Macquarie University

Central Courtyard Redevelopment

SSD 8755 Acoustic Report for Modification Application

SSDA

Issue 2 | 16 April 2020

Job number 270734-00

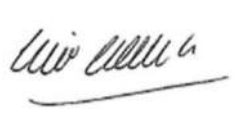
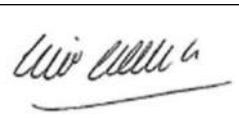
Arup
Arup Pty Ltd ABN 18 000 966 165

Arup
Level 10 201 Kent Street
PO Box 76 Millers Point
Sydney 2000
Australia
www.arup.com

ARUP

Document Verification

ARUP

Job title		Central Courtyard Redevelopment			**Job number** 270734-00
Document title		SSD 8755 Acoustic Report for Modification Application			**File reference**
Document ref		SSDA			
Revision	**Date**	**Filename**	270734-ACv1_Unibar Acoustics_SSD modification.docx		
Issue 1	25 Mar 2020	**Description**	First draft		
			Prepared by	Checked by	Approved by
		Name	Camilo Chalela	Glenn Wheatley	Glenn Wheatley
		Signature			
Issue 2	16 Apr 2020	**Filename**	270734-AC01v2_Unibar Acoustics_SSD modification.docx		
		Description	Final issue		
			Prepared by	Checked by	Approved by
		Name	Camilo Chalela	Glenn Wheatley	Glenn Wheatley
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
				Issue Document Verification with Document	✓

Contents

Appendices

1 Introduction

This report supports a request to modify the development consent for the Macquarie University Central Courtyard Precinct (MUCCP) redevelopment, SSD 8755. Specifically, Macquarie University (MU), the applicant, is seeking to modify development consent condition E2 which relates to the operational hours of the U-bar which will be located in the ground level of the new Student Hub to be constructed in place of the existing Building C10A.

This report provides an assessment of noise impacts generated U-bar activities during the proposed extended hours of operation onto the future student accommodation buildings (Buildings R1 and R2), located about 25 m to the west of the U-bar, as well as external residential development to the North West of the site along Culloden Road, Marsfield at about 450 m from the U-bar. Figure 1 and Figure 2 below show the location of the bar U-bar in relation to Buildings R1 and R2 and residences along Culloden Road.

Figure 1: U-bar location

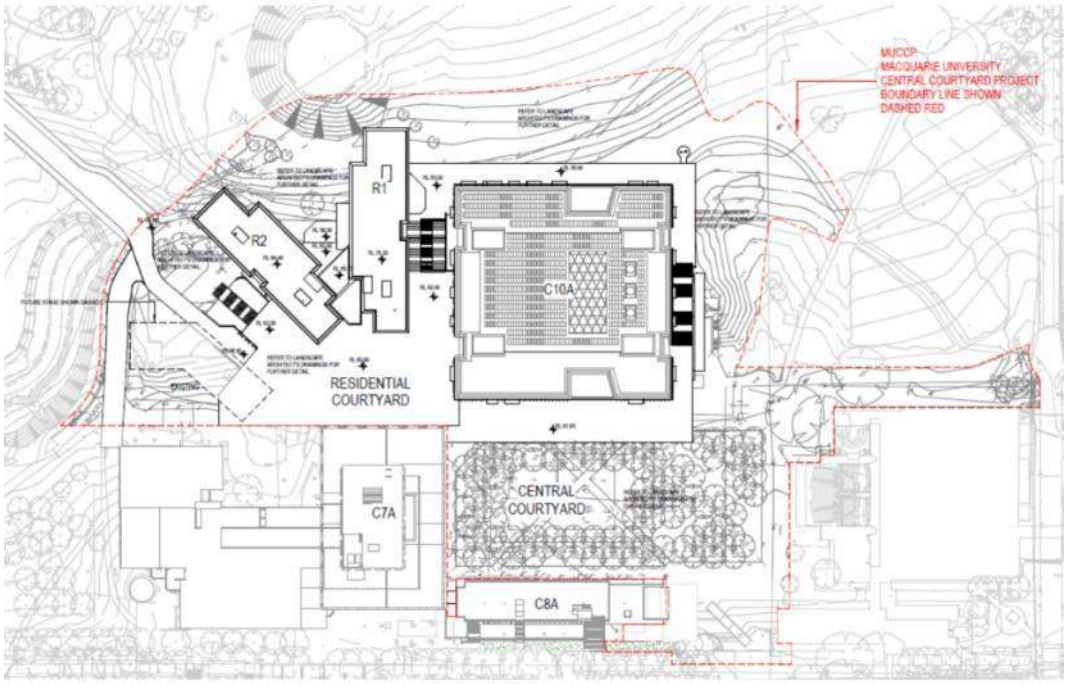


Figure 2: Extent of MUCCP

This report should be read in conjunction with *Macquarie University Central Courtyard Precinct (MUCCP) Redevelopment – State Significant Development Application 8755 Acoustic Report,* prepared by Arup and dated 6 November 2017 (SSDA Acoustic Report).

