RANDWICK CAMPUS REDEVELOPMENT

Noise and Vibration Impact Assessment for State Significant Development (SSD) – Integrated ASB Addition

Issued

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Executive Summary

In order to assist in realising the vision for the Randwick Health and Education Precinct, an extension to the approved Acute Services Building (ASB) is proposed to create opportunities for UNSW to integrate health related academic and translational research activities collocated within the ASB. The proposal is known as the Integrated Acute Services Building (IASB) Addition. The Project consists of the construction and operation of the UNSW Extension to the ASB and in conjunction, the lowering of a section of Hospital Road (southern portion). The Randwick Campus Redevelopment Project site is bound by High Street (north), Botany Street (west), Magill Street (south) and Hospital Road (east), located in Randwick (the site).

This report is an addendum to the Noise and Vibration Impact Assessment[1] previously submitted under State Significant Development Application (SSDA) 9113 Prince of Wales Expansion Stage 1. The content of this report relates only to the additional core scope elements of the IASB Addition.

This acoustic report includes a construction and operational noise and vibration impact assessment (the assessment) of the Project. The assessment has been prepared in accordance with Items 4 and 10 of the Secretary's Environmental Assessment Requirements (SEARs) issued on 26 June 2019 for State Significant Development Application (SSDA) No. SSD 10339.

The existing noise environment has been established based on long-term and short-term monitoring data. Appropriate criteria for both noise and vibration have been discussed and set according to established guidelines and standards, including:

- NSW Noise Policy for Industry (NSW NPI) 2017
- Interim Construction Noise Guideline 2009
- Assessing Vibration: A Technical Guideline 2006
- Development Near Rail Corridors and Busy Roads – Interim Guideline 2008

A summary of the outcomes and recommendations of this noise and vibration assessment are as follows:

- Operational Noise

  Once completed, the IASB will operate 24 hours a day, seven days per week.

  Mechanical Plant

[1] Report Reference: Randwick Campus Redevelopment, Noise and Vibration Impact Assessment for SSD - ASB – 20180808 AUR.0003.Rep.

The following are recommended external noise controls where allowances are to be made for buildings services for the proposed development:

A. Plant Rooms
   Including, but not limited to, the following:
   - Level 05 AHU plant – attenuation / acoustic louvres.
   - Level 09
     - Chillers – attenuation / acoustic louvres
     - AHU Plant – attenuation / acoustic louvres
     - FCU Plant – attenuation / acoustic louvres.

B. Cooling Towers and Emergency Generators

   No additional cooling towers or emergency generators have been proposed as part of the Project and there will be no changes to the selections for the ASB cooling towers and emergency generators as a result of the integration. Sections 6.1.1.2 and 6.1.1.3 of the Noise and Vibration Impact Assessment for SSD, dated 8 August 2018[2], report provide recommended external noise controls for the ASB cooling towers and emergency generators; these recommendations remain unchanged and are to continue to be implemented.

C. Fans (Levels 05 & 09)

   Fans will generally need to allow for a minimum 1 m of internally lined duct plus 1 lined mitred bend as follows:
   - Discharge for Exhaust Air Fan (EAF), Toilet Exhaust Fan (TEF) and Smoke Exhaust Fan / Return Air Fan (SEF / RAF).

Traffic Noise Generation

There will be no changes to the operation of the ambulance bay, loading dock / waste collection, Emergency Department (ED) drop-off area and emergency helicopters as a result of the IASB Addition and so the associated noise impacts require no further assessment. Therefore, these items have been excluded from this assessment.

A. General Traffic Noise
   - When compared with the approved ASB, there is no increase in traffic volumes during the day-time as a result of the IASB Addition.

[2] Report Reference: Randwick Campus Redevelopment, Noise and Vibration Impact Assessment for SSD - ASB – 20180808 AUR.0003.Rep.

Consequently, traffic noise impacts at Magill Street residences during the day-time will be the same as the approved ASB and, therefore, require no further assessment.

- When compared with the approved ASB, there will be no additional traffic using Magill Street during the night-time period (6pm to 7am). Consequently, traffic noise impacts at Magill Street residences as a result of the IASB Addition during the night-time will be the same as the approved ASB and, therefore, require no further assessment.

In addition:

- The car park exit on to Hospital Road is currently closed between 6pm and 6am. A boom-gate is proposed at the intersection of Magill Street and Hospital Road which will be closed between 10pm and 7am in order to help mitigate potential noise impacts during the night-time, particularly from Magill Street through-traffic and traffic accessing the car park via Magill Street.

- As cars depart the ASB drop-off to proceed to park, drivers will be advised via signage that access to the car park after 6pm is via Barker Street and Easy Street.

- Staff accessing the car park will be aware of the 6am to 7am closure of the boom-gate at the intersection of Magill Street and Hospital Road and proceed as usual via Barker Street.

- Arup Transport Planning has noted that, with appropriate installation of road and site signage and given the distance between respective ASB driveways and the Magill Street / Botany Street intersection, vehicle acceleration events affecting Magill Street are unlikely to increase significantly relative to current (pre-ASB) occurrences. Therefore, instances of vehicle acceleration events are expected to remain low and, in any case, the likelihood of vehicle acceleration events and associated noise impacts will be the same as the approved ASB.

- Based on the above, general traffic noise generated on surrounding roads as a result of the operations of the IASB Addition will be the same as the approved ASB during all time periods (Day, Evening and Night).

- Construction Noise

  Proposed construction hours for the Project are as follows:

  - Monday to Friday - 7:00am to 6:00pm.
  - Saturday - 8:00am to 5:00pm.

- Sunday and Public Holidays – No works.

In addition to the regular working hours above, forty weekends of works will be required over 18 months to ensure operational continuity of the loading dock during core working hours during the week. These works are to take place during those weekends between,

- Friday – 6:00pm to 10:00pm
- Saturday and Sunday 8:00am to 10:00pm.

Based on the results of the assessment of construction activities, we make the following comments:

- The noise sensitive receivers at Residential Catchment B and the existing Randwick Hospitals Campus buildings fronting Hospital Road are the most sensitive receivers to the site as they are closer to the construction works. Existing buildings at UNSW and Residential Catchment A are also identified as sensitive receivers.
- There will be times / situations when construction works are likely to exceed stated criteria, particularly when works occur in the areas closest to sensitive receivers. The extent of exceedances may vary depending on the activities, equipment used, plus the times and locations of the works.
- Construction works activities / plant are predicted to exceed the relevant criteria by up to 32 dB(A) when used during recommended standard hours and up to 30 dB(A) when used outside recommended standard hours. The worst-case exceedances are for excavators and demo / circular saws. In these cases, noisy activities are to be scheduled to less sensitive times to minimise potential noise impacts.
- The predictions for noise levels exceeding the relevant criteria are not unusual given the heavy plant and equipment that must be used, such as excavators, and the proximity of those sensitive receivers.
- Construction traffic along the roads surrounding the site will have no adverse noise impacts on nearby receivers during all time periods.
- The noise impacts as a result of the re-distribution of existing traffic, due to closure of Hospital Road in all three stages of construction, are considered to be insignificant.
- However, management of the timing of construction traffic movements shall be planned and managed wherever possible to: (a) avoid Magill Street and Hospital Road during early morning and out of standard hours; and (b) limit the frequency of construction vehicle movements to keep any increase in equivalent continuous traffic noise levels to a minimum. It is noted that construction vehicle access is not proposed along Magill Street.

- If, during construction works, an item of equipment exceeds the stated airborne noise criteria at any sensitive location, the additional noise control measures presented in Section 8.4.4, together with construction best practices presented in Section 8.4.1, are to be reviewed and implemented to minimise the noise impacts on the neighbourhood.
- It is recommended that a Construction Noise and Vibration Management Plan (CNVMP) is prepared by the Contractor at the detailed design stage. The Contractor would be required to prepare a final CNVMP based on their proposed plant, equipment and construction methodology.

- Construction Vibration

  Based on the scope of works and typical equipment required, some structural and human perception vibration impacts are expected – particularly from the use of piling rigs during piling works and excavators with hammers during excavation works. In addition, there is potential for vibration impacts on sensitive equipment within existing Randwick Hospitals Campus and UNSW buildings. The significance of these impacts will need to be determined as part of the CNVMP prepared by the Contractor. In addition to the Catchment A and Catchment B residential receivers, the CNVMP prepared by the Contractor must ensure, at the relevant UNSW and Randwick Hospitals Campus areas where sensitive equipment is operated, that the equipment-specific vibration criteria are set and managed accordingly.
  The Contractor shall carry out a vibration assessment at the commencement of operations for each vibration generating activity to determine whether the existence of significant vibration levels justifies a more detailed investigation. If the assessment indicates that vibration levels are to exceed the relevant criteria then appropriate vibration mitigation measures will need to be put in place to ensure vibration impacts are minimised using all reasonable and feasible measures and will allow for the planning of works around the use of sensitive buildings within the Randwick Hospitals Campus and on the UNSW campus.

  A more detailed investigation would involve constraining activities which generate high vibration levels. A method of monitoring vibration levels could then be put in place. Vibration mitigation measures and vibration criteria will then need to be reviewed.

  All practical means are to be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on site.

  The following considerations shall be taken into account:

  - Modifications to excavation and construction equipment used.
  - Modifications to methods of excavation and construction.
  - Rescheduling of activities to less sensitive times.

1 Introduction

Acoustic Studio has been engaged by NSW Health Infrastructure (HI) to carry out a construction and operational noise and vibration impact assessment (the assessment) for the proposed Integrated Acute Services Building (IASB) Addition (the Project) consisting of the construction and operation of the University of New South Wales (UNSW) Extension to the approved Acute Services Building (ASB) and in conjunction, the lowering of a section of Hospital Road (southern portion). The Randwick Campus Redevelopment Project is bound by High Street (north), Botany Street (west), Magill Street (south) and Hospital Road (east), located in Randwick (the site).

This report is an addendum to the Noise and Vibration Impact Assessment[3] previously submitted under State Significant Development Application (SSDA) 9113 Prince of Wales Expansion Stage 1. The content of this report relates only to the additional core scope elements of the IASB Addition.

The assessment has been prepared in accordance with Items 4 and 10 of the Secretary's Environmental Assessment Requirements (SEARs) issued on 26 June 2019 for SSDA 10339. Refer to Section 3 for further details.

The assessment has been carried out by:

- Establishing the appropriate noise and vibration criteria in accordance with the relevant standards and guidelines.
- Quantifying the existing ambient and background noise levels at noise sensitive receivers on and surrounding the site.
- Identifying the main noise and vibration generating sources.
- Assessing whether the relevant criteria can be achieved and, where applicable, recommending measures to minimise and mitigate potential impacts.

The scope of this assessment covers noise and vibration emissions during the construction and operation of the Project. Where no changes to the approved ASB and its components are proposed as a part of scope of the Project, no further assessment is required and therefore not included in this assessment.

The assessment considers noise and vibration impacts for:

- Community and land uses surrounding the site.
- Existing buildings/facilities within the Randwick Hospitals Campus and UNSW Campus.

