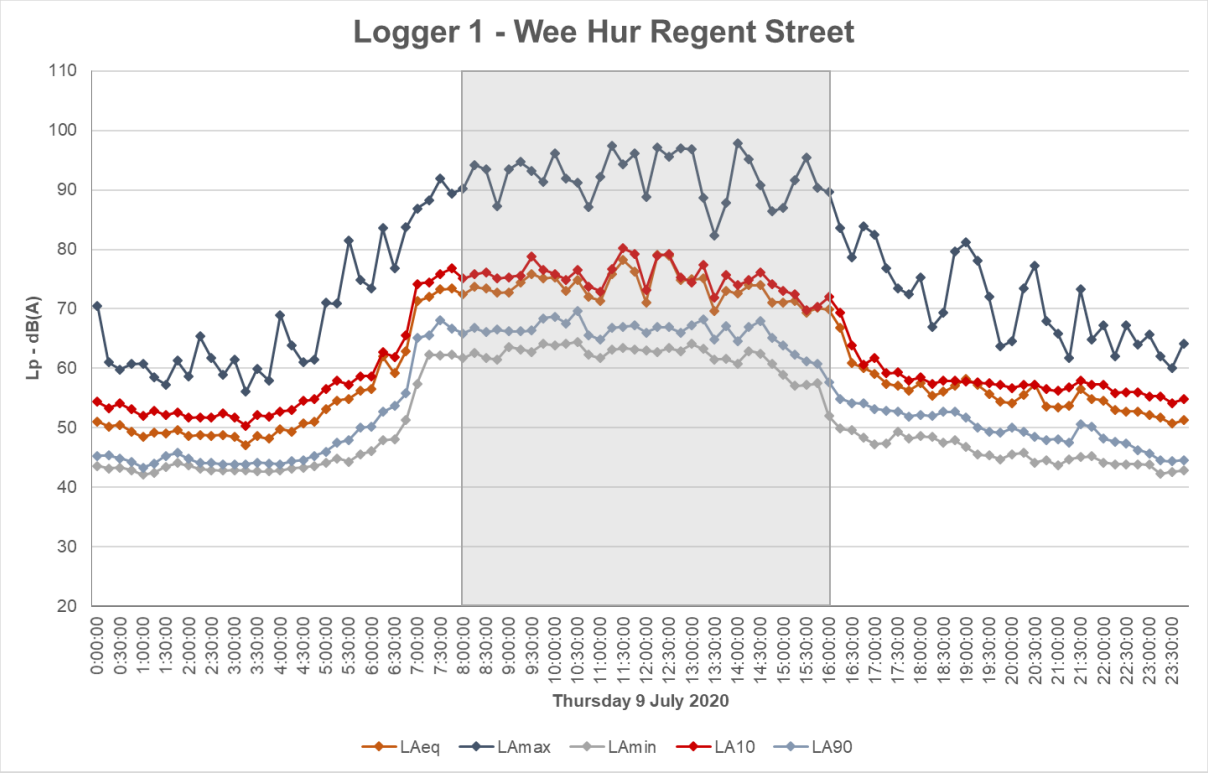
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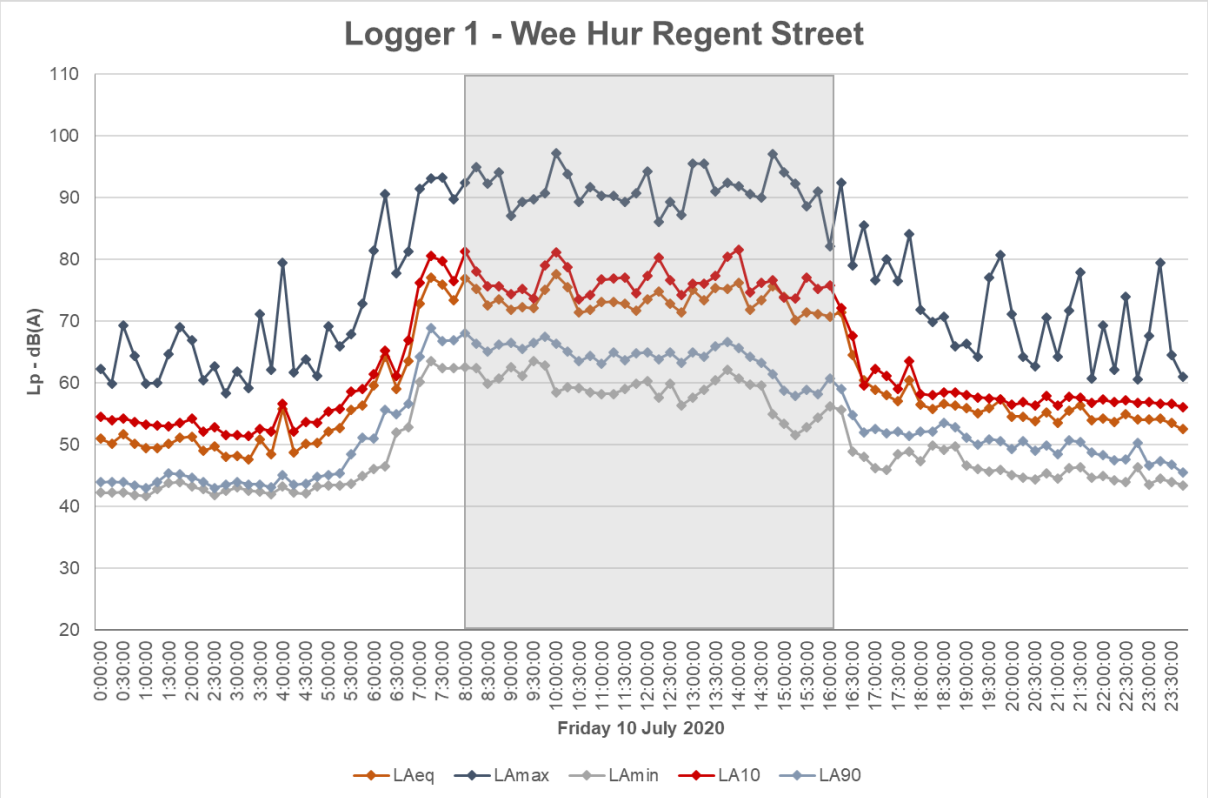
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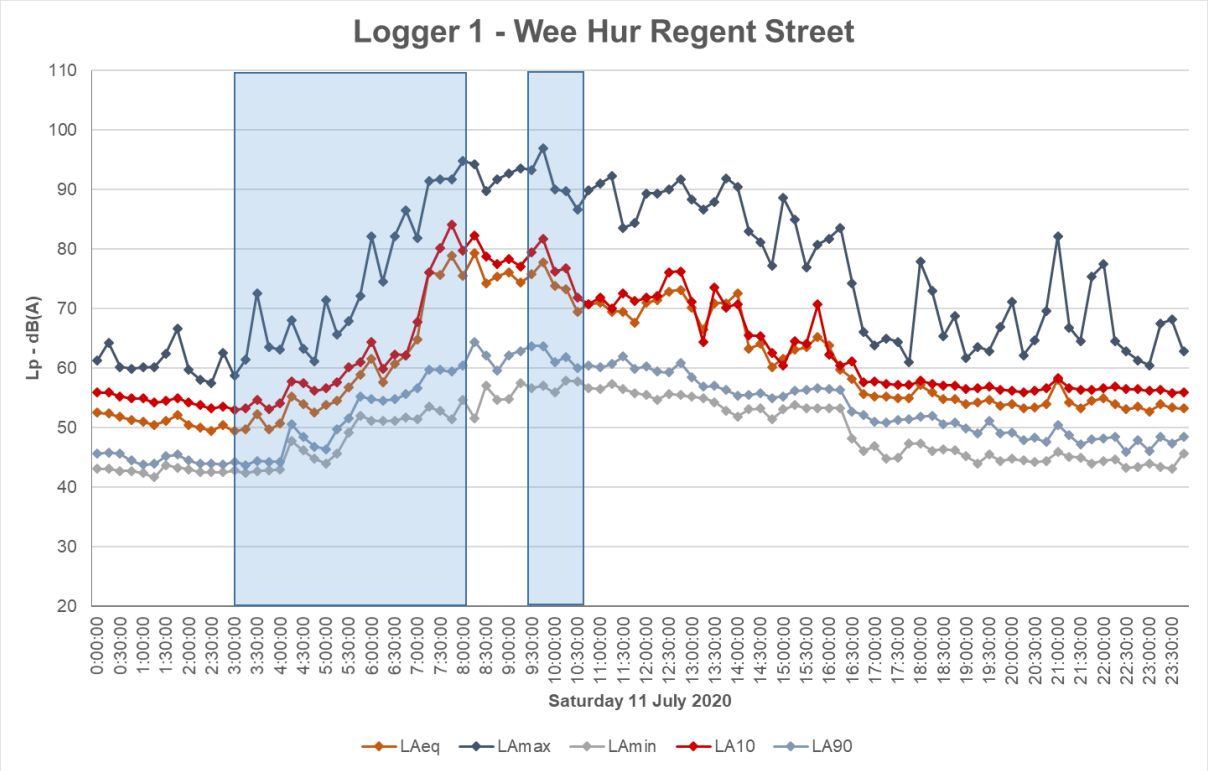
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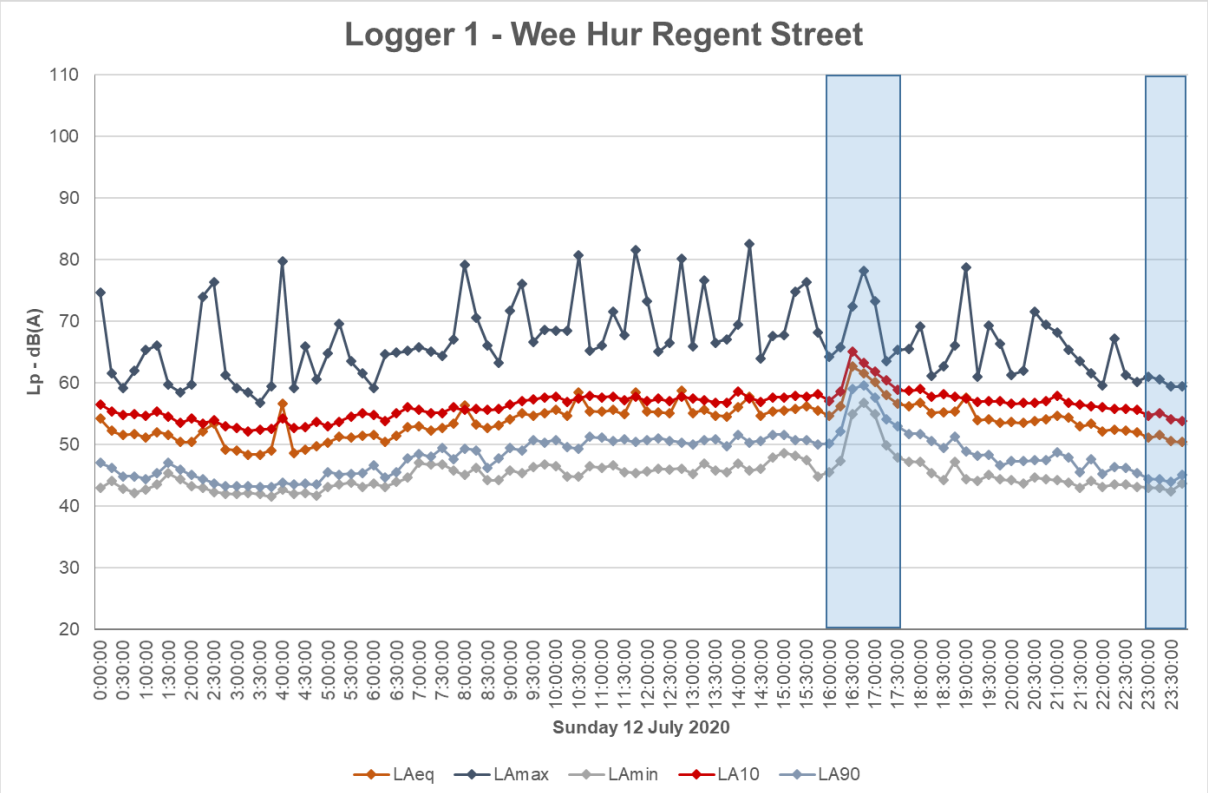