1.1 Development consent conditions

The following development consent conditions for SSD 8755 are relevant to operational noise:

> *E2. The Applicant must ensure that the hours of use of the student bar (u-bar) are limited between 12pm and 8pm Monday to Friday*
>
> *E3. Windows and doors to the student bar (u-bar) must be closed whilst operational in the evening.*
>
> *E4. The Applicant must ensure that noise generated by operation of the development does not exceed the noise limits in Macquarie University Central Courtyard Precinct (MUCCP) Redevelopment – State Significant Development Application Acoustic Report prepared by Arup and dated 6 November 2017.*
>
> *E5. The Applicant must undertake short term noise monitoring in accordance with the Noise Policy for Industry where valid data is collected following the commencement of use of each stage of the development. The monitoring program must be carried out by an appropriately qualified person and a monitoring report must be submitted to the Planning Secretary within two months of commencement use of each stage of the development to verify that operational noise levels do not exceed the recommended noise levels for mechanical plant identified in Macquarie University Central*

Courtyard Precinct (MUCCP) Redevelopment – State Significant Development Application Acoustic Report prepared by Arup and dated 6 November 2017. Should the noise monitoring program identify any exceedance of the recommended noise levels referred to above, the Applicant is required to implement appropriate noise attenuation measures so that operational noise levels do not exceed the recommended noise levels or provide attenuation measures at the affected noise sensitive receivers.

1.2 Proposed modification

MU is seeking to modify condition **E2** to reflect the following operational hours for the U-bar:

- **8am to 2am Monday to Saturday**
- **8am to 8pm Sunday**

2 U-bar activity noise assessment

The U-bar is centrally located within the University precinct and significantly removed from surrounding noise sensitive land uses. The nearest external sensitive receivers are the residential developments North West of the site along Culloden Road, Marsfield, approximately 450 m from the proposed site.

As a result, objectives for the control of operational noise will likely be governed by potential impacts upon the buildings within the University precinct, in the immediate vicinity of the proposed development. Of particular sensitivity, will be the proposed student accommodation Buildings R1 and R2.

2.1 Criteria

2.1.1 Student accommodation

The approach to managing noise impacts on receivers within the University grounds is considered to be at the discretion of the University. Notwithstanding, the SSDA Acoustic Report recommended targets, aimed at protecting the acoustic amenity of the MUCCP and neighbouring noise sensitive buildings.

The SSDA Acoustic Report established external noise targets for retail uses (i.e. U-bar activity) of 5 dB(A) above the building services noise criteria for the different noise receivers within the University grounds. The building services noise criteria were determined based on the NSW *Industrial Noise Policy* (INP) and acoustic surveys carried out within the proposed precinct. They are presented in Table 1.

Table 1: U-bar activity – external noise targets for Student Accommodation

Receiver Type	**Time Period[1]**	**External noise targets $dBL_{Aeq(15minute)}$**
Macquarie University – Student Accommodation	Day	55
	Evening	50
	Night	45

Notes:

1- Day (7am – 6pm Monday to Saturday; or 8am – 6pm Sundays and Public Holidays)

Evening (6pm – 10pm)

Night (remaining periods)

Further to the above, during detailed design, the university have provided both student accommodation buildings with mechanically ventilation (satisfying the requirements of the National Construction Code), and a façade design to provide noise mitigation while windows are closed. Internal noise targets for the spaces, based on AS 2107:2016, for spaces within these two buildings are proposed as follows:

Table 2: Internal noise target for Student Accommodation

Type of occupancy	Internal noise target $dBL_{Aeq(15minute)}$
Sleeping areas	30 to 35

2.1.2 Culloden Road residences

With regard to noise sensitive receivers outside the University grounds, the nearest most potentially affected receivers were identified as the residential developments along Culloden Road, North West of the MUCCP.

An additional acoustic survey has been carried out at a location representative of the acoustic environment of the residences along Culloden Road to determine appropriate noise criteria for these based on the INP. Table 3 below summarises the survey results and derivation of the criteria. Refer to Appendix B for detailed information of the acoustic survey.

Table 3: U-bar activity – external noise criteria for Culloden Road residences

Receiver Type	Time Period[1]	RBL	Intrusive Criteria $dBL_{Aeq(period)}$	Amenity Criteria $dBL_{Aeq(period)}$	Project Criteria $dBL_{Aeq(period)}$
Residential – Culloden Road	Day	47	52	55	52
	Evening	47	52	45	45
	Night	45	50	40	40

Notes
1- Day (7am – 6pm Monday to Saturday; or 8am – 6pm Sundays and Public Holidays)
Evening (6pm – 10pm)
Night (remaining periods)

It is noted that modifying factor corrections have been applied to the established noise criteria in Table 3.

2.2 U-Bar activity noise impact assessment

Internal sound levels generated by the operation of the ground floor U-bar will vary dependant on the student numbers, number of people talking and their behaviour, provision of music and its level. These factors will likely vary by time of day and potentially day of the week.