[3] Report Reference: Randwick Campus Redevelopment, Noise and Vibration Impact Assessment for SSD - ASB – 20180808 AUR.0003.Rep.

Separate acoustic reports were prepared by Acoustic Studio to support:

1) a Development Application[4] for demolition and site clearance works, dated 10 April 2018,

2) a Review of Environmental Factors[5] (REF) for the diversion of infrastructure services, dated 13 February 2018,

3) a REF[6] for the demolition and site clearance works within Eurimbla Avenue, dated 2 August 2018, and

4) a State Significant Development Application[7] (SSDA) for construction and operation of the ASB, dated 8 August 2018.

[4] Report Reference: Randwick Campus Redevelopment, Acoustic Assessment of Demolition and Site Clearance Works For Development Application (DA) – 20180410 AUR.0005.Rep

[5] Report Reference: Randwick Campus Redevelopment, Acoustic Assessment of Early And Enabling Works For Review of Environmental Factors (REF) – 20180213 AUR.0002.Rep.

[6] Report Reference: Randwick Campus Redevelopment, Acoustic Assessment of Demolition and Site Clearance Works For Review of Environmental Factors (REF) – 20180802 AUR.0008.Rep.

[7] Report Reference: Randwick Campus Redevelopment, Noise and Vibration Impact Assessment for SSD - ASB – 20180808 AUR.0003.Rep.

1.1 Scope

This acoustic report has been prepared as part of a State Significant Development Application (SSDA) known as the Integrated Acute Services Building (IASB) Addition. It provides a review and assessment of potential construction and operational noise and vibration impacts associated with the proposed development.

1.2 Project Overview

The scope of proposed works included as part of this SSDA is:

- UNSW Eastern Extension (Base building only).
- Associated modifications within the ASB.
- Lowering of Hospital Road.
- Landscaping.

2 Site Details and Project Description

The site is located within an urban environment in Randwick, characterised by medium to high levels of activity throughout the day / evening and low noise levels in the night.

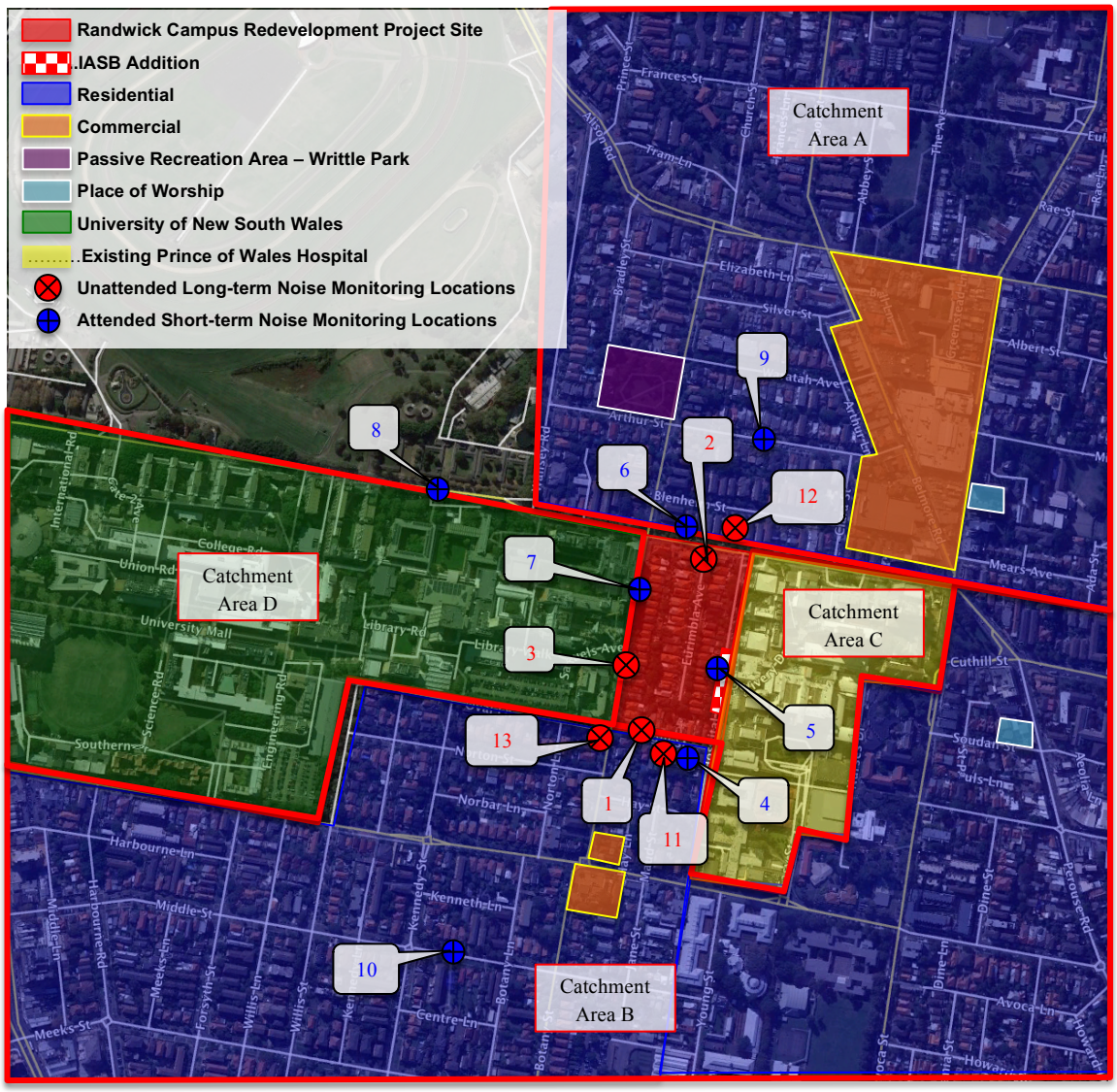


Figure 1: The proposed Project site in relation to noise-sensitive receivers. In addition to unattended long-term noise monitoring, attended short-term noise measurements were also carried out at Locations 1 to 3.

The following land-uses surround the Project site:

- Catchment Area A
    - Residential dwellings to the north along High Street.
    - Commercial buildings to the northeast.
    - Writtle Park to the north.
    - Our Lady of the Sacred Heart Church to the northeast.

- Catchment Area B
    - Residential dwellings to the south and southwest.
    - Residential dwellings to the east and southeast adjacent to the Randwick Hospitals Campus.
    - Commercial buildings to the south.
    - Randwick Baptist Church to the east.
- Catchment Area C
    - Randwick Hospitals Campus to the east, including Royal Hospital for Women (RHW) and Sydney Children's Hospitals Network (SCHN) buildings across Hospital Road. These receivers include sensitive research laboratories and equipment as well as general hospital accommodation and administration activities.
- Catchment Area D
    - UNSW Campus to the west. This receiver includes sensitive research laboratories and equipment as well as residential accommodation, learning, teaching and administration activities.

2.1 Operating Hours

Once the construction is completed, the Project premises are to operate 24 hours a day, seven days per week.

2.2 Proposed Construction Hours

Proposed construction hours for the Project are as follows:

- Monday to Friday - 7:00am to 6:00pm.
- Saturday - 8:00am to 5:00pm.
- Sunday and Public Holidays – No works.

In addition to the regular working hours above, forty weekends of works will be required over 18 months to ensure operational continuity of the loading dock during core working hours during the week. These works are to take place during those weekends between,

- Friday – 6:00pm to 10:00pm.
- Saturday and Sunday 8:00am to 10:00pm.

3 The Key Acoustic Issues

The SEARS for the SSDA states the following in regards to Noise and Vibration.

"…

4. Environmental Amenity

Detail amenity impacts including solar access, acoustic impacts, visual privacy, view loss, overshadowing and wind impacts. A high level of environmental amenity for any surrounding residential land uses must be demonstrated.

…

…

10. Noise and Vibration

- *Identify and provide a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation, construction. Outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.*
- *Identify and assess operational noise, including consideration of mechanical services (e.g. air conditioning plant), ambulance movements, patient and visitor arrival/departures. Outline measures to minimize and mitigate the potential noise impacts on surrounding occupiers of land.*
- *→ Relevant Policies and Guidelines:*
- *NSW Noise Policy for Industry 2017 (EPA)*
- *Interim Construction Noise Guideline (DECC)*
- *Assessing Vibration: A Technical Guideline 2006*
- *Development Near Rail Corridors and Busy Road – Interim Guideline (Department of Planning 2008*
- *Australian Standard 2363:1999 Acoustics – Measurement of noise from helicopter operations.*

…"

The following acoustic issues are to be addressed as part of the assessment:

External Noise Emissions - Noise emissions from the Project are to be managed to limit environmental noise impacts on sensitive receivers resulting from the operation of the Project. In particular, this applies to:

- Building services and plant - The impact of mechanical noise generated by mechanical plant and equipment to be installed at Levels 5 and 9 of the building.

The mechanical plant noise levels are to be assessed against the NSW EPA Noise Policy for Industry 2017 (NSW NPI).

- Traffic noise generation - The impact of operational traffic noise on surrounding receivers from changes in traffic flow as a result of the new development.

Construction Noise and Vibration - The impact of noise and vibration generated during the construction stage of the Project on surrounding noise and vibration sensitive premises (including other Randwick Hospitals Campus buildings and UNSW campus buildings).

The proposed development will contribute to an increase in noise and vibration to the surrounding environment during the construction stage. This will result from intermittent noise from construction equipment and plant commonly used on construction sites.

Design noise and vibration limits have been set for the project and construction noise impacts have been anticipated from standard construction procedures.

The construction noise and vibration limits and expected impacts are reported in Section 5 and Section 8 of this report. Where the noise and vibration impacts are predicted to exceed the relevant criteria, then all reasonable and feasible noise and vibration mitigation measures must be considered as detailed in Section 8.

It is recommended that a Construction Noise and Vibration Management Plan (CNVMP) is prepared further to this assessment, prior to commencement of works. The Contractor would be required to prepare a final CNVMP based on their proposed plant, equipment and construction methodology.

The CNVMP is to provide the following:

- A quantitative construction noise and vibration assessment, which includes:
    - Identifying noise and vibration sensitive receivers potentially affected by the proposed works.
    - Reporting noise surveys which determine the existing ambient and background noise and vibration levels at the nearest sensitive receivers that surround the proposed development site.
    - Establishing the appropriate construction noise and vibration criteria based on the measurement results from the surveys.
    - Identifying noise and vibration sources associated with the proposed works.
    - Providing an assessment of noise and vibration generated by the proposed works against the relevant criteria.
    - Determining the likely need for noise and vibration mitigation and management measures.
- A control strategy for construction noise and vibration mitigation to best minimise potential impacts through implementation of reasonable and feasible measures.
- Noise and vibration monitoring as required, using monitors equipped with alert/notification systems to ensure works are carried out within established criteria.

4 Existing Noise Environment

4.1 General Survey Information

A survey of the existing noise environment around the site perimeter bounded by Magill Street, Botany Street, High Street and Hospital Road was conducted with six individual unattended noise monitors used to continuously record the noise levels on the site. Unattended long-term noise monitoring was carried out from Wednesday 18th October to Friday 3rd November 2017 and Wednesday 18th to Wednesday 25th July 2018 to establish the typical range of ambient noise levels of the proposed site and surrounds.