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Sunday 12 July 2020
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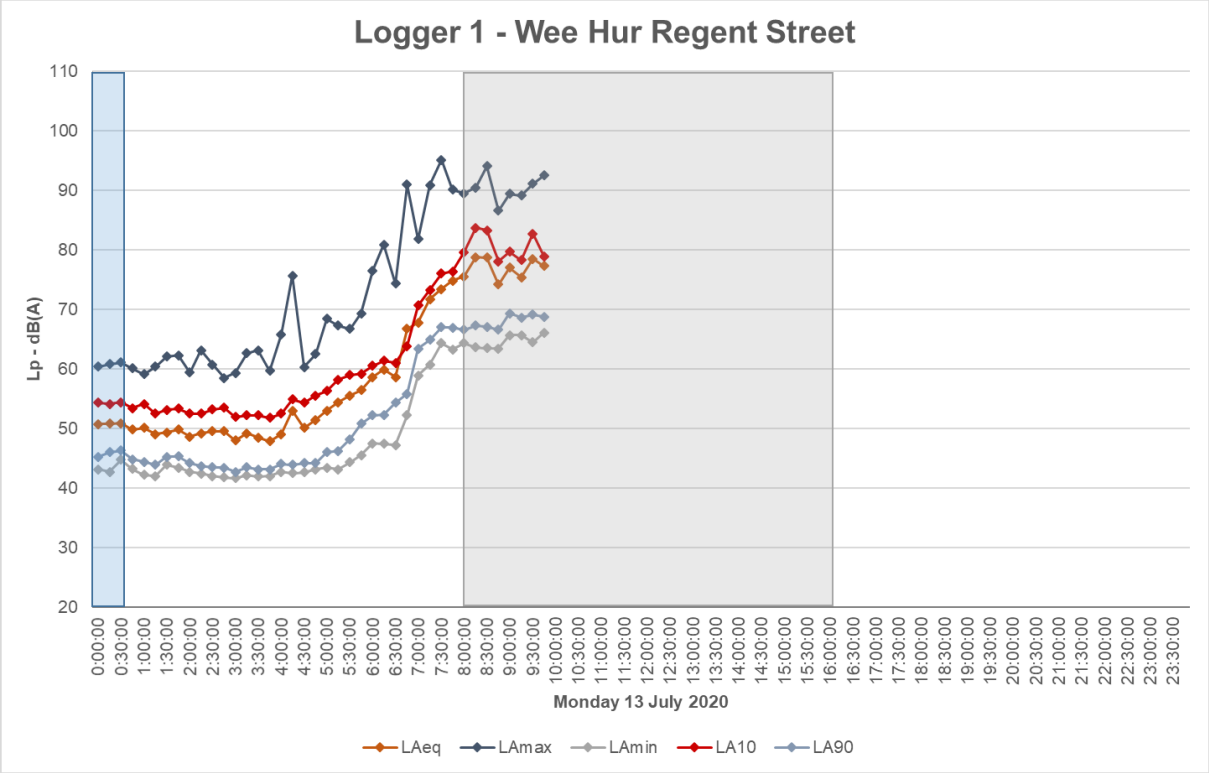
Logger 1 - Wee Hur Regent Street
Lp - dB(A)
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Monday 13 July 2020
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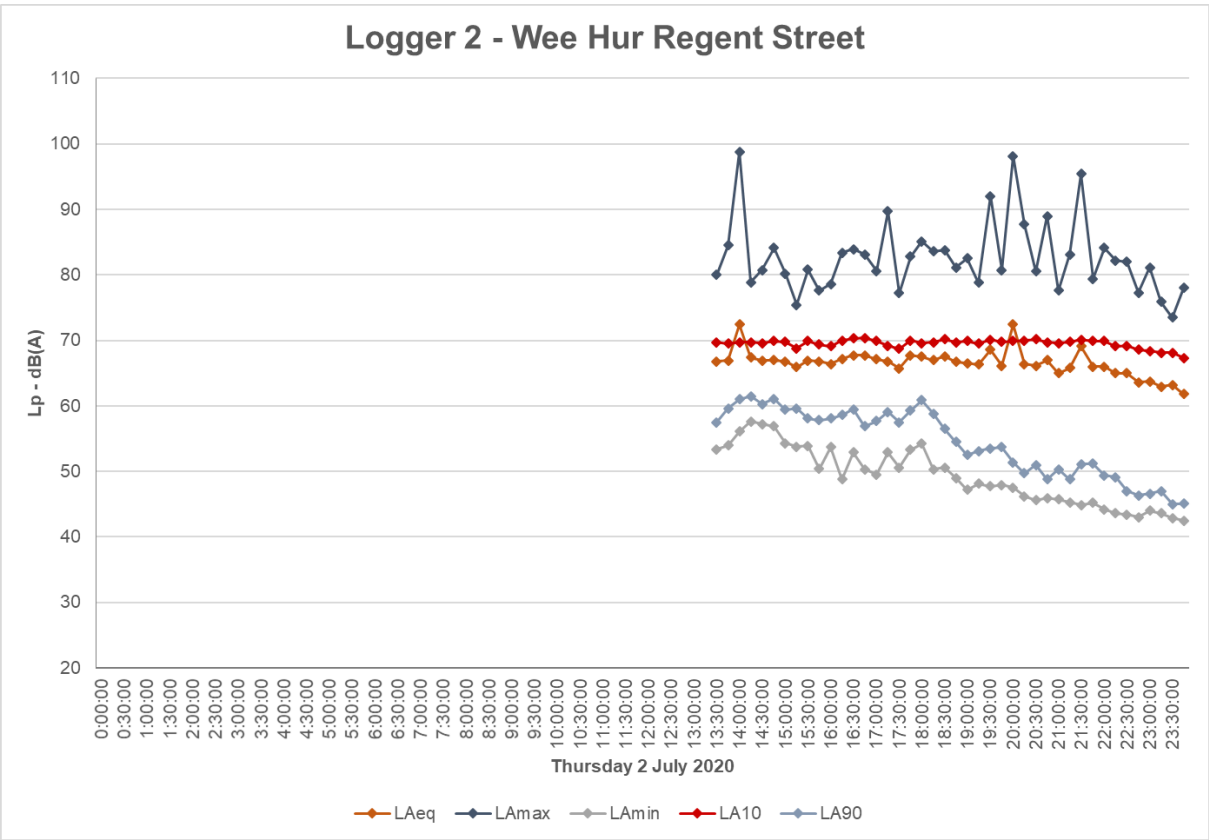