An assessment of the U-bar usage with respect to the noise targets has been conducted based on the following operational conditions:

- Internal sound pressure levels in U-bar:

  Table 4: Internal sound pressure levels in U-bar, $dBL_{eq(15min)}$

Description	Overall		Octave Band Centre Frequency, Hz, dB							
	dB(A)	dB(C)	63	125	250	500	1 k	2 k	4 k	8 k
U-bar internal sound pressure level (inc. patron and background music)	86	90	80	85	81	82	80	79	78	72

- U-bar operational scenarios:
  - One set of double doors open on west façade
  - All doors closed
- Ventilation strategy for Student Hub and Buildings R1 and R2:
  - Mechanical – façade fully sealable
- Façade acoustic performance:

  Based on façade shop drawings the following acoustic performance has been assumed:

  - Student Hub façade

    Fixed glazing: $R_w + C_{tr}$ 32

    Doors: R_w 30
  - Student accommodation buildings

    All glazing: $R_w + C_{tr}$ 30

Figure 3 below shows the location of the U-bar within the Student Hub and highlights the façade elements.

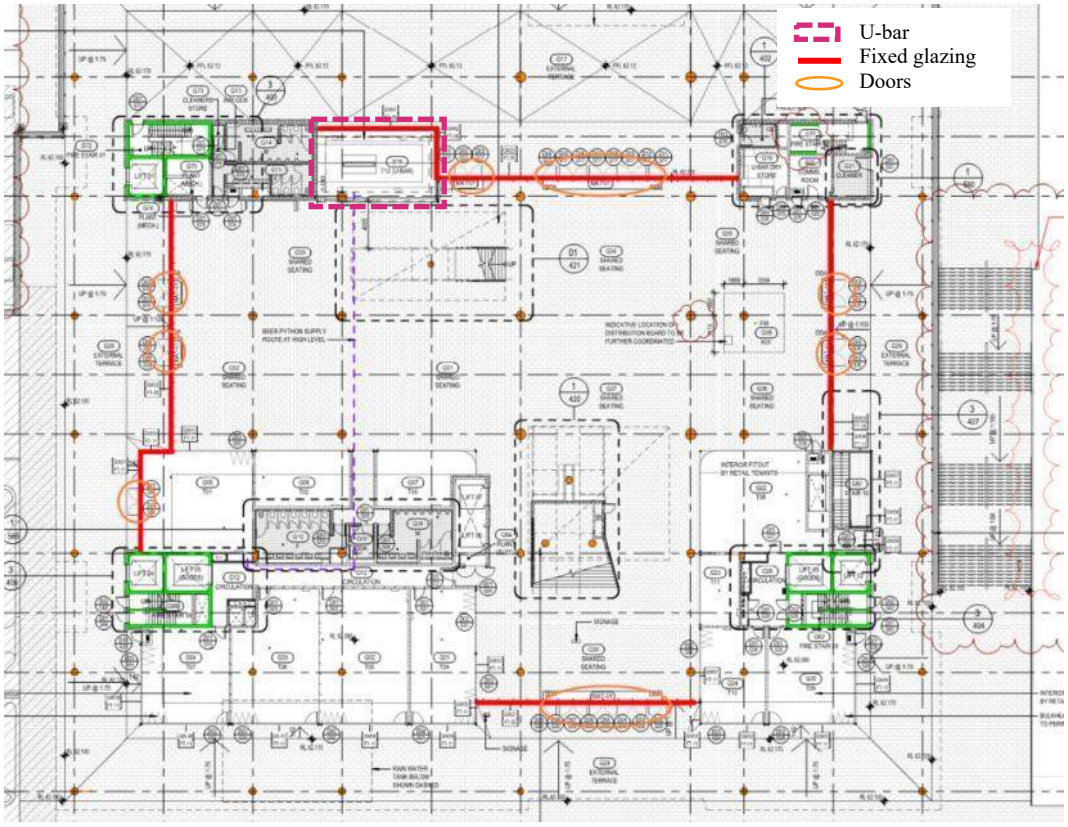


Figure 3: U-bar location and façade elements

2.2.1 Noise level predictions

Noise levels have been predicted and are summarised in Table 5 below.

Table 5: U-bar – noise emission assessment

Receiver Location	Bar Operational Scenario	Predicted $dBL_{Aeq15minute}$		Compliance with noise targets? (Y/N)		
				Day	Evening	Night
R1 eastern façade (worst case)	General use – one set of double doors OPEN	External	57	N	N	N
		Internal	29	Y	Y	Y
	General use – doors CLOSED	External	37	Y	Y	Y
		Internal	20	Y	Y	Y
Culloden Road residences	General use – one set of double doors OPEN	External	31	Y	Y	Y
	General use – doors CLOSED	External	19	Y	Y	Y

2.3 Discussion

For the assumed operational conditions, predictions at residences along Culloden Road indicate sound emissions from the U-bar are well below the established criteria, and unlikely to be detected at those receivers.

Exceedance at R1 is predicted at all times with one set of doors open on the west façade of the Student Hub, although only marginal (by 2 dB) during the day. It is noted that during the day, internal noise levels within the U-bar are unlikely to be as loud as assumed. Doors of the U-bar will otherwise need to be closed while operational during the evening (as per development consent condition E3) and night.