Unattended long-term noise monitoring was carried out with the following noise loggers:

- Logger 1: B&K 3659-B (Serial Number 3010119).
    - This logger was used at Location 1 from 18th to 22nd October 2017 and then from 26th October to 3rd November 2017.
    - This logger was used at Location 13 from 18th to 25th July 2018.
- Logger 2: Ngara (Serial Number 878197).
    - This logger was used at Location 2 from 18th to 25th October 2017.
- Logger 3: RTA 02 (Serial Number 038).
    - This logger was used at Location 3 from 23rd October to 3rd November 2017.
- Logger 4: Ngara (Serial Number 878000).
    - This logger was used at Location 11 from 18th to 25th July 2018.
- Logger 5: Ngara (Serial Number 87809E).
    - This logger was used at Location 12 from 18th to 24th July 2018.

The loggers recorded L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} noise parameters at 15-minute intervals continuously for the 25-day measurement period. The calibrations of the loggers were checked before and after use and no variations were noted.

The unattended long-term noise monitoring locations are shown in Figure 1. The noise loggers at Locations 1, 2 and 3 were located at the street-side boundaries of residential and commercial properties at the site. At Locations 11, 12 and 13, the noise loggers were located within the front yards of residential properties in the vicinity of the proposed development. These locations were chosen as they:

- are secure places to leave the noise loggers unattended, and
- are representative of background and ambient noise levels (Location 11, 12 and 13) at the nearest and potentially most-affected noise sensitive residential

receivers, plus traffic noise levels (Location 1, 2 and 3) along roads surrounding the site.

If background noise levels had changed in the area since being measured in 2018 they would have most likely increased slightly, due to small increases in traffic flow and intensification of land use in the area. The use of the 2018 background levels is, therefore, considered acceptable for this assessment.

Operator attended, short-term monitoring was also carried out on Wednesday 18th, Monday 23rd and Wednesday 25th of October and Friday 3rd of November 2017 in order to supplement the long-term outdoor data across the site and at key surrounding receivers, such as UNSW, Randwick Hospitals Campus and residences nearby, and to obtain spectral noise data for traffic noise at the proposed site.

Attended short-term measurements were made with two Brüel & Kjær Hand-held Analysers Type 2250 (Serial Numbers 2832406 and 3010373). The calibrations of the analysers were checked before and after the surveys and no variation in levels occurred.

Windshields were used to protect the microphones of all the loggers and analysers. Weather conditions were calm and dry during the attended noise surveys.

The unattended long-term noise monitoring locations and attended short-term noise monitoring locations are shown in Figure 1.

At the time of monitoring, High Street residential receivers (Catchment A) were affected by construction noise associated with the Sydney CBD and South East Light Rail Project, which is now moving into commissioning. Acoustic Studio has undertaken attended, short-term noise level measurements along High Street and on surrounding streets to establish:

a) the construction noise levels affecting the Catchment A residences on High Street; and
b) the likely Rating Background Level (RBL) for the Catchment A residences in the absence of the Sydney CBD and South East Light Rail Project construction works.

The results from these additional attended, short-term noise level measurements are included in Section 4.3.

4.2 Unattended Long-term Monitoring Results

The loggers were located at the proposed site at the following locations:

- Location 1 – at the backyard of 101 Botany Street (now demolished) located in the southwestern corner of the site, to capture existing **traffic noise** levels along Magill Street.
- Location 2 – at the parking space east of 1-3 Eurimbla Avenue (now demolished) to capture existing **traffic noise** levels along High Street.
- Location 3 – at the front yard of 79 Botany Street (now demolished) to capture existing **traffic noise** levels along Botany Street.

- Location 11 – at the front yard of 7 Magill Street residential property to capture a combination of **ambient and background noise** levels along Magill Street. This logger location is representative of the background and ambient noise levels at the nearest residential receivers on Magill Street.
- Location 12 – at the front yard (High Street frontage) of 12 Blenheim Street residential property to capture existing **ambient and background noise** levels along High Street. This logger location is representative of the background and ambient noise levels at the nearest residential receivers on High Street.
- Location 13 – at the front yard of 40 Botany Street residential building to capture existing **ambient and background noise** levels along Botany Street. This logger location is representative of the background and ambient noise levels at the nearest residential receivers on Botany Street.

The unattended long-term noise monitoring locations are shown in Figure 1.

The detailed results of the unattended long-term noise monitoring at the six (6) logger locations are shown in Appendix A.

4.2.1 Traffic Noise

Traffic noise monitoring results are summarised in Table 1 below.

Location	Traffic Noise Levels[8], dB(A)			
	Period		Noisiest 1 Hour Period	
	Day $L_{eq, (15\ hr)}$	Night $L_{eq, (9\ hr)}$	Day $L_{eq, (1\ hr)}$	Night $L_{eq, (1\ hr)}$
Location 1[9] Traffic along Magill Street (Catchment B)	45	43	47	45
Location 2 Traffic along High Street (Catchment A)	58	52	59	54
Location 3 Traffic along Botany Street (Catchment D)	59	55	60	60

Table 1: Summary of measured long-term traffic noise levels

4.2.2 Background and Ambient Noise

The logged data shows the background and ambient noise levels representative of the area. The recorded background noise levels have been used to establish limiting criteria for noise emitted from the operation of the new building.

The background sound level is defined as the sound level exceeded 90% of the time, and is designated as the L_{90}. The ambient noise level impacting on the buildings is referred to as the equivalent continuous sound level (L_{eq}). This parameter is commonly used to describe a time varying noise such as traffic noise.

The background sound levels have been established in general accordance with the methodology described in the NSW NPI, i.e. the 10^{th} percentile background sound level for each period for each day of the ambient noise survey. The median of these levels is then presented as the background sound level for each assessment period. These background noise levels are shown in Table 2 below together with the L_{Aeq} ambient noise levels measured for each period.

In accordance with the NSW NPI, any data likely to be affected by rain, wind or other extraneous noise have been excluded from the calculations.

[8] Levels are adjusted to represent levels at facades, taking into consideration distance attenuation, façade reflection and shielding to the logger location.

[9] Levels are adjusted to exclude ambient noise levels which are not associated with traffic from Magill Street.

Location	Background Noise Levels (RBL), dB(A)			Leq Ambient Noise Levels, dB(A)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
Logger Location 3 79 Botany Street (Catchment D)	47	41	39	60	58	55
Logger Location 11 7 Magill Street (Catchment B)	46	44	43	55	51	51
Logger Location 12 12 Blenheim Street (Catchment A)	47	45	43	59	53	55
Logger Location 13 40 Botany Street (Catchment B)	49	46	43	65	64	59

Table 2: Long-term background and ambient noise levels

Based on our observations during the site inspections, both ambient and background noise levels around the proposed site are generally dominated by traffic noise around the site at all six locations and also by construction noise at Locations 2, 3 and 12.

4.3 Short-term Monitoring Results

Ten (10) short-term noise monitoring locations were chosen as representative of the site and surrounds as follows:

- **Location 1** on the footpath of Magill Street outside 101 Botany Street.
- **Location 2** on the footpath of High Street adjacent to the parking space of 1-3 Eurimbla Avenue commercial building.
- **Location 3** on the footpath in front of 79 Botany Street residential building.
- **Location 4** on the footpath in front of 9 Magill Street residential building.
- **Location 5** on the footpath of Hospital Road, opposite to the Randwick Hospitals Campus Ainsworth building.
- **Location 6** on the footpath of High Street behind 12 Blenheim Street residential building.
- **Location 7** on the footpath in front of 63 Botany Street residential building.
- **Location 8** on the footpath of High Street, outside UNSW Gate 8.
- **Location 9** on the footpath in front of 44 Arthur Street residential building.
- **Location 10** on the footpath in front of 56 Middle Street residential building.

The attended short-term monitoring locations are shown in Figure 1. The attended short-term noise measurements carried out at Locations 1 to 3 were carried out in addition to unattended long-term noise monitoring.

A summary of the measured values of the short-term background and ambient noise monitoring around the existing site is provided in Table 3.

Location	Time	Descriptor	Measured sound level, dB re 20 µPa									
			Overall dB(A)	Octave band centre frequency[1], Hz								
				31.5	63	125	250	500	1k	2k	4k	8k
1	Between 2pm and 3pm, 18 October 2017	L_{eq}	55	69	67	60	54	51	50	47	43	37
		L_{90}	49	62	58	51	48	45	44	40	35	27
2	Between 3pm and 4pm, 18 October 2017	L_{eq}	59	68	66	60	57	54	52	50	51	45
		L_{90}	53	61	59	54	51	48	47	44	41	34
3	Between 10am and 11am, 25 October 2017	L_{eq}	67	71	74	71	66	64	63	59	52	47
		L_{90}	55	62	62	58	53	51	51	47	39	30
4	Between 2pm and 3pam, 23 October 2017	L_{eq}	50	63	61	53	49	46	45	43	40	33
		L_{90}	44	57	52	46	44	41	38	34	29	23
5	Between 2pm and 3pm, 23 October 2017	L_{eq}	61	67	66	60	57	55	56	56	48	45
		L_{90}	48	59	55	50	47	46	43	38	32	21
6	Between 11am and 12pm, 25 October 2017	L_{eq}	59	69	67	62	59	57	54	51	47	42
		L_{90}	54	65	60	56	54	52	47	44	39	31
7	Between 2pm and 3pm, 18 October 2017	L_{eq}	64	74	72	65	61	60	61	56	50	44
		L_{90}	56	67	64	57	53	51	51	48	42	35
8	Between 9am and 10am, 3 November 2017	L_{eq}	70	74	79	72	69	67	65	62	58	53
		L_{90}	55	62	64	57	53	49	50	46	40	30
9	Between 10am and 11am, 3 November 2017	L_{eq}	64	70	73	66	64	61	60	56	50	44
		L_{90}	48	60	59	52	47	43	42	38	31	22
10	Between 10am and 11am, 3 November 2017	L_{eq}	63	67	67	64	67	61	56	51	40	33
		L_{90}	41	54	53	48	41	37	34	30	23	18

Table 3: Summary of short-term traffic, background and ambient noise levels – Day time survey

5 Project Noise and Vibration Criteria

5.1 Relevant Standards and Guidelines

The following acoustic standards and guidelines have been considered in establishing noise and vibration criteria and assessment for this project.