Logger 2 - Wee Hur Regent Street
Lp - dB(A)
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Thursday 2 July 2020
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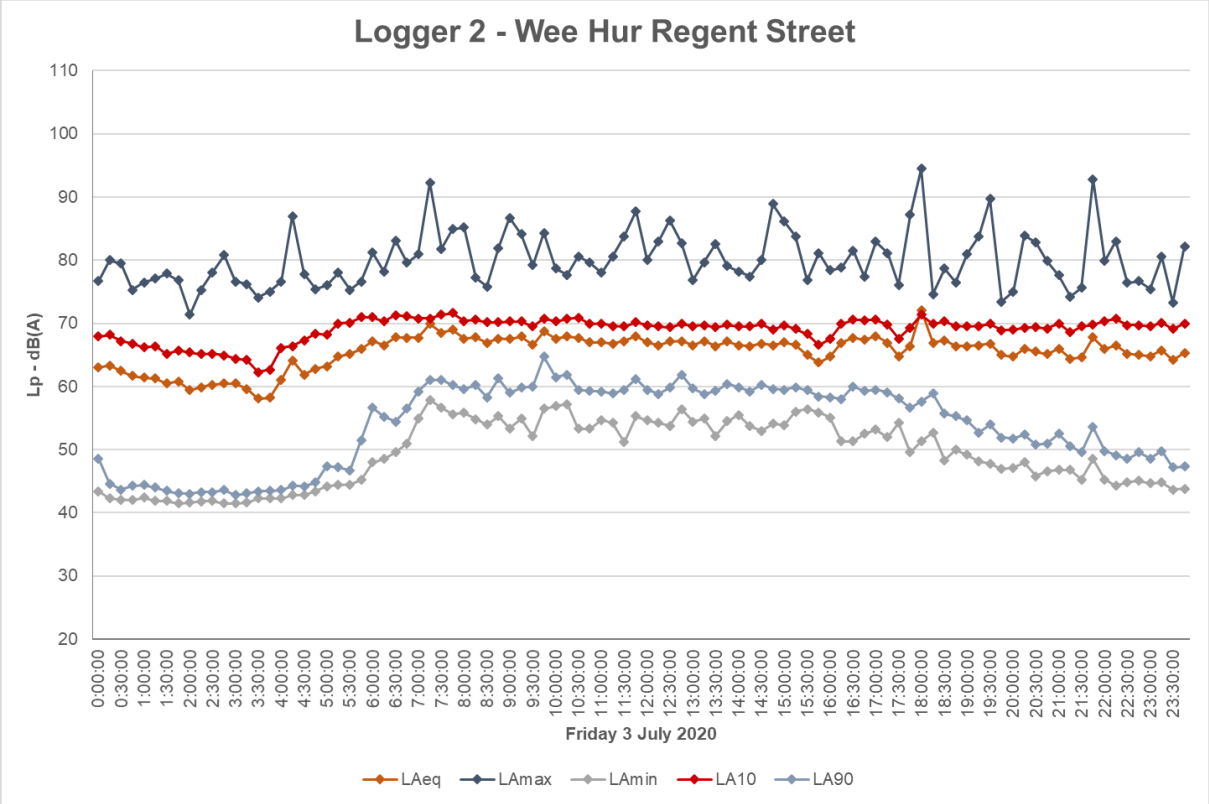
Logger 2 - Wee Hur Regent Street
Lp - dB(A)
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Friday 3 July 2020