The predicted noise levels within Building R1 with windows closed, indicate compliance with the target levels.

Compliance is predicted at all times with the Student Hub doors closed.

As predictions are below the criteria with doors closed, some increase in music sound level might practicably be accommodated, however consideration would need to be given to excess bass content and impacts to internal areas on other floors.

3 Recommendations

Based on the assessment undertaken, the following recommendations provide in-principle advice for the mitigation and management of noise emission from the premises. This information is presented for statutory approvals process and project planning and shall not be used for construction unless otherwise approved in writing by the acoustic consultant.

3.1 Operational controls

An operational management plan should be developed for the U-bar and include the following provisions:

- Windows and doors operation:
  - Windows and doors shall be closed during the evening and night periods.
  - Entry doors to remain closed except for patron egress.
  - Prioritise entry and exit to the east and north during the evening and night period.
- Implementation of signage to make patrons aware of the proximity to student accommodation and the need to keep noise to a minimum.
- Operate within the approved patron capacity numbers.

4 Conclusion

Arup has completed an acoustic assessment to support an application to modify the SSD 8755 consent condition that relates to hours of operation of the U-bar.

Based on the assumed operating conditions presented in this report, the assessment concludes that the U-bar may operate during the proposed extended hours with all of its doors closed without exceeding the noise criteria at residences on Culloden Road and Building R1.

A double set of open doors may be open on the west façade of the Student Hub and compliance will still be achieved at residences on Culloden Road. The noise criteria at Building R1 will be exceeded, but noise could be mitigated effectively by closing the windows of Building R1.

In principle noise management and mitigation measures have also been provided.

Appendix A

Glossary

Ambient Noise Level

The ambient noise level is the overall noise level measured at a location from multiple noise sources. When assessing noise from a particular development, the ambient noise level is defined as the remaining noise level in the absence of the specific noise source being investigated. For example, if a fan located on a city building is being investigated, the ambient noise level is the noise level from all other sources without the fan running. This would include sources such as traffic, birds, people talking and other nearby fans on other buildings.

Background Noise Level

The background noise level is the noise level that is generally present at a location at all or most times. Although the background noise may change over the course of a day, over shorter time periods (e.g. 15 minutes) the background noise is almost-constant. Examples of background noise sources include steady traffic (e.g. motorways or arterial roads), constant mechanical or electrical plant and some natural noise sources such as wind, foliage, water and insects.

Assessment Background Level (ABL)

A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night time period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background L_{A90} noise levels – i.e. the measured background noise is above the ABL 90% of the time.

Rating Background Level (RBL / min$L_{A90,1hour}$)

A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey. This parameter is denoted RBL in NSW, and min$L_{A90,1hour}$ in QLD.

Decibel

The decibel scale is a logarithmic scale which is used to measure sound and vibration levels. Human hearing is not linear and involves hearing over a large range of sound pressure levels, which would be unwieldy if presented on a linear scale. Therefore a logarithmic scale, the decibel (dB) scale, is used to describe sound levels.

An increase of approximately 10 dB corresponds to a subjective doubling of the loudness of a noise. The minimum increase or decrease in noise level that can be noticed is typically 2 to 3 dB.

dB(A)

dB(A) denotes a single-number sound pressure level that includes a frequency weighting ("A-weighting") to reflect the subjective loudness of the sound level.

The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, and so the A-weighting is used to account for this effect. An A-weighted decibel level is written as dB(A).

Some typical dB(A) levels are shown below.

Sound Pressure Level dB(A)	Example
130	Human threshold of pain
120	Jet aircraft take-off at 100 m
110	Chain saw at 1 m
100	Inside nightclub
90	Heavy trucks at 5 m
80	Kerbside of busy street
70	Loud stereo in living room
60	Office or restaurant with people present
50	Domestic fan heater at 1m
40	Living room (without TV, stereo, etc)
30	Background noise in a theatre
20	Remote rural area on still night
10	Acoustic laboratory test chamber
0	Threshold of hearing

L_1

The L_1 statistical level is often used to represent the maximum level of a sound level that varies with time.

Mathematically, the L_1 level is the sound level exceeded for 1% of the measurement duration. As an example, 87 dB $L_{A1,15min}$ is a sound level of 87 dB(A) or higher for 1% of the 15 minute measurement period.

L_{10}

The L_{10} statistical level is often used as the "average maximum" level of a sound level that varies with time.

Mathematically, the L_{10} level is the sound level exceeded for 10% of the measurement duration. L_{10} is often used for road traffic noise assessment. As an

example, 63 dB $L_{A10,18hr}$ is a sound level of 63 dB(A) or higher for 10% of the 18 hour measurement period.

L_{90}

The L_{90} statistical level is often used as the "average minimum" or "background" level of a sound level that varies with time.

Mathematically, L_{90} is the sound level exceeded for 90% of the measurement duration. As an example, 45 dB $L_{A90,15min}$ is a sound level of 45 dB(A) or higher for 90% of the 15 minute measurement period.