- Randwick Local Environmental Plan (LEP) 2012.
- Randwick Development Control Plan (DCP) 2013.
- NSW EPA Noise Policy for Industry (NSW NPI), 2017.
- NSW Department of Environment and Climate Change (DECC) "Interim Construction Noise Guideline" (ICNG), 2009.
- NSW Department of Environment and Conservation (DEC) "Assessing Vibration: A Technical Guideline", 2006.
- Department of Planning "Development Near Rail Corridors and Busy Roads – Interim Guideline", 2008.
- Protection of the Environmental Operations (POEO) Act 1997.
- Australian Standard AS 2107:2000 "Acoustics – Recommended design sound levels and reverberation times for building interiors".
- Australian Standard AS 2021:2000 "Acoustics – Aircraft noise intrusion - building siting and construction".
- Australian Standard "AS 2436 : Guide to Noise and Vibration Control on Construction, Demolition & Maintenance Sites", 2010.
- Australian Standard "AS 1055 : Acoustics – Description and Measurement of Environment Noise", 1997.
- Australian Standard "AS 2670.2 : Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz)", 1990.
- British Standards Institution "BS 6472 – Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)", 1992.
- German Standard DIN 4150-3:1999 "Structural vibration Part 3: Effects of vibration on structures".
- Swiss Standard SN 640 312:1978.
- British Standard BS7385: Part 2: 1993 "Evaluation and measurement for vibration in buildings. Guide to damage levels from ground borne vibration".
- NSW EPA Road Noise Policy (RNP), 2011.

- NSW Health Infrastructure "Engineering Services Guidelines (ESG)", August 2016. We note that Section 13 (Acoustics) of these guidelines has been updated. The updated guideline performance requirements for acoustics are provided in "Design Guidance Note No.33", (RevA 19 July 2017).
- *"Australasian Health Facility Guidelines"* December 2012 Revision v.4.0.

5.2 External Noise Emissions

5.2.1 Operational Noise

5.2.1.1 NSW Noise Policy for Industry

The NSW NPI provides guidance on methodology for determining limiting noise criteria for external noise emissions from plant associated with a development.

The criteria have two components:

- Intrusiveness Noise Level – controlling intrusive noise impacts in the short term for residences.
- Amenity Noise Level (ANL) – maintaining noise level amenity for particular land uses for residences and other land uses.

Applying the more stringent of the two criteria provides the Project Noise Trigger Level (PNTL).

The NSW NPI considers the following when establishing the criteria:

- The existing Ambient (L_{eq}) and Background noise levels (L_{90}) that surround the site.
- The time of day that the noise generating development will be in operation, defined by the following:
    - Day (7am to 6pm).
    - Evening (6pm to 10pm).
    - Night (10pm to 7am).
- The type of receivers.
- The type of area that the development site and its nearest receivers are located. The NSW NPI provides recommended noise levels for specific receiver types and the type of area they are located within.
- The type of noise source and its characteristics. The NSW NPI provides modifying factors for noise sources with certain characteristics that may potentially cause greater annoyance than other noise sources of the same level.

Further guidance on establishing the criteria can be found in the NSW NPI.

5.2.1.1.1 Noise Impacts on the Surrounding Community

Based on the measured noise levels detailed in Section 4 and in accordance with the methodology outlined in the NSW NPI (further described in Appendix B), Table 4 details the corresponding limits of allowable noise emission from external plant and equipment at the nearest receiver boundaries from the proposed development.

Receiver (External)	Period	Project Noise Trigger Level (PNTL)[10]
Residential (Catchment A)	Day	52
	Evening	45
	Night	45
Residential (Catchment B)	Day	51
	Evening	45
	Night	41
Commercial Premises (Catchment A)	When in use	60
Commercial Premises (Catchment B)	When in use	60
Randwick Hospitals Campus (Catchment C)	Noisiest 1 Hour Period	45 (refer also to Section 5.3.1.1.2)
UNSW Clasroom (Catchment D)	Noisiest 1-hour period when in use	45
Place of Worship (Catchment B)	When in use	45
Passive Recreation Area (Catchment A)	When in use	45

Table 4: NSW NPI Project Noise Trigger Levels for external noise emissions from proposed development

5.2.1.1.2 Noise Impacts on the Existing Randwick Hospitals Campus and UNSW

Redevelopment of any site must consider all neighbouring receivers. When the redevelopment site is an extension of an existing campus, neighbouring receivers will include existing "on-campus" buildings. Therefore, noise impacts on the existing Randwick Hospitals Campus buildings can be considered as "on-campus". Therefore, compliance with the NPI PNTL (Table 5) is discretionary.

Based on observations made by Acoustic Studio during site inspections and noise surveys at the Randwick Hospitals Campus, a maximum noise level of 55 dB(A) is recommended as the external noise criterion for all existing buildings within the Randwick Hospitals Campus.

[10] Project Noise Trigger Level is based on the more stringent of the Project Amenity and Intrusiveness Noise Levels.

We note that this noise level is lower than existing plant noise levels measured for some areas of the existing Randwick Hospitals Campus (for example, close to existing cooling towers).

Considering the above, the design of the new development is to consider strategies to maintain cumulative noise levels from all new plant to not exceed 55 dB(A) at the façade of all existing hospital buildings. The above criteria is to also apply to other industrial operational noise associated with the development (including ambulance, truck reversing beepers and loading dock activity) as recommended.

5.2.1.2 Traffic Noise Emission Criteria

5.2.1.2.1 NSW Road Noise Policy

The RNP provides criteria for traffic noise from new roads or additional traffic generated on roads from land use development.

Table 5 below provides the RNP criteria for traffic noise levels due to additional traffic generated on local roads from land use development in relation to the applicable receiver types surrounding the site.

Receiver	Assessment Criteria (external[11])	
	Day (7am to 10pm) $L_{Aeq\ (Period)}$	Night (10pm to 7am) $L_{Aeq\ (Period)}$
Residential	55 (1 hour)	50 (1 hour)
Places of worship	50 (1 hour)	50 (1 hour)
Passive Recreational Space	55 (15 hour)	-
School classrooms	60 (1 hour)	-
Hospital Wards	45 (1 hour)	45 (1 hour)

Table 5: RNP assessment criteria for additional traffic on local roads generated by land use development

Results from the long-term traffic noise level measurements along High Street and Botany Street presented in Table 1 show that the existing traffic noise levels are currently equal to or exceeding the dB $L_{Aeq\ (1hr)}$ RNP criteria for all receiver types surrounding the site. In such cases, the increase in the traffic noise levels arising from the additional traffic generated from land use development is assessed in relation to the existing noise levels.

When considering land use redevelopment and the impact on sensitive land uses (residential / schools / hospitals / recreational) the RNP guideline states that *"In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB"… (in relation to existing noise levels).. "represents a minor impact that is considered barely perceptible to the average person".*

[11] Non-residential external noise criteria are derived from internal noise criteria, assuming windows are opened to provide natural ventilation (worst-case). This methodology is supported by the NSW INP.

5.2.2 Construction Noise

The relevant guideline applied for the assessment of construction noise is the ICNG. This guideline provides construction noise criteria for Residential, Commercial and Industrial noise receivers as follows.

5.2.2.1 Residential Receivers

Section 4 of the ICNG provides recommendations for standard hours of work and suggests construction noise management levels that aim to minimise the likelihood of annoyance caused to noise sensitive receivers. These consider both airborne and ground borne noise level impacts.

Table 6 outlines the methodology for determining construction noise criteria at nearby residential receivers surrounding the development site based on existing background noise levels.

Time of Day	Management level $L_{Aeq\ (15\ min)}$	How to Apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL[12] + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details
	Highly noise affected 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours:	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2.

Table 6: Residential construction noise criteria for airborne noise as outlined in the ICNG

The project-specific construction noise criteria are shown in Table 7 based on the measured background noise levels at the site (Section 4.2).

[12] The RBL is the overall single figure background level representing each assessment period (day/evening/night) over the whole assessment period. This is the level used for assessment purposes and is further described in the NSW NPI.

Location	Period		Rating Background Level RBL, dB(A)	Criteria $L_{eq\ (15\ min)}$ dB(A)	
Residential (Catchment A)	Recommended Standard Hours	Monday to Friday 7am to 6pm	47	RBL + 10	57
		Saturday 8am to 1pm	47		57
	Outside Recommended Standard Hours[13]	Friday 6pm to 10pm	45	RBL + 5	50
		Saturday 7am to 8am	47		52
		Saturday 1pm to 6pm	47		52
		Saturday 6pm to 10pm	44		49
		Sunday 7am to 6pm	44		49
		Sunday 6pm to 10pm	44		49
Residential (Catchment B)	Recommended Standard Hours	Monday to Friday 7am to 6pm	46	RBL + 10	56
		Saturday 8am to 1pm	46		56
	Outside Recommended Standard Hours	Friday 6pm to 10pm	44	RBL + 5	49
		Saturday 7am to 8am	43		48
		Saturday 1pm to 6pm	46		51
		Saturday 6pm to 10pm	43		48
		Sunday 7am to 6pm	43		48
		Sunday 6pm to 10pm	43		48

Table 7: Project Specific residential construction noise criteria for **airborne** noise

[13] For "Outside Recommended Standard Hours" the relevant RBL has been established based on the NSW NPI period (Day, Evening, Night) that the proposed outside hours works fall within. Shoulder periods are applied where the outside hour's works are proposed within one hour of "Recommended Standard Hours".

The ICNG also recommends *ground-borne* noise management levels at residences affected by nearby construction activities. Ground-borne noise is noise generated by vibration transmitted through the ground into a structure and can be more noticeable than airborne noise.

The ground-borne noise levels presented below are for evening and night-time periods only, as the objective is to protect the amenity and sleep of occupants during the more sensitive time periods.

Time of Day	Management level L_{Aeq} (15 min)
Evening (6pm to 10pm)	40 dB(A) - Internal
Night (10pm to 7am)	35 dB(A) - Internal

Table 8: Residential construction noise criteria for **ground-borne** noise

5.2.2.2 Non-Residential Receivers: Commercial, Industrial and Educational Receivers

The ICNG also provides recommended construction noise management levels for commercial, industrial and educational facilities surrounding a construction site, which are as follows:

Occupancy	Management level L_{Aeq} (15 min)
Industrial premises	75 dB(A) - External
Offices, retail outlets	70 dB(A) - External
Classrooms at schools and other educational institutions	45 dB(A) - Internal / 55 dB(A) - External[14]
Hospital Wards and operating Theatres	45 dB(A) - Internal / 65 dB(A) - External[15]
Place of worship	45 dB(A) - Internal
Passive recreation areas	60 dB(A) - External

Table 9: Industrial, commercial, educational and hospital construction noise criteria for airborne noise

[14] Where internal noise levels are specified, the NSW NPI assessment methodology states that in cases where the gaining of internal access for monitoring is difficult, then external noise levels 10 dB above internal noise levels apply assuming a window opened sufficiently to provide ventilation.

15 For hospitals, where windows are typically fixed (inoperable), it is assumed that the weakest building element (typically glazing) will provide a minimum of 20 dB(A) sound reduction. Therefore, external levels are based on an internal noise level plus 20 dB.

5.2.2.3 Construction Noise Impacts on Existing Randwick Hospitals Campus and UNSW

The ICNG does not provide specific guidance for hospitals, other than recommending an internal noise "management level" of 45 dB(A) for wards and operating theatres, above which the proponent is to consult with the health authority to determine ways to manage construction noise impacts.

In this case, HI is the project proponent, as well as the affected receiver. Also, there are a number existing hospital uses and activities that could be affected by construction noise, in addition to wards and operating theatres outlined in Table 9.

For this project, it is recommended that the ICNG internal management level of 45 dB(A) is adopted for the existing POW Hospital buildings, including a corresponding external management level of 65 dB(A)[15].