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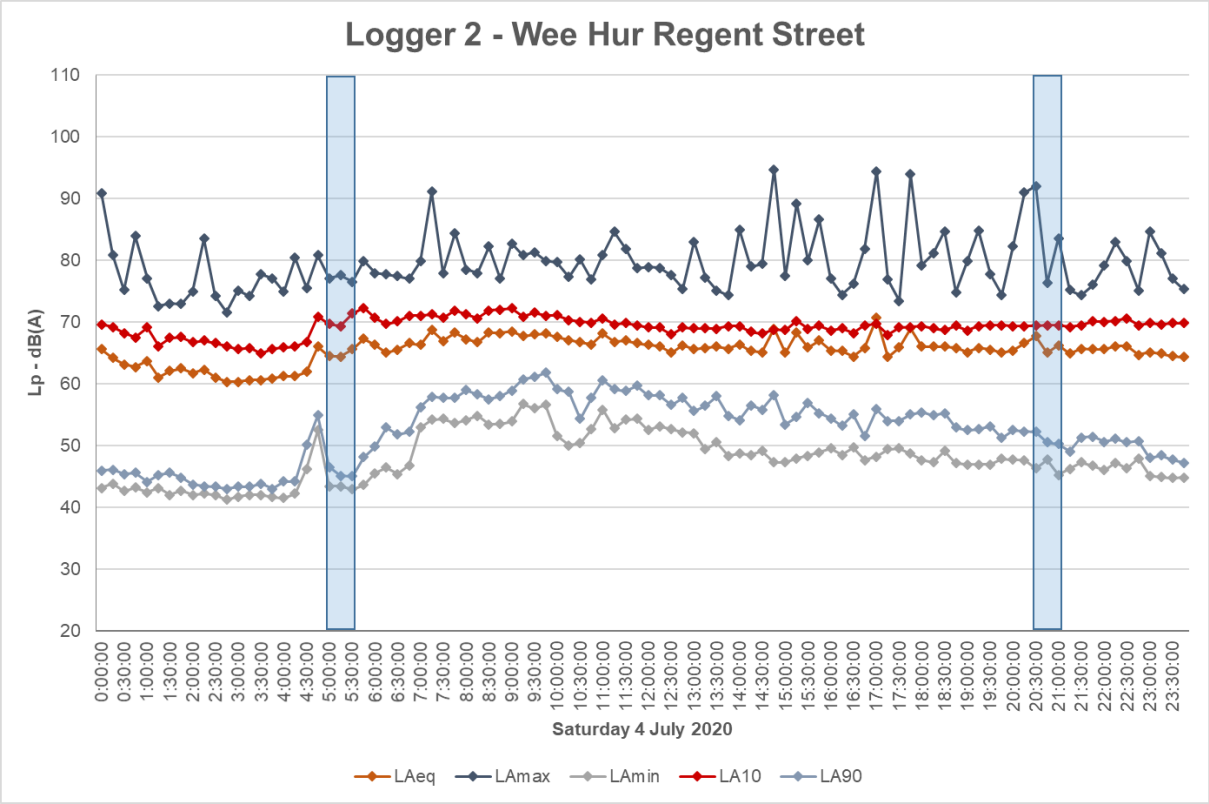
Logger 2 - Wee Hur Regent Street
Lp - dB(A)
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Saturday 4 July 2020
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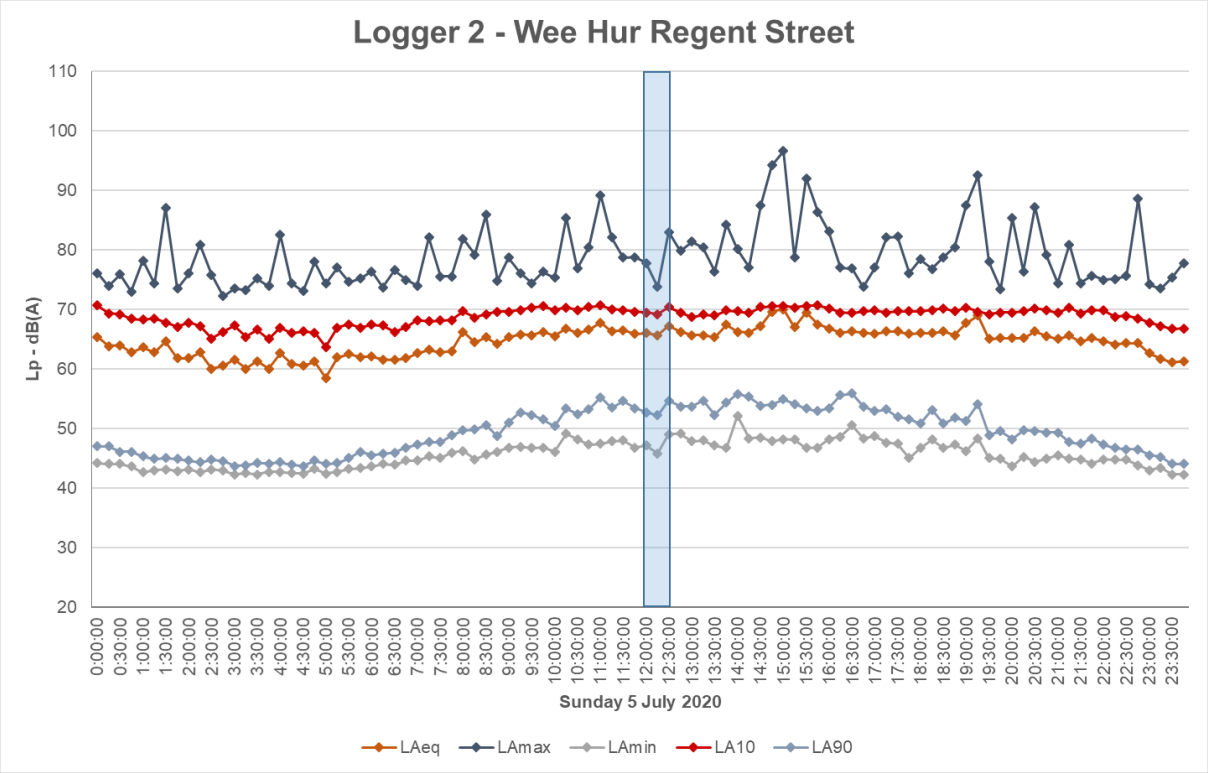
Logger 2 - Wee Hur Regent Street
Lp - dB(A)
Sunday 5 July 2020