L_{eq}

The 'equivalent continuous sound level', L_{eq}, is used to describe the level of a time-varying sound or vibration measurement.

L_{eq} is often used as the "average" level for a measurement where the level is fluctuating over time. Mathematically, it is the energy-average level over a period of time (i.e. the constant sound level that contains the same sound energy as the measured level). When the dB(A) weighting is applied, the level is denoted dB $L_{Aeq.}$ Often the measurement duration is quoted, thus $L_{Aeq,15\ min}$ represents the dB(A) weighted energy-average level of a 15 minute measurement.

L_{max}

The L_{max} statistical level can be used to describe the "absolute maximum" level of a sound or vibration level that varies with time.

Mathematically, L_{max} is the highest value recorded during the measurement period. As an example, 94 dB L_{Amax} is a highest value of 94 dB(A) during the measurement period.

Since L_{max} is often caused by an instantaneous event, L_{max} levels often vary significantly between measurements.

Frequency

Frequency is the number of cycles per second of a sound or vibration wave. In musical terms, frequency is described as "pitch". Sounds towards the lower end of the human hearing frequency range are perceived as "bass" or "low-pitched" and sounds with a higher frequency are perceived as "treble" or "high pitched".

Impact Sound Pressure Level

The technical parameter used to determine impact sound isolation of floors is the impact sound pressure level, L_i.

In the laboratory, the weighted normalised impact sound pressure level, $L_{n,w}$, is used to represent the impact sound isolation as a single figure.

On site, the weighted normalised apparent impact sound pressure level, $L'_{n,w,}$ and the weighted standardised apparent impact sound pressure level, $L'_{n,Tw}$, are used to represent the impact sound isolation of a floor as a single figure.

These single weighted values are determined by comparing the spectral impact sound pressure levels (as defined in ISO 140-6 & ISO 140-7) with reference values outlined in AS/NZS ISO 717.2.

Sound Power and Sound Pressure

The sound power level (L_w) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level (L_p) varies as a function of distance from a source. However, the sound power level is an intrinsic characteristic of a source (analogous to its mass), which is not affected by the environment within which the source is located.

Sound Reduction Index (R)

The sound reduction index (or transmission loss) of a building element is a measure of the loss of sound through the material, i.e. its sound attenuation properties. It is a property of the component, unlike the sound level difference, which is affected by the common area between the rooms and the acoustics of the receiving room. R is the ratio (expressed in decibels) of the sound energy transmitted through the building element to the sound energy incident on the building element for a particular frequency.

The weighted sound reduction index, R_w, is a single figure description of sound reduction index across a wider frequency range and is defined in BS EN ISO 717-1: 1997. R_w values are calculated from measurements in an acoustic laboratory. Sound insulation ratings derived from site measurements (which are invariably lower than the laboratory figures) are referred to as apparent sound reduction index (R'_w) ratings.

Spectrum Adaptation Terms (C and C_{tr})

The terms C and C_{tr} are spectrum adaptation terms (in dB) that are added to the R_w or D_w value of a partition in order to determine the overall sound insulation rating of a partition for various conditions. The overall performance of the partition is quoted as the sum of the Rw value and the spectrum adaptation terms, e.g. D_w + C 55 dB; R_w + C_{tr} 60 dB.

C is a spectrum adaptation term used to measure the performance of a partition for medium to high-frequency noise sources, such as speech.

C_{tr} is a spectrum adaptation term used to measure the performance of a partition for low-frequency noise sources such as traffic noise.

The values of C and C_{tr} are dependent on the construction of the partition. Because C and C_{tr} are (usually) negative quantities, they typically increase the Rw requirement of a partition (eg if C_{tr} is -6 dB, an R_w of 56 dB is required to achieve a rating of R_w + C_{tr} 50 dB).

Appendix B

Unattended Monitoring Results

B1 Noise monitoring location

An environmental noise logger was set up near the Macquarie University Observatory which was considered representative of the acoustic environment around the residences on Culloden Road. The location is shown in Figure 4 below.