There are some areas of the existing Randwick Hospitals Campus and UNSW campus where the noise management level may be higher or lower than these values. These areas will be assessed individually prior to works commencing on site and incorporated within the CNVMP - as information becomes available from the Local Health Department (LHD) and UNSW.

5.2.2.4 Construction Traffic Noise on Public Roads

The RNP provides criteria for traffic noise from new roads or additional traffic generated on roads from land use development. The criterion applies to additional traffic generated on public roads from construction vehicles / traffic.

Table 10 below provides the RNP criteria for additional traffic generated on local roads from land use development in relation to the applicable receiver types surrounding the site.

Receiver	Assessment Criteria (external[16])	
	Day (7am to 10pm) $L_{Aeq\ (period)}$	Night (10pm to 7am) $L_{Aeq\ (period)}$
Residential	55 (1 hour)	50 (1 hour)
Places of worship	50 (1 hour)	50 (1 hour)
Passive Recreational Space	55 (15 hours)	-
School classrooms	60 (1 hour)	-
Hospital Wards	45 (1 hour)	45 (1 hour)

Table 10: RNP assessment criteria for additional traffic on local roads generated by land use development including construction vehicles / traffic

Results from the long-term traffic noise level measurements along High Street and Botany Street presented in Table 1 show that the existing traffic noise levels are currently equal to

[16] Non-residential external noise criteria are derived from internal noise criteria, assuming a transmission loss of 10dBA if windows are opened to provide natural ventilation (worst-case) and 20dBA if the windows are closed or external façade is glazing. This methodology is supported by the NPI.

or exceeding the dB $L_{Aeq\ (1hr)}$ RNP criteria for all receiver types surrounding the site. In such cases, the increase in the traffic noise levels arising from the additional traffic generated from land use development is assessed in relation to the existing noise levels.

When considering land use redevelopment and the impact on sensitive land uses (residential / schools / hospitals / recreational) the RNP guideline states that *"In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB"… (in relation to existing noise levels).. "represents a minor impact that is considered barely perceptible to the average person".*

5.2.3 Construction Vibration

Construction vibration is to be assessed in terms of:

- Human comfort
- Disruption to sensitive equipment (applicable to surrounding Randwick Hospitals Campus and UNSW buildings)
- Structural damage

Relevant criteria for each of these are detailed in the sections that follow.

5.2.3.1 Human Comfort

The Department of Environment and Conservation (DEC) "Assessing Vibration: A Technical Guideline", (2006) provides suitable criteria that can be applied to the assessment of vibration and human comfort. The guideline makes reference to the British Standard BS 6472: 1992, which shares many similarities to the Australian Standards AS 2670.2: 1990. This guideline presents preferred and maximum vibration values for use in assessing human responses to vibration plus limits for critical areas in hospital and educational buildings, and provides recommendations for measurement and evaluation techniques.

Vibration in buildings can be caused by many different external sources, including industrial, construction and transportation activities. The vibration may be continuous (with magnitudes varying or remaining constant with time), impulsive (such as in shocks) or intermittent (with the magnitude of each event being either constant or varying with time). Vibration in buildings may also occur from internal sources (within a building structure), such as building services and plant. As well as being sensitive to vibration, medical equipment can also be the source of vibration within the building.

Vibration and its associated effects are usually classified as continuous, impulsive or intermittent:

- **Continuous vibration** continues uninterrupted for a defined period (usually throughout daytime and/or night-time). This type of vibration is assessed on the basis of weighted rms acceleration values.

- **Impulsive vibration** is a rapid build up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds.
- **Intermittent vibration** can be defined as interrupted periods of continuous (e.g. a drill) or repeated periods of impulsive vibration (e.g. a pile driver), or continuous vibration that varies significantly in magnitude. It may originate from impulse sources (e.g. pile drivers and forging presses) or repetitive sources (e.g. pavement breakers), or sources which operate intermittently, but which would produce continuous vibration if operated continuously (for example, intermittent machinery, railway trains and traffic passing by). This type of vibration is assessed on the basis of vibration dose values.

The criterion also considers the type of vibration being assessed, namely continuous, impulsive and intermittent vibration. Examples of these vibration types are provided in Table 11 below.

Continuous	Impulsive	Intermittent
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer this would be assessed against impulsive vibration criteria.

Table 11: Examples of vibration types

The relevant criteria for human exposure to continuous and impulsive vibration are detailed in Table 12. Vibration levels are assessed through the consideration of the summation of effects for vibration levels at frequencies from 1 to 80 Hz for all axes.

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration					
Critical areas	Day or night time	0.10	0.072	0.20	0.14
Residences	Day time	0.20	0.14	0.40	0.28
	Night time	0.14	0.10	0.28	0.2
Offices, schools, educational institutions and places of worship	Day or night time	0.40	0.28	0.80	0.56
Workshops	Day or night time	0.80	0.58	1.6	1.16
Impulsive vibration					
Critical areas	Day or night time	0.10	0.072	0.20	0.14
Residences	Day time	6.0	4.2	12.0	8.4
	Night time	2.0	1.4	4.0	2.8
Offices, schools, educational institutions and places of worship	Day or night time	13.0	9.2	26.0	18.4
Workshops	Day or night time	13.0	9.2	26.0	18.4

Table 12: Preferred and maximum weighted rms values for continuous and impulsive vibration velocity (mm/s) 1-80 Hz

Human exposure to intermittent vibration is assessed using the Vibration Dose Value (VDV). The VDV accumulates the vibration energy experienced over an extended period (daytime and night-time periods) from intermittent events. Table 13 sets out the acceptable VDV values for intermittent vibration.

Location	Daytime		Night-time	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Table 13: Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

5.2.3.2 Sensitive Equipment

Areas of the existing Randwick Hospitals Campus and UNSW campus (see Section 5.2.3.4) with sensitive equipment are likely to require a higher degree of vibration isolation than the values outlined in Table 12 and Table 13.

Vibration Criterion (VC) curves are used to provide the basis for the design and protection of highly vibration sensitive equipment. Table 14 details the VC curves applicable to a range of highly sensitive equipment that is to be referred to and considered in conjunction with manufacturer guidelines specific to each type of equipment.

Curve	Max Value 8-80Hz	Detail Size	Equipment Types / Requirements
	Microns / sec, rms	Microns	
VC-A	50	8	Bench Microscopes < 400 x Magnification, optical and other precision balances, coordinate measuring machines and optical comparators
VC-B	25	3	Bench Microscopes > 400 x Magnification, microsurgery and neurosurgery
VC-C	12.5	1	Electron Microscopes < 30,000 x magnification, magnetic resonance imagers and microelectronics manufacturing equipment
VC-D	6	0.3	Electron Microscopes > 30,000 x magnification, mass spectrometers and cell impact equipment
VC-E	3	0.1	Un Isolated laser and optical research systems

Table 14: VC Curves for Highly Sensitive Equipment

Figure 2 shows the relationship between criteria for highly sensitive equipment and human exposure criteria shown in Table 12.

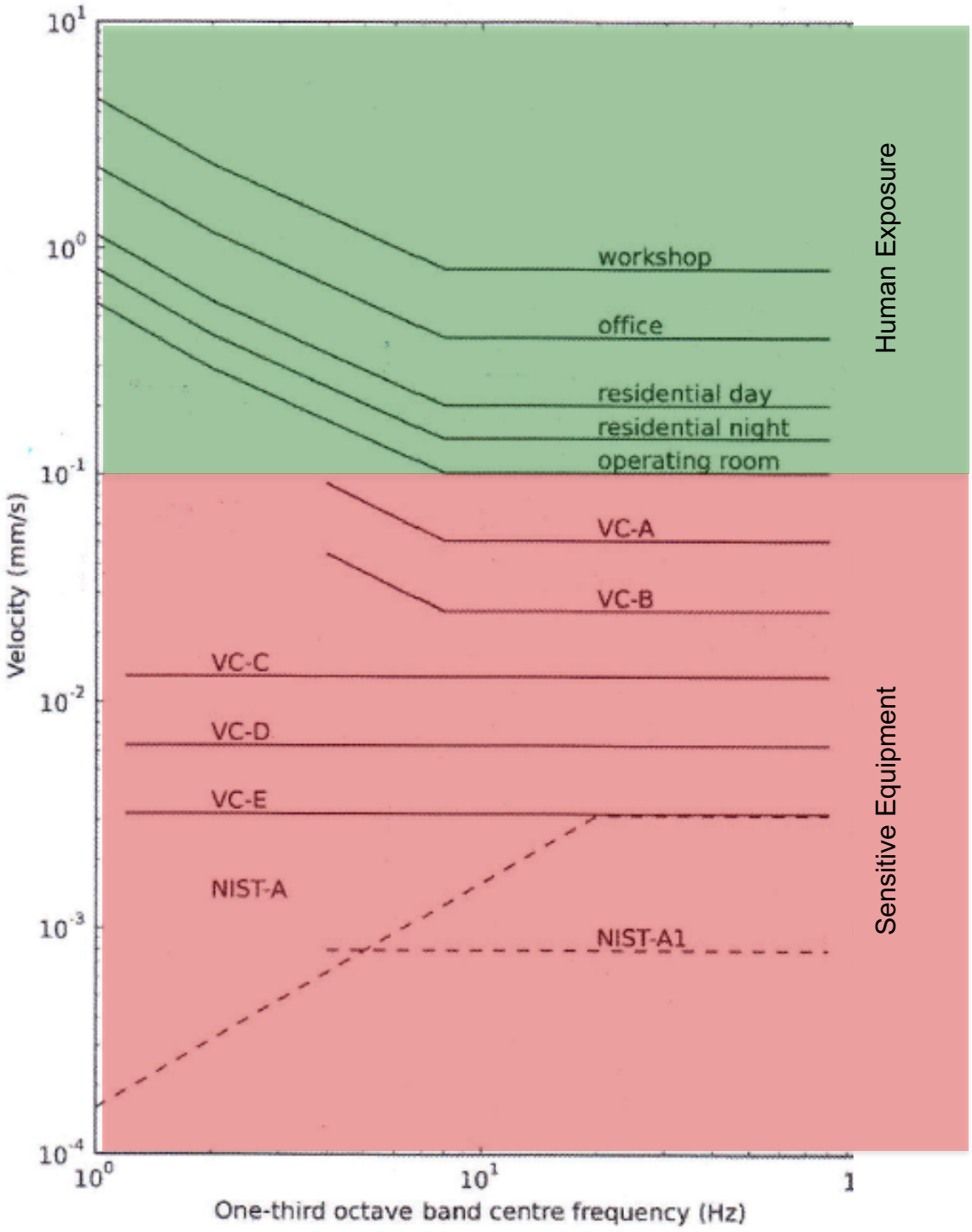


Figure 2: VC Curves - Source: ANC Guidelines – Measurement and Assessment of Ground-borne Noise & Vibration, Association of Noise Consultants (2012)

5.2.3.3 Structural Damage

Vibration-induced damage of buildings and structures is a common concern, but it is actually rare in practice. This explains why there is limited reliable data on the threshold of vibration-induced damage in buildings and there is no directly relevant Australian Standard. There are guidelines available in a number of international standards, although these vary significantly.