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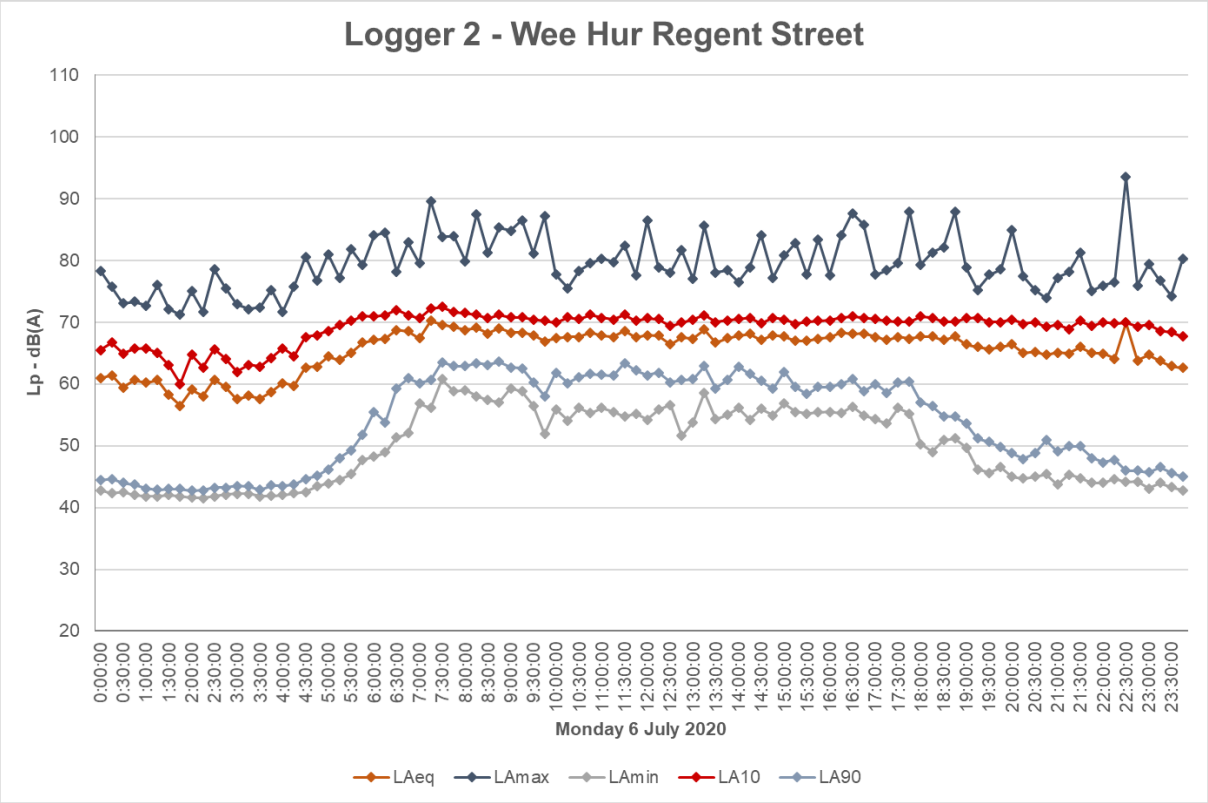
Logger 2 - Wee Hur Regent Street
Lp - dB(A)
Monday 6 July 2020
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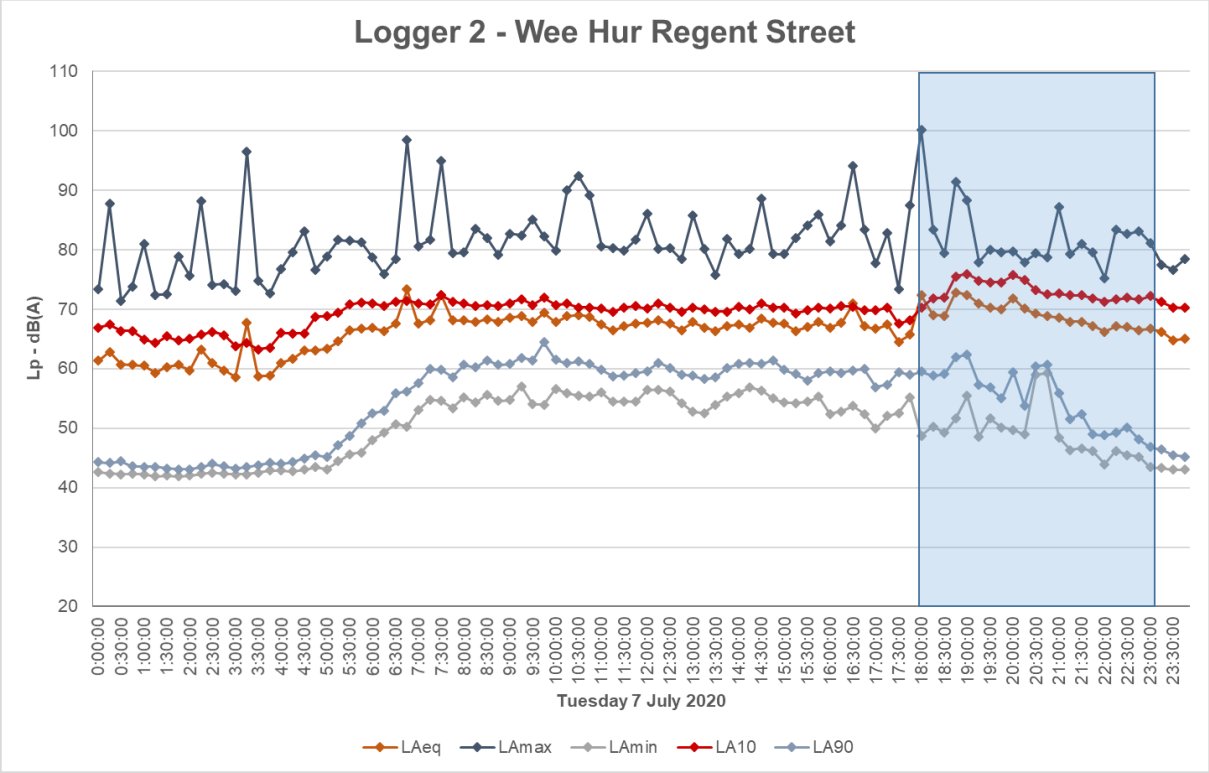
Logger 2 - Wee Hur Regent Street
Lp - dB(A)
Tuesday 7 July 2020
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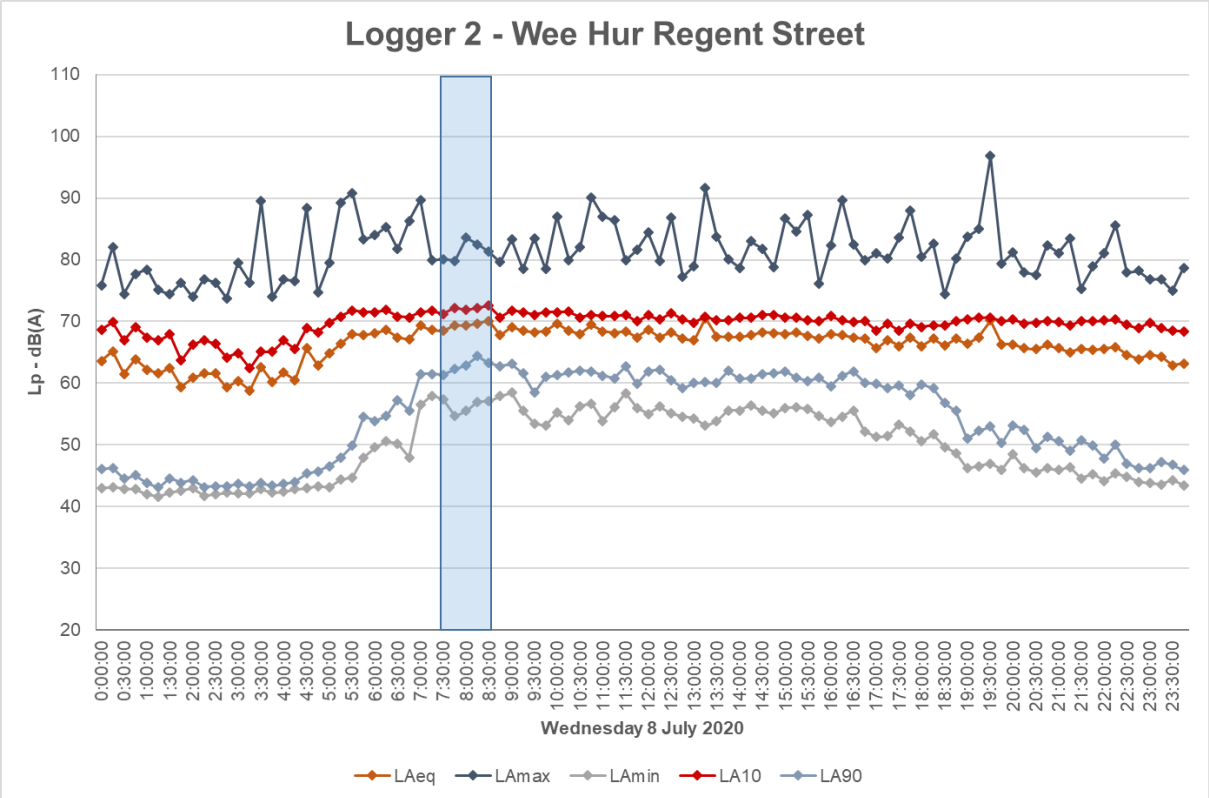