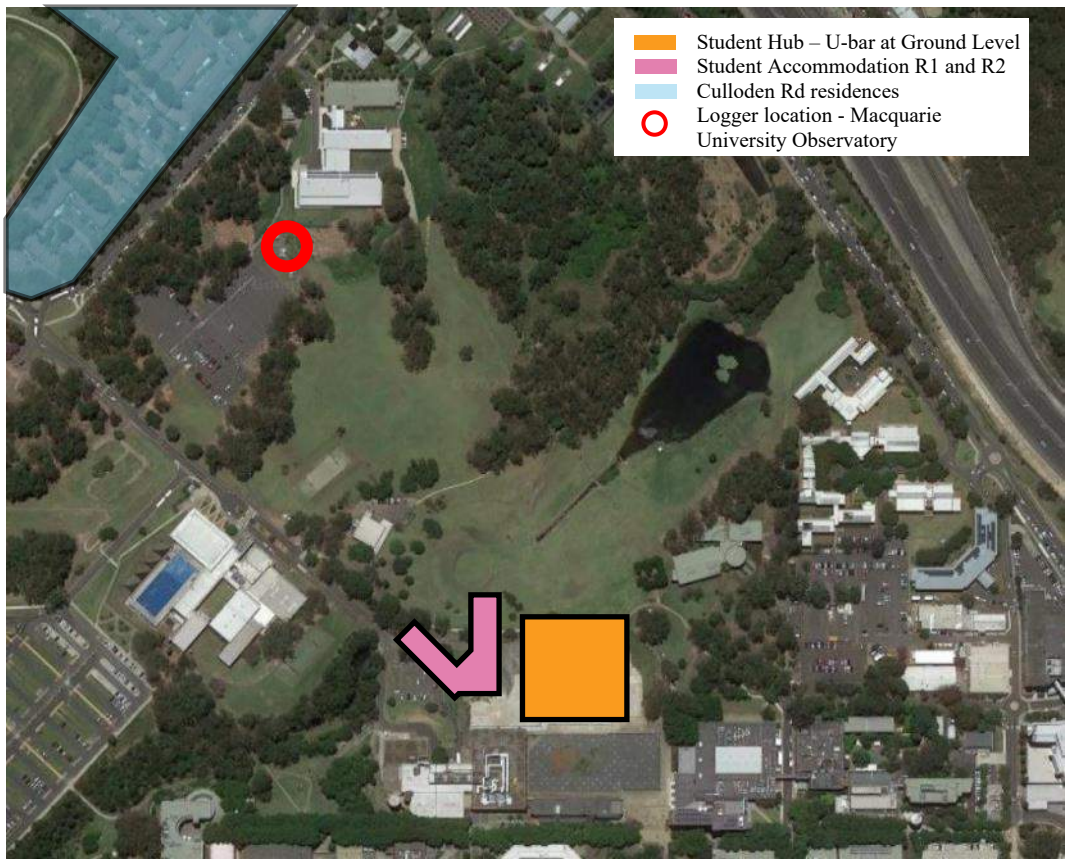


Figure 4: Noise logger location

B2 Noise monitoring equipment

Unattended monitoring was carried out using the following equipment:

Measurement location	Equipment/model	Serial No.	SLM Type
L1	ARL Ngara		Type 1

Notes:

All meters comply with AS IEC 61672.1 2004 “Electroacoustics - Sound Level Meters” and designated either Type 1 as per table, and are suitable for field use.

The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Type 4231 calibrator. No significant drift in calibration was observed.

B3 Extraneous/weather affected data

Measurement samples affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the procedures outlined in Appendix B of the NSW Industrial Noise Policy (INP).

Data provided by the Bureau of Meteorology (BOM), for the nearest representative weather station to noise monitoring location(s). Wind speed data was adjusted to account for the difference in measurement height and surrounding environment between the BOM weather station (measured 10 m above ground) and the microphone location based on Table C.1 of ISO 4354:2009 '*Wind actions on structures*'.