5.2.3.3.1 German Standard

The relevant German standard is *DIN 4150-3 Structural vibration Part 3: Effects of vibration on structures" (Feb 1999)*. This standard gives guidelines for short-term and steady state structural vibration. The short-term vibration limits as follows:

Structural type	Vibration Velocity, v_i, in mm/s			
	Foundation			Plane of floor of uppermost full storey
	less than 10 Hz	10 to 50 Hz	50 to 100 Hz	Frequency mixture
Commercial, Industrial or Similar	20	20 to 40	40 to 50	40
Dwellings or Similar	5	5 to 15	15 to 20	15
Particularly Sensitive	3	3 to 8	8 to 10	8

Table 15: Guideline Values of Vibration Velocity, v_i, for Evaluating the Effects of Short-term Vibration

The guidelines note that: "*provided the values given in* Table 15 *are observed, damage due to vibration, in terms of a reduction in utility value, is unlikely to occur. If the values of* Table 15 *are exceeded, it does not necessarily follow that damage will occur. Should these values be significantly exceeded, further investigation is necessary.*"

5.2.3.3.2 Swiss Standard

The relevant Swiss standard is SN 640 312:1978. The vibration limits for steady state vibration are as follows:

Structural type	Vibration Velocity, v_i, in mm/s	
	Foundation	
	10 to 30 Hz	30 to 60 Hz
Commercial, Industrial including retaining walls	12	12 to 18
Foundation walls and floors in concrete or masonry. Retaining walls and ashlar construction	8	8 to 12
Foundations and basement floors concrete, with wooden beams on upper floors. Brick walls.	5	5 to 8
Particularly sensitive	3	3 to 5

Table 16: Guideline Values of Vibration Velocity, v_i, for Evaluating the Effects of Steady State Vibration

5.2.3.3.3 British Standard

The relevant standard is BS7385: Part 2: 1993[17]. This standard was developed from an extensive review of UK data, relevant national and international documents and other published data, which yielded very few cases of vibration-induced damage. This standard contains the most up-to-date research on vibration damage in structures. Part 2 of the standard gives specific guidance on the levels of vibration below which building structures are considered to be at minimal risk.

The Standard proposes the following limits on the foundations of the buildings:

Structural type	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15Hz and above
Unreinforced or light framed structures Residential or light commercial type buildings	15mm/s @ 4Hz increasing to 20mm/s @ 15Hz	20mm/s @ 15Hz increasing to 50mm/s @ 40Hz and above

Table 17: Transient Vibration Guide Values for Cosmetic Damage

[17] BS 7385: Part 2: 1993 Evaluation and Measurement for vibration in Buildings, Guide to damage levels from ground-borne vibration.

The standard states in Annex A, that … "*the age and existing condition of a building are factors to consider in assessing the tolerance to vibration. If a building is in a very unstable state, then it will tend to be more vulnerable to the possibility of damage arising from vibration or any other ground-borne disturbance".* It is recommended that buildings of importance be considered on a case-by-case basis with detailed engineering analysis being carried out if necessary.

Annex B of the Standard gives a breakdown of data that would be recorded. Included in this are details of the building structure, such as general condition of the structure, list of defects, photographs, details of all major extensions, repairs and renovations. A crack exposure report would be prepared both pre and post exposure, both internally and externally.

5.2.3.3.4 Australian Standard

There is no specific Australian Standard referring to structural vibration in buildings. There is however AS 2187.2 - 1993[18], which, in Appendix J, recommends maximum peak particle velocities, measured at the ground surface due to blasting. The lower recommended peak particle velocity is 10 mm/s. The standard states however, that structures that may be particularly susceptible to ground-borne vibration would be examined on an individual basis. It is suggested that in the absence of a particular site-specific study then a maximum peak particle velocity of 5 mm/s is used.

5.2.3.3.5 Summary

Table 18 gives a summary of vibration limits recommended in relevant standards and guidelines for minimising the risk of vibration-induced damage to buildings.

[18] AS 2187.2 - 1993 Explosives - Storage, transport and use. Part 2: Use of explosives.

Standard	Type of building	Recommended vibration limit	Comments
DIN 4150	Structures of particular sensitivity or worthy of protection	3 mm/s to 20 mm/s @ < 10 Hz 3-40 mm/s @ 10-50 Hz 8-50 mm/s @ 50 Hz+ Also measurement at the top floor with limit of 8 mm/s to 40 mm/s across frequency range	Limit is for peak particle velocity in x,y, and z directions. Measurement on the top floor in x and y directions only
BS 7385	Un-reinforced or light framed	15 mm/s @ 4 Hz rising to 20 mm/s @ 15 Hz then rising to 50 mm/s @ 40 Hz and above[1]	Limit is for peak particle velocity in x, y, and z directions
AS 2187	Houses and low-rise residential, commercial buildings not of reinforced or steel construction	5 mm/s[1]	For buildings particularly susceptible to vibration. Limit is for peak *resultant* particle velocity, measured on the ground adjacent to the structure
SN 640 312	Structures of particular sensitivity	3 mm/s to 12 mm/s @ 10-30 Hz 3 mm/s to 18 mm/s @ 30-60 Hz	Limit is for peak particle velocity in x, y, and z directions

Table 18: Summary of vibration limits

5.2.3.3.6 Recommendations

It is clear from the above that relevant standards provide a wide range of suggested vibration limit values for structural damage, but the actual risk of vibration-induced damage is relatively low.

It is recommended that a precautionary approach for managing vibration-induced damage be taken for this project, whereby conservative vibration criteria are adopted in the first instance. It would be possible to relax these criteria if required, subject to review of specific buildings by a structural engineer and a regime of vibration monitoring.

The recommended precautionary criteria are:

- 3 mm/s (130 dB re 10^{-6} mm/s) for buildings surrounding the project site identified as "sensitive". At this stage no structures at or surrounding the site have been identified as particularly sensitive to vibration-induced damage.
- 5 mm/s (134 dB re 10^{-6} mm/s) for residential dwellings.
- 20 mm/s (146 dB re 10^{-6} mm/s) for classrooms, non-precision laboratories and commercial premises.

These limits apply across the full frequency range of relevance (i.e. typically 1 Hz – 100Hz encountered in building construction).

5.2.3.4 Additional Criteria

The following outlines areas that we understand to have specific sensitivity to vibration. Objective requirements will be updated pending receipt of additional information from relevant stakeholders prior to works commencing on site, and incorporated within the CNVMP.

5.2.3.4.1 UNSW Receivers

Feedback from UNSW representatives has identified a number of areas where particularly sensitive research equipment is located. Appendix D, Table D outlines the facilities plus identifies general locations and applicable vibration to be considered for the purpose of this SSDA. Confirmation of the exact criteria is to be agreed with the relevant stakeholders to inform the CNVMP.

5.2.3.4.2 Randwick Hospitals Campus

The Randwick Hospitals Campus has provided the following diagram highlighting the areas, which are considered to have some level of vibration sensitivity that will need to be considered with regard to construction vibration levels.

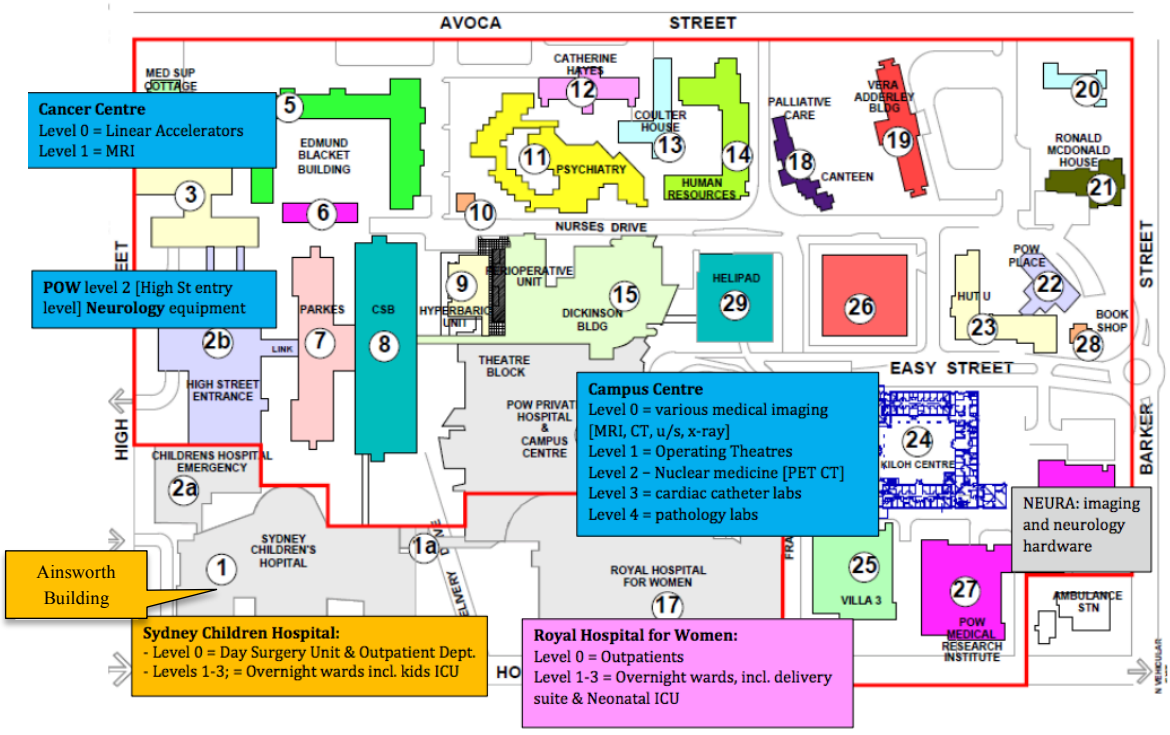


Figure 3: Randwick Hospitals Campus - Sensitive Receivers

Based on the above, Table 19 below outlines area-specific vibration criteria considered applicable for the construction works. Confirmation of the exact criteria and any specialist equipment requirements will need to be agreed with the relevant stakeholders to inform the CNVMP.

Facility	Space	Vibration Criterion Max RMS Velocity (mm/s)
Sydney Childrens Hospital, Randwick (including Ainsworth Building)	Day Surgery Unit	0.2
	Overnight Wards	0.14
POW Level 2	Neurology Hardware	VC-B
NEURA	Neurology Equipment	VC-B
Royal Hospital for Women	Outpatient	0.2
	Overnight Wards	0.14
	Delivery	0.4
	Neonatal ICU	0.14
Campus Centre	Medical Imaging	VC-C
	Operating Theatres	0.1
	Nucleare Medicine / Cardiac Catheter Labs, Pathology Labs	VC-A
Cancer Centre	Linear Accelerator	VC-E
	MRI	VC-C

Table 19: Randwick Hospitals Campus vibration sensitive receivers surrounding the IASB, plus construction works vibration criteria

The CNVMP prepared by the Contractor will need to consider the relevant Randwick Hospitals Campus and UNSW campus areas where sensitive equipment is located and the equipment-specific vibration criteria to be set and managed accordingly.