Logger 2 - Wee Hur Regent Street
Lp - dB(A)
Wednesday 8 July 2020
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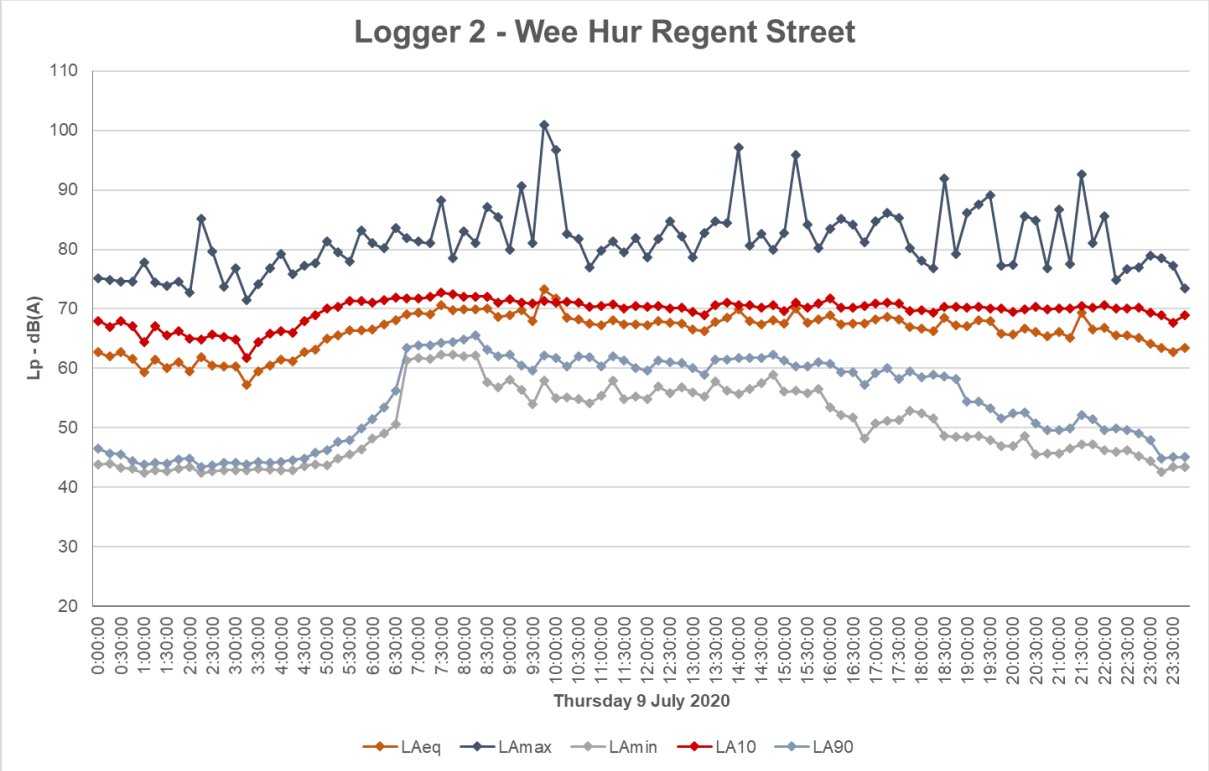
Logger 2 - Wee Hur Regent Street
Lp - dB(A)
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Thursday 9 July 2020
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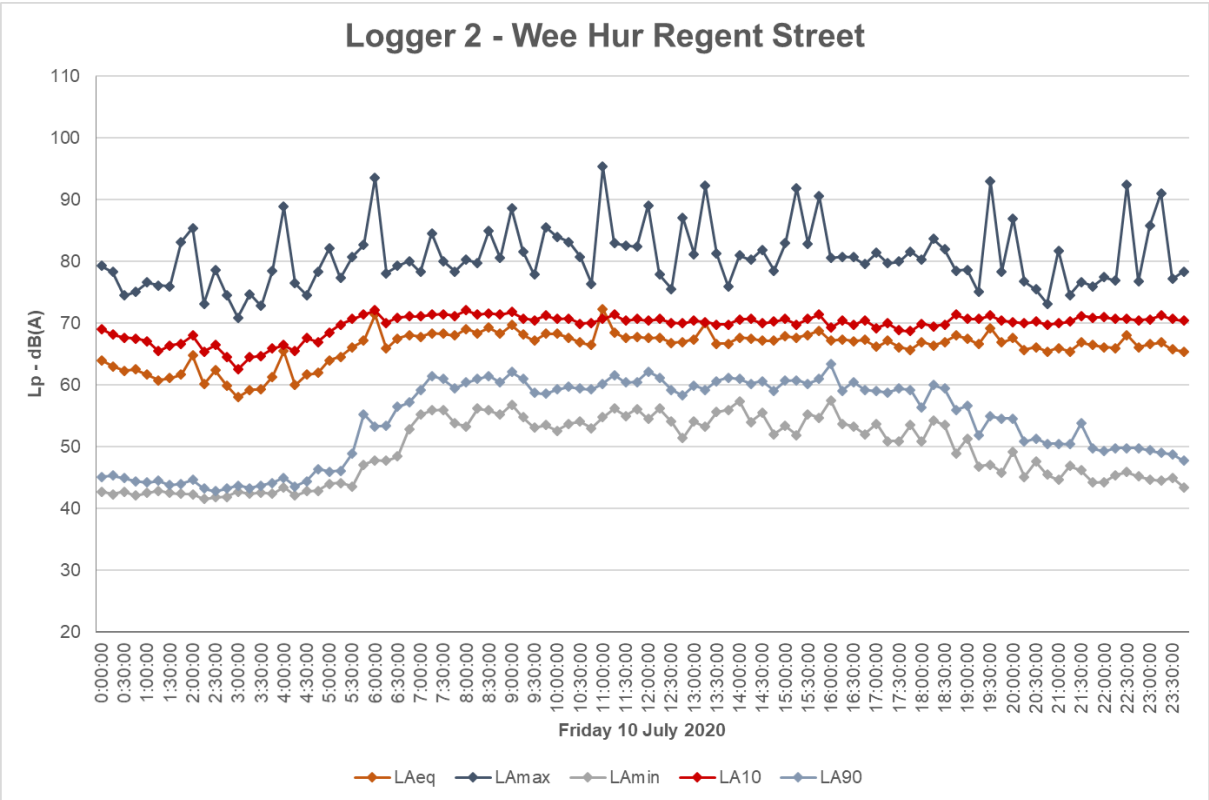