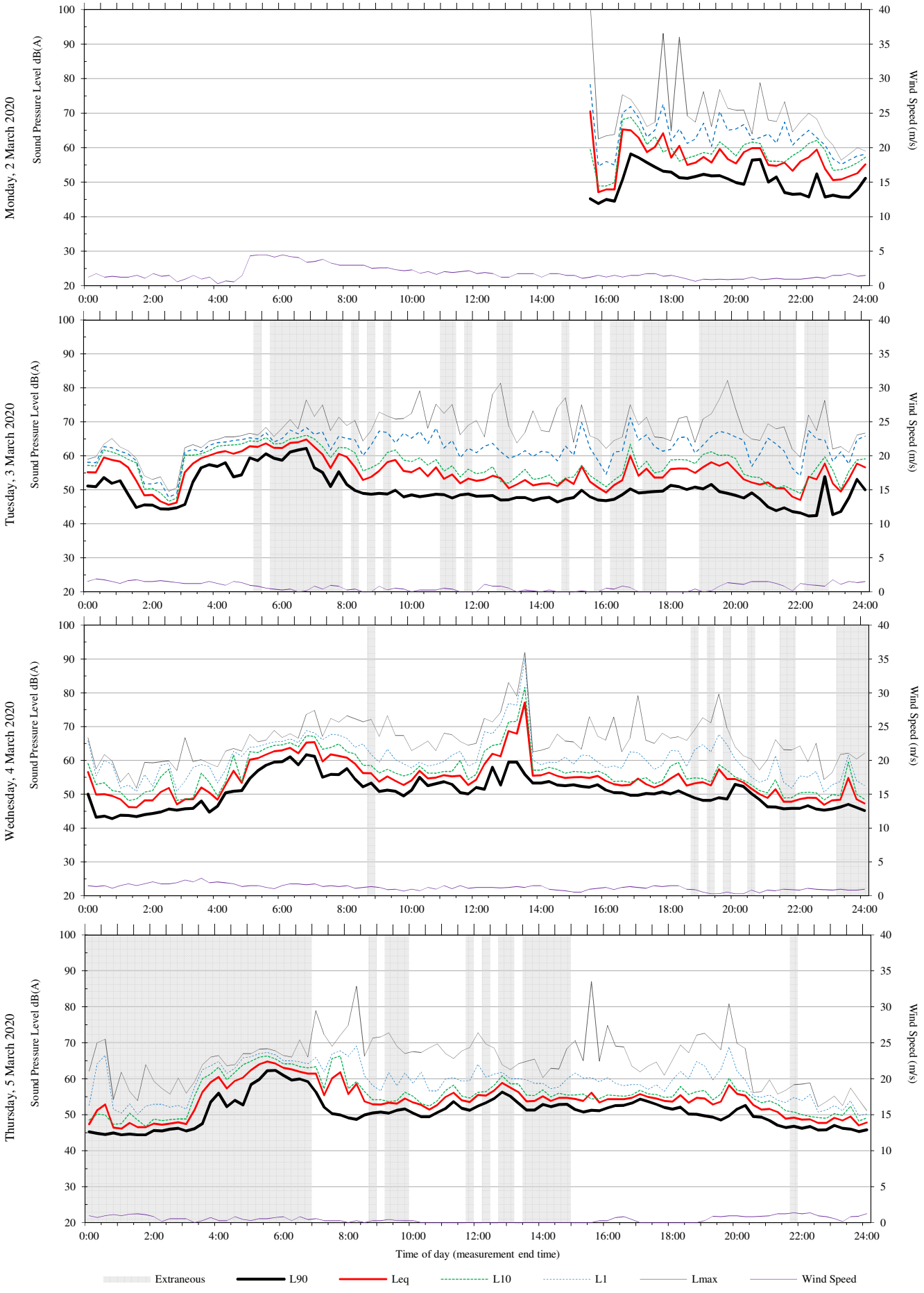
B4 Logger graphs

The following noise level vs time graphs present overall dB(A) levels recorded by the unattended logger(s) for a range of noise descriptors, including L_{Aeq}, L_{A90}, L_{A10} and L_{Amax}. While line graphs are presented, sampling is typically at 15 minute intervals.

Wind speeds are also show where relevant, and periods of excluded data are shaded grey.

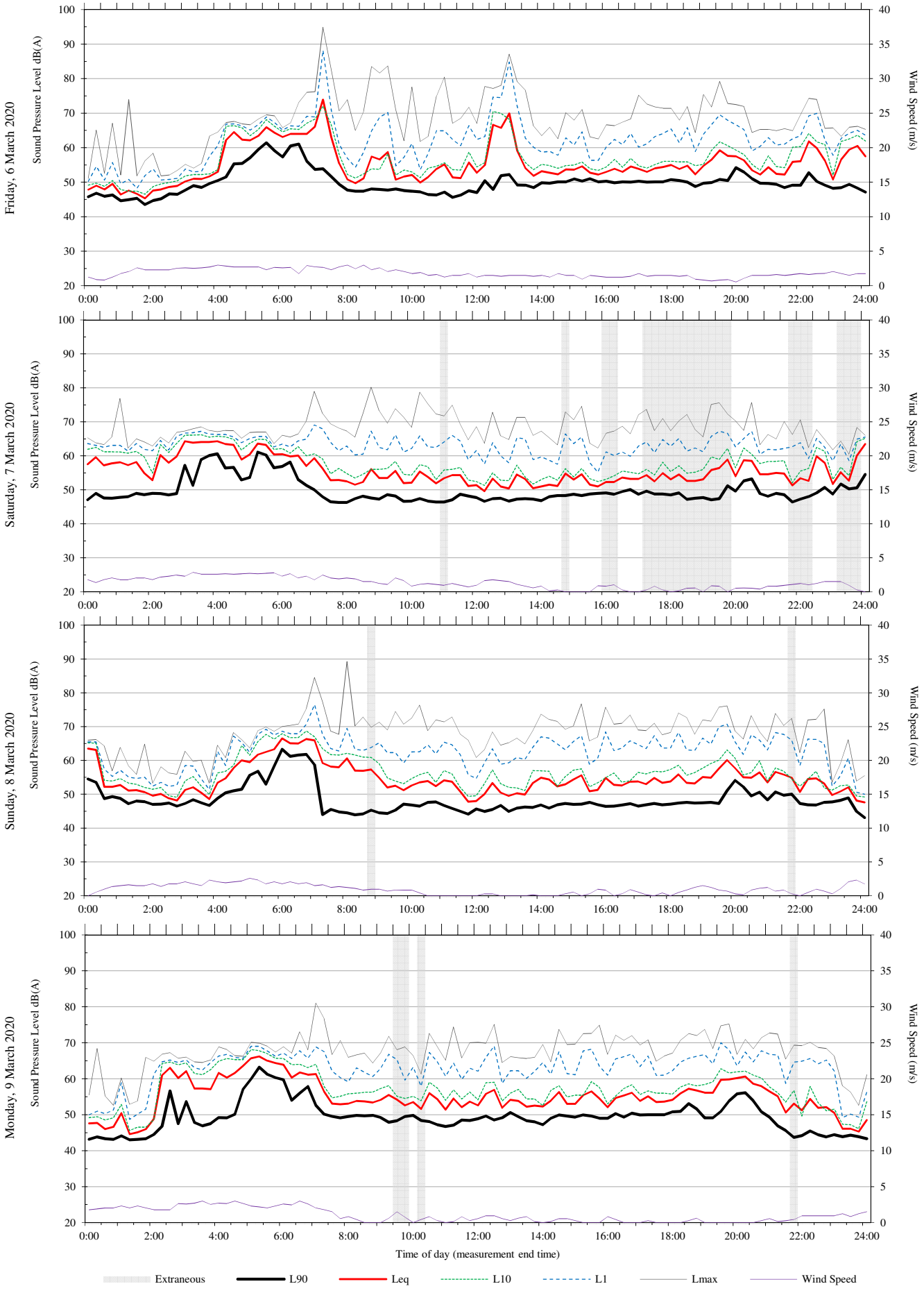
Unattended monitoring: Macquarie Uni Observatory (Free Field)