5.2.4 Sleep Disturbance

Noise sources with the potential for sleep disturbance are likely to occur during night-time period operational (10pm to 7am) activities.

The NSW NPI provides guidance on the assessment of sleep disturbance based on the predicted event $L_{Aeq,15min}$ and/or L_{AFmax} noise levels at the receiver that are considered applicable to the SSDA. It suggests a Sleep Disturbance Screening Criteria of:

Event $L_{Aeq,15min}$ 40 dB(A) or Night Time RBL+ 5 dB, whichever is the greater, and/or

Event L_{AFmax} 52 dB(A) or Night Time RBL + 15 dB, whichever is the greater.

If the event $L_{Aeq,15min}$ noise level above background is less than 5 dB and/or maximum noise emergence above background is less than 15 dB, then the noise is considered unlikely to cause sleep disturbance. If the screening test level is exceeded, then further assessment of sleep disturbance effects is warranted.

The Sleep Disturbance Screening Criteria are presented in Table 20.

Residential Receiver Location	Period	Sleep Distrubance Screening Criteria	
		$L_{Aeq,15min}$ dBA	L_{AFmax}, dBA
Catchment A	Night (10pm to 7am)	48	58
Catchment B		48	58

Table 20: Sleep Disturbance Screening Criteria

The Sleep Disturbance Screening Criteria $L_{Aeq,15min}$ and L_{AFmax} not exceeding the $L_{A90,\ (15\ minute)}$ by more than 5 dB(A) and 15 dB(A) respectively are screening criteria for the purpose of assessing potential impacts from a project. It applies outside bedroom windows during the night-time period.

If the Sleep Disturbance Screening Criteria is exceeded, the detailed analysis is to cover the extent to which the noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the RNP.

Other factors that may be important in assessing the extent of impacts on sleep include:

- How often high noise events will occur;
- Time of day (normally between 10pm and 7am);
- Whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

A further consideration for sleep awakening is whether the environmental noise has changed. Section 5.3 “Response to a Change in Noise Level” of the RNP states:

"While people may express a certain tolerance for their existing noise environment, they may feel strongly about increases in noise. […] The difference in reported awakenings from sleep was equivalent to a difference of 7 dB(A) in maximum noise levels."

Section 5.4 of the RNP, "Sleep Disturbance", states that:

"From the research on sleep disturbance to date it can be concluded that:

- *Maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep;*
- *One or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly."*

The internal noise levels provided in the RNP are related to potential sleep awakening.

Typically noise impact assessments consider the worst-case scenario, including when residential receivers have windows open sufficiently to provide natural ventilation. This would result in approximately 10 dB(A) attenuation from outside to inside through the open window. This situation is considered likely during warmer seasons. When windows are closed, the likely sound attenuation through standard windows with poor seals (common in older houses) is approximately 20 dB(A).

Based on a minimum attenuation of 10 dB(A) with windows open, the first conclusion of the RNP suggests (extract from RNP Section 5.4 above) that short term external noises of 60 to 65 dB(A) are unlikely to cause awakening reactions. In addition, external levels of 75 to 80 dB(A) are unlikely to affect health and wellbeing significantly, provided that these events occur no more than twice in one night.

Residential Receiver Location	Period	Sleep Awakening Level[19]
		L_{AFmax}, dB(A)
Catchment A Catchment B	Night (10pm to 7am)	60 to 65

Table 21: Sleep Awakening Level

[19] External noise criteria assuming minimum attenuation of 10 dB(A) with windows open.

6 External Noise Emissions

6.1 Building Services

The following are recommended external noise controls where allowances are to be made for buildings services proposed for the development. Recommendations for key / major plant noise controls are also shown on diagrams in Appendix C.

6.1.1 Mechanical Plant and Equipment

Mechanical plant and equipment associated with the operation of the development is to be controlled to ensure external noise emissions are not intrusive and do not impact on the amenity of neighbouring receivers in accordance with the relevant criteria established in Section 5 of this report.

Major plant is proposed to be located in the following areas:

- Level 05 plant room (AHUs)
- Level 09 plant room (AHUs, FCU and Chillers)

6.1.1.1 Plant Rooms

Including but not limited to the following:

- Level 05 AHU plant – attenuation / acoustic louvres
- Level 09
    - Chillers – attenuation / acoustic louvres
    - AHU plant – attenuation / acoustic louvres
    - FCU plant – attenuation / acoustic louvres

6.1.1.2 Cooling Towers and Emergency Generators

No additional cooling towers or emergency generators have been proposed as part of the Project and there will be no changes to the selections for the ASB cooling towers and emergency generators as a result of the integration. Sections 6.1.1.2 and 6.1.1.3 of the Noise and Vibration Impact Assessment for SSD, dated 8 August 2018[20], report provide recommended external noise controls for the ASB cooling towers and emergency generators; these recommendations remain unchanged and are to continue to be implemented.

[20] Report Reference: Randwick Campus Redevelopment, Noise and Vibration Impact Assessment for SSD - ASB – 20180808 AUR.0003.Rep.

6.1.1.3 Fans (Levels 05 & 09)

Fans will generally need to allow for a minimum 1m of internally lined duct plus 1 lined mitred bend as follows:

- Discharge for Exhaust Air Fan (EAF), Toilet Exhaust Fan (TEF) and Smoke Exhaust Fan / Return Air Fan (SEF / RAF).

6.2 Operational Noise

As outlined in the Executive Summary of this assessment report, the operational noise impacts of the IASB Addition are considered to be limited to three matters above those highlighted in the report for the approved ASB SSDA (9113);

1. Revised access for trucks to the existing POW Hospital Dock.
    - **Consideration:** The works to lower Hospital Road will limit traffic access to the existing Prince of Wales Hospital Dock to entry and exit along Hospital Road from the south off Barker Street.
2. Opening of Magill Street for traffic.
    - **Consideration:** Impact of Magill Street opening to through traffic.
    - **Mitigation:** There will be no change in the general traffic noise generated by the approved ASB SSDA (9113). The existing Prince of Wales Car Park entry and exit points on Hospital Road will remain closed from 6pm to 6am. A boom-gate is proposed at the intersection of Magill Street and Hospital Road which will be closed between 10pm and 7am.
3. An increase in traffic dropping off at the ASB Main entry.
    - **Consideration:** The IASB Addition may result in increased drop off traffic at the ASB main entry plaza.
    - **Mitigation:** Cars departing the ASB drop-off to proceed to park, drivers will be advised via signage that access to the car park from 6pm to 6am is via Barker Street and Easy Street. Staff accessing the car park will be aware of the 6am to 7am closure of the boom-gate at the intersection of Magill Street and Hospital Road and proceed as usual via Barker Street.

The above items are assessed and discussed in the sections to follow.

6.2.1 Traffic Noise Generation

Acoustic Studio has considered additional traffic noise generation impacts (associated with the IASB Addition) on streets surrounding the Project.

Following a review of the Transport Assessment[21] prepared by Arup we make the following comments:

[21] Reference: Randwick Campus Redevelopment – Integrated Acute Services Building (IASB) Addition, Transport Assessment Report prepared by Arup, July 2019.

Daytime and Evening Time Periods (7 am to 10 pm)

- When compared with the approved ASB, there is no increase in traffic volumes during the day-time as a result of the IASB Addition. Consequently, traffic noise impacts at Magill Street residences during the day-time will be the same as the approved ASB and, therefore, require no further assessment.

Night Time Period (10 pm to 7 am)

- When compared with the approved ASB, there will be no additional traffic using Magill Street during the night-time period (6pm to 7am). Consequently, traffic noise impacts at Magill Street residences as a result of the IASB Addition during the night-time will be the same as the approved ASB and, therefore, require no further assessment.

  In addition:

- The carpark exit on to Hospital Road is currently closed between 6pm and 6am. A boom-gate is proposed at the intersection of Magill Street and Hospital Road which will be closed between 10pm and 7am in order to help mitigate potential noise impacts during the night-time, particularly from Magill Street through-traffic and traffic accessing the car park via Magill Street.

  - As cars depart the ASB drop-off to proceed to park, drivers will be advised via signage that access to the car park after 6pm is via Barker Street and Easy Street.

  - Staff accessing the car park will be aware of the 6am to 7am closure of the boom-gate at the intersection of Magill Street and Hospital Road and proceed as usual via Barker Street.

  - Arup Transport Planning has noted that, with appropriate installation of road and site signage and given the distance between respective ASB driveways and the Magill Street / Botany Street intersection, vehicle acceleration events affecting Magill Street are unlikely to increase significantly relative to current (pre-ASB) occurrences. Therefore, instances of vehicle acceleration events are expected to remain low and, in any case, the likelihood of vehicle acceleration events and associated noise impacts will be the same as the approved ASB.

Based on the above, general traffic noise generated on surrounding roads as a result of the operations of the IASB Addition will be the same as the approved ASB during all time periods (Day, Evening and Night).

7 Light Rail Noise and Vibration

It is understood that the CBD and South East Light Rail corridor will pass through along High Street, nearby to the proposed development.

Potential noise and vibration impacts have been considered and we make the following comments.

- The IASB will be setback a sufficient distance (approximately 140m) from the light rail such that airborne noise impacts are not considered an issue. The determining factor for the building envelope construction will be driven by the control of helicopter noise, which will be louder than noise associated with light rail operations.
- The design of the light rail network will include vibration control measures to achieve specific vibration limits at the nearest residential receivers along High Street. Satisfying these limits will also ensure the vibration limits at the IASB are also achieved.

8 Construction Noise and Vibration

8.1 Description of Proposed Works

The Contractor has developed an indicative construction works program that outlines the key activities in each particular location. Based on this, it is anticipated that the key activities to occur for each area / stage are as follows:

Item	Stage of Works	Main Tasks	Itemised Activities[22]	Typical Plant
1	***Hospital Rd – Site Establishment***	Site preparation and HV diversions		Hand tools / hammer drill / concrete mixer / demo saw / circular saw / angle grinder
2	***Hospital Rd – Piling Works***	Piling		Piling Rigs
3	***Hospital Rd - Excavation & Roadworks***	Bulk excavation		Excavators / bobcat / skip trucks
		Foundation		Forklift / demo saw / mobile crane / concrete mixer truck/ concrete vibrator
		Roadworks		Hand tools / hammer drill / concrete mixer / demo saw / circular saw / angle grinder
4	***IASB – Structure, Concrete Cores & Roof***	Structure[23] (structural and precast columns during weekends of work)		Tower crane / mobile crane / hand tools / drill
		Concrete cores		Concrete mixer / concrete pump / concrete vibrator
		Roofing		Hand tools / drills / tower crane / angle grinders / circular saw
5	***IASB – Floors & Façade***	Stripping floors		Hand tools / angle grinders
		Installation of façade and glazing		Drill / hand tools / mobile crane / tower crane
6	***IASB - Internal Works***	Essential services		Hand tools / hammer drill / concrete mixer / demo saw / circular saw / angle grinder
		Fitout and finishes		Cement mixer / masonry saw / Hand tools / circular saw / angle grinders

Note: Items shaded in grey are works to be carried out internally within the building

Table 22: Proposed Works

[22] Where applicable

23 Only items 1-3 plus structural and precast columns portion under item 4 will be undertaken during weekends of work i.e. during specific weekends between Friday 6pm to 10pm, and Saturday and Sunday 7am to 10pm.