Logger 2 - Wee Hur Regent Street
Lp - dB(A)
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Friday 10 July 2020
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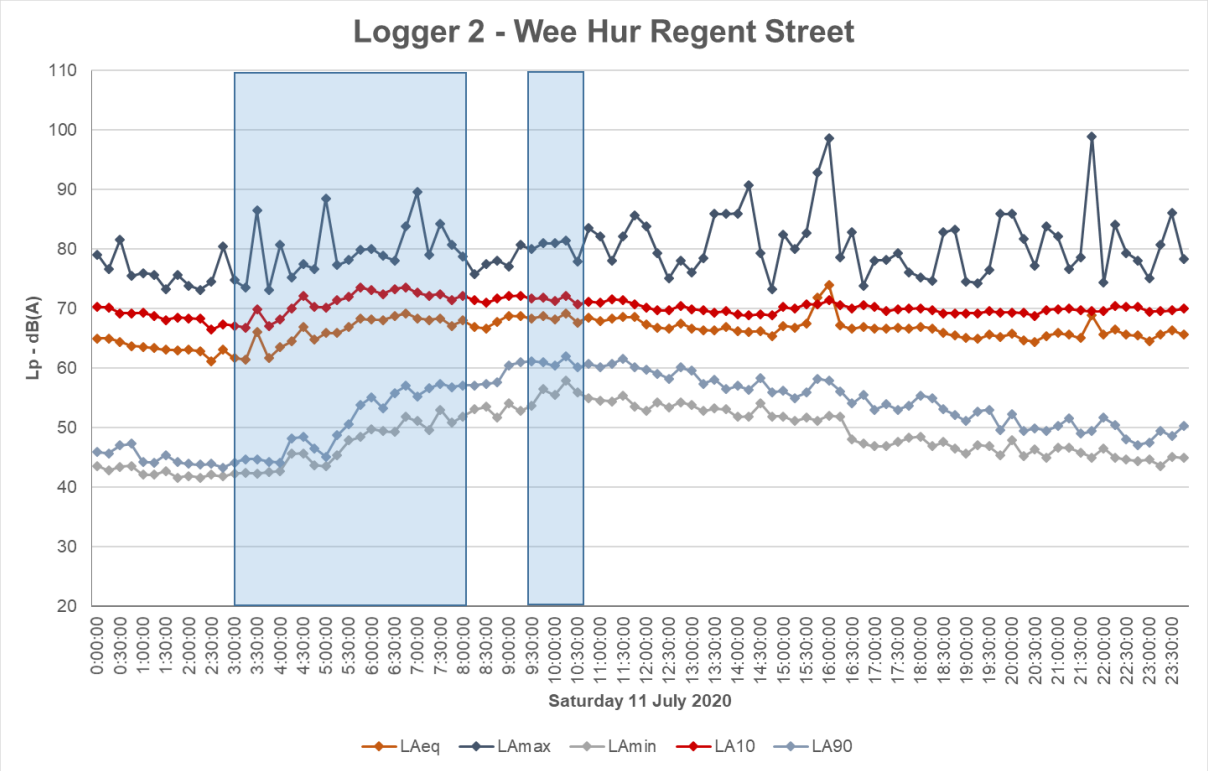
Logger 2 - Wee Hur Regent Street
Lp - dB(A)
Saturday 11 July 2020