ARUP



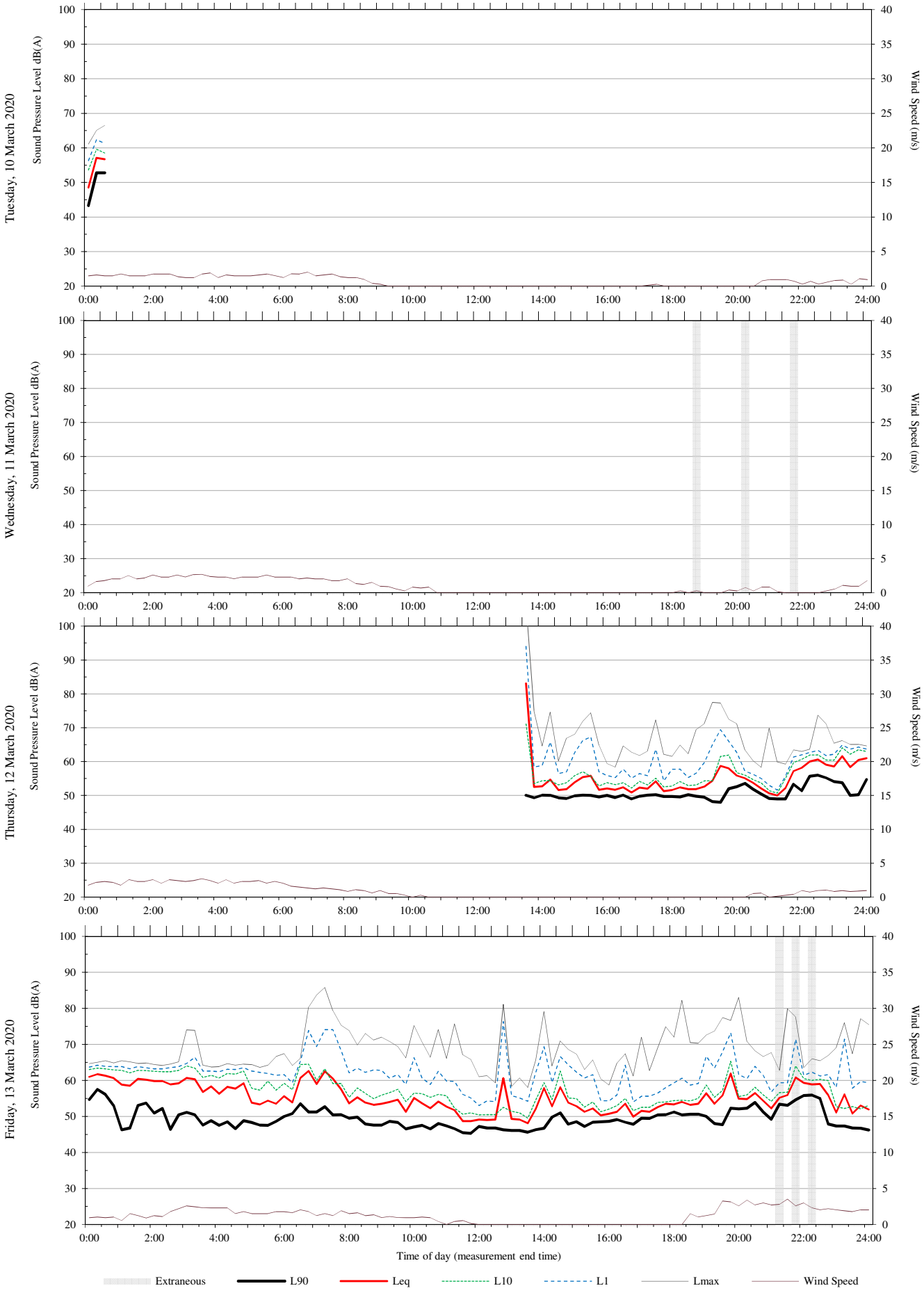
Unattended monitoring: Macquarie Uni Observatory (Free Field)

ARUP



Unattended monitoring: Macquarie Uni Observatory (Free Field)

ARUP



Unattended monitoring: Macquarie Uni Observatory (Free Field)

ARUP