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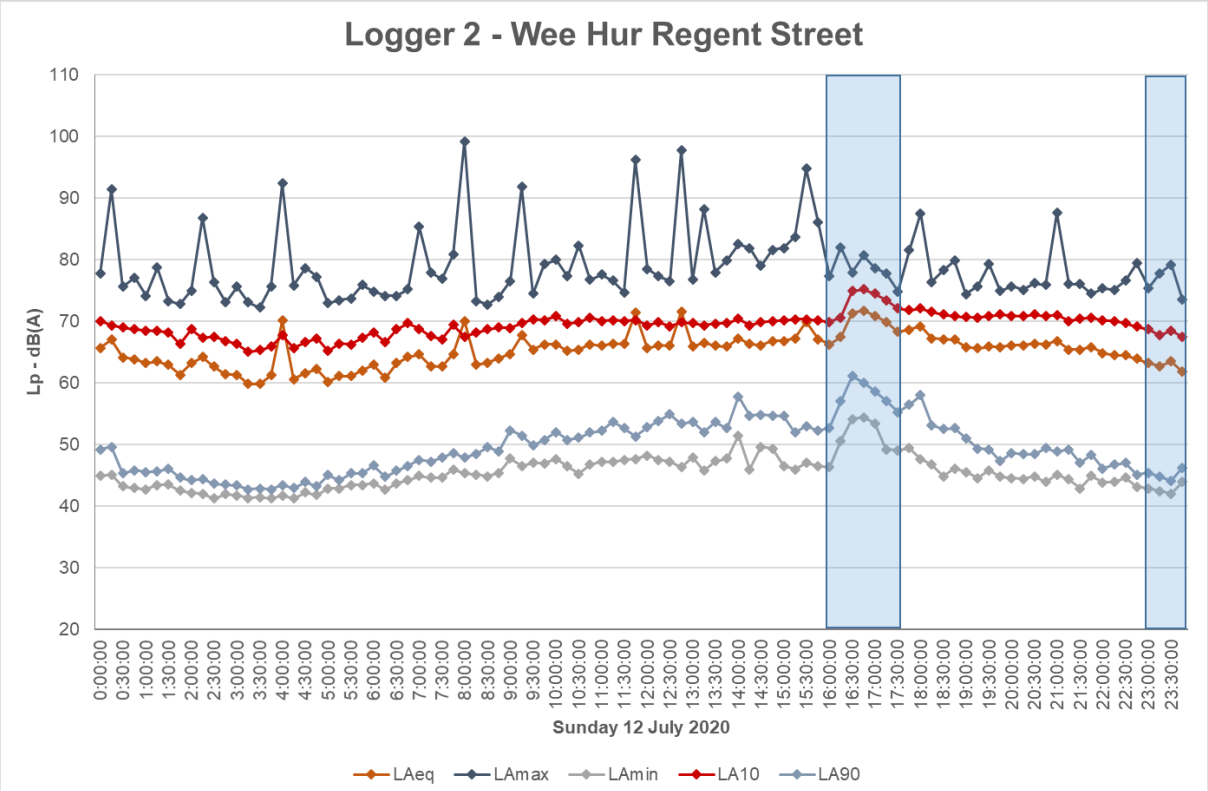
Logger 2 - Wee Hur Regent Street
Lp - dB(A)
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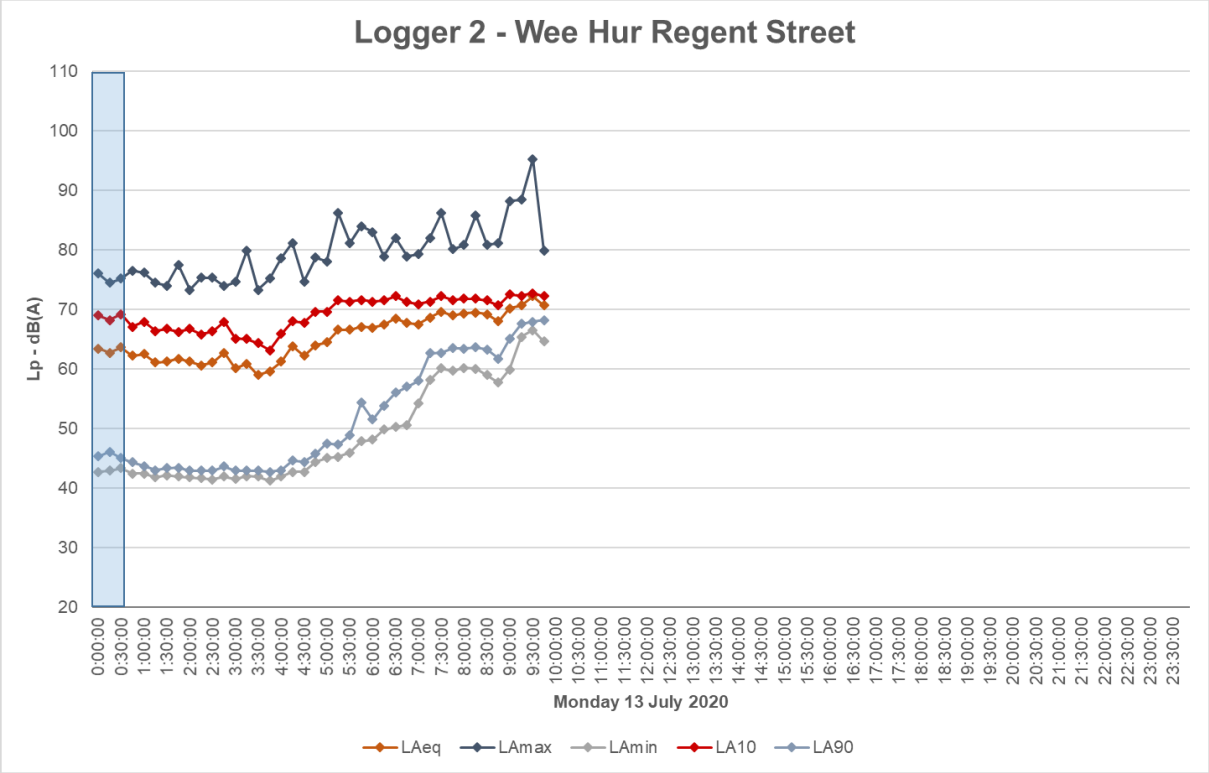
Logger 2 - Wee Hur Regent Street
Lp - dB(A)
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Monday 13 July 2020
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