8.2 Construction Noise

The following sections outline the preliminary assessment carried out for construction noise emissions.

8.2.1 Noise Sources

The key noise sources for the activities occurring during construction works and the associated equipment noise levels are listed in Table 23. These values are based on Acoustic Studio's database and the relevant Australian and International Standards including AS2436:2010 and BS5228-1:2009.

Equipment Type	Item	Typical Noise Level $L_{Aeq,15min}$ SWL[24]
Heavy Vehicles	Tipper Truck	111
	Bin Lift Truck	111
	Hiab Truck	113
	Delivery trucks (semi-trailers, rigid trucks)	105
	Concrete Mixer trucks	109
Site Machinery	Mobile Crane	108
	Bobcat	110
	Excavator (with rock breaker / rock saw)	116
	Excavator (8 Tonne w/bucket)	105
	Wood Chipper	117
	Piling Rig	113
	Tower Crane	105
	Concrete Vibrator	101
	Concrete pump	110
Hand Held Tools	Angle Grinder	101
	Drill	91
	Hammer Drill	104
	Jackhammer	110
	Hand Tools (Electric)	99
	Circular saw	112
	Chain Saw	114
	Demo Saw	119

Table 23: Anticipated airborne noise levels for equipment / plant during construction works

[24] Noise levels provided in terms of Sound Power Level (SWL).

Potential sources of vibration and ground-borne noise during the Project works include:

- Construction and excavation plant including rock-breakers and jack hammers.
- Grinding, cutting and drilling of building structures.

Vibration and ground-borne noise impacts are likely to be highest during the excavation and piling work stages of the Project, when equipment such as rock breakers, jackhammers and piling rigs are used.

In addition, construction traffic movements around the site on the public roads will have the potential to impact on nearby noise-sensitive receivers.

8.2.2 Sensitive receivers

Nearest sensitive receivers to the Project site that will be potentially affected by noise and vibration are surrounding residential, commercial and educational premises as presented in Section 2.

Table 24 outlines the most critical receivers surrounding the site for each type of impact.

Receiver	Impact	Location	Approximate Distance from construction site	
			Closest Construction Site Boundary	Centre of Construction Site
Residential	Airborne + Ground Borne	Catchment A	155m	230m
	Airborne +Ground Borne	Catchment B	45m	65m
Commercial	Airborne	Catchment A	210m	265m
	Airborne	Catchment B	245m	260m
Place of Worship	Airborne	Catchment A	420m	460m
		Catchment B	400m	400m
Passive Recreation Area	Airborne	Catchment A	350m	410m
Educational	Airborne	UNSW Catchment D	150m	155m
Hospital	Airborne	Catchment C	5m	8m
Wallace Wurth Building	Airborne + Ground Borne + Vibration (Sensitive Equipment / Human Comfort / Building Damage)	UNSW Catchment D	155m	180m

Receiver	Impact	Location	Approximate Distance from construction site	
			Closest Construction Site Boundary	Centre of Construction Site
Lowy Building	Airborne + Ground Borne + Vibration (Sensitive Equipment / Human Comfort / Building Damage)	UNSW Catchment D	220m	255m
Biosciences Building	Airborne + Ground Borne + Vibration (Sensitive Equipment / Human Comfort / Building Damage)	UNSW Catchment D	145m	155m
Sydney Children's Hospital, Randwick (including Ainsworth Building)	Airborne + Ground Borne + Vibration (Sensitive Equipment / Human Comfort / Building Damage)	Catchment C	5m	25m
POW Level 2	Airborne + Ground Borne + Vibration (Sensitive Equipment / Human Comfort / Building Damage)	Catchment C	135m	185m
NEURA	Airborne + Ground Borne + Vibration (Sensitive Equipment / Human Comfort / Building Damage)	Catchment C	130m	160m
Royal Hospital for Women	Airborne + Ground Borne + Vibration (Sensitive Equipment / Human Comfort / Building Damage)	Catchment C	5m	20m
Campus Centre	Airborne + Ground Borne + Vibration (Sensitive Equipment / Human Comfort / Building Damage)	Catchment C	55m	60m
Cancer Centre	Airborne + Ground Borne + Vibration (Sensitive Equipment / Human Comfort / Building Damage)	Catchment C	220m	255m

Table 24: Noise sensitive receivers and approximate distance to Project construction works site

8.2.3 Construction Noise Assessment Methodology

A preliminary assessment of the likely noise impacts of the proposed works on the most-affected receivers surrounding the site has been carried out.

The assessment has considered the following:

- Typical activities considered in the noise impact assessment are as detailed in Section 8.1.
- Project specific criteria at each sensitive receiver location as outlined in Section 5.2.
- Noise level predictions are calculated using the noise data provided in Table 23.

- Noise level predictions consider:
    - Distance attenuation
    - Ground and building reflections
    - Meteorological conditions
- The noise level predictions are based on assumptions that represent the worst-case scenario.
- L_{Aeq} noise levels are predicted for the operations of the nearest works area on the site to each of the nearest sensitive receiver location.
- The predictions consider a range from individual tasks and associated equipment up to the cumulative noise contribution from all key activities and corresponding equipment with plant running simultaneously for each phase and main task.
- The predictions assume continuous operation of equipment / plant over the 15-minute assessment period, unless otherwise stated.

8.2.4 Assessment Results

8.2.4.1 Construction Noise

Table 25 presents the results for the construction noise assessment at surrounding receivers based on typical plant and equipment outlined in Section 8.2.1 operating within the boundary of the construction works site.

Location and Construction Activity	Predicted equipment noise levels at surrounding community receivers, in $dBL_{Aeq,15min}$							
	Residential		Commercial		Place of Worship	Passive Re-creational Area	Educational (UNSW)	Randwick Hospitals Campus
	Catchment							
	A	B	A	B	A/B	A	D	C
	Criteria, dB(A)							
	57[25] / 49[26]	56 / 48	70	70	55	60	55	65
Skip Truck	66/66	76/76	63	61	56	58	65	95
Concrete Mixer Truck	57/57	68/68	54	53	47	49	57	87
Concrete Vibrator	53/53	63/63	50	48	43	45	52	82
Excavator with Hammer	68/68	78/78	65	63	58	60	67	97
Bobcat	59/59	69/69	56	54	49	51	58	88
Concrete Pump	59/59	69/69	56	54	49	51	58	88
Mobile Crane	66/66	76/76	63	61	56	58	65	95
Tower Crane	57/57	67/67	54	52	47	49	56	86
Jackhammer	65/65	75/75	65	61	55	62	64	94
Piling Rig	66/66	76/76	63	61	56	58	65	95
Grinder	52/52	63/63	50	48	42	45	52	82
Hand Tools	52/52	63/63	50	48	42	45	52	82
Drill	52/52	63/63	49	47	42	44	52	82
Demo / Chain / Circular Saw	68/68	78/78	65	63	58	60	67	97
Forklift	52/52	62/62	49	47	42	44	51	81

Table 25: Predicted equipment/plant noise levels at the nearest surrounding community receiver locations – Levels predicted to exceed the "Recommended Standard Hours"/ commercial, industrial, educational criteria and "Outside Recommended Standard Hours" criteria" are in **red** and **blue**[27] respectively.

[25] Project specific "Recommended Standard Hours" criteria for Monday to Friday and Saturday

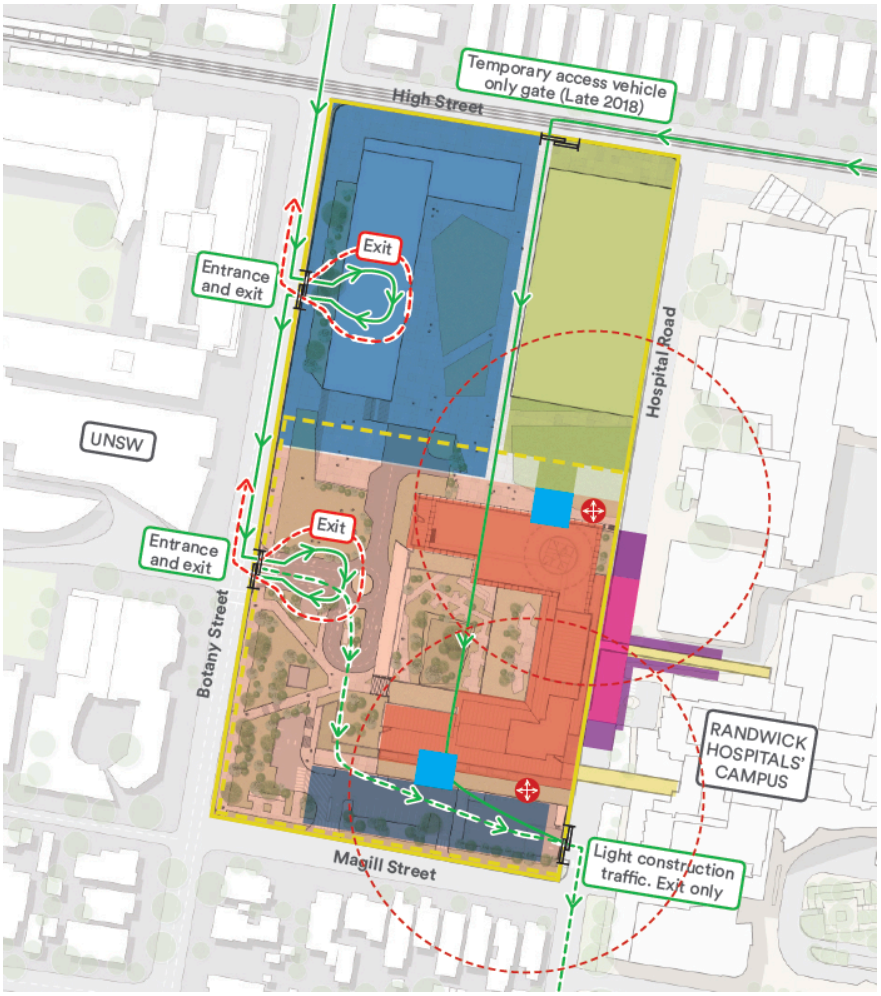
[26] Project specific "Outside Recommended Standard Hours" for Friday (6pm to 10pm), Saturday (7am to 8am and 1pm to 10pm) and Sunday (7am to 10pm)– worst-case (i.e. during Sunday evening)

No construction activities are proposed during the night-time period (10pm to 7am) and therefore, there is no potential for sleep disturbance or sleep awakening.

8.2.4.2 Construction Traffic Noise

As described in Section 5.2.2.4 and according to the RNP guideline, an increase in the traffic noise level of up to +2dB in relation to the existing traffic noise level is considered to be a minor impact and barely perceptible to the average person.

Figure 4 shows proposed construction traffic flow around the site, plus general traffic and work zones.



[27] Where recommended standard hours criteria are exceeded, outside recommended standard hours criteria are also exceeded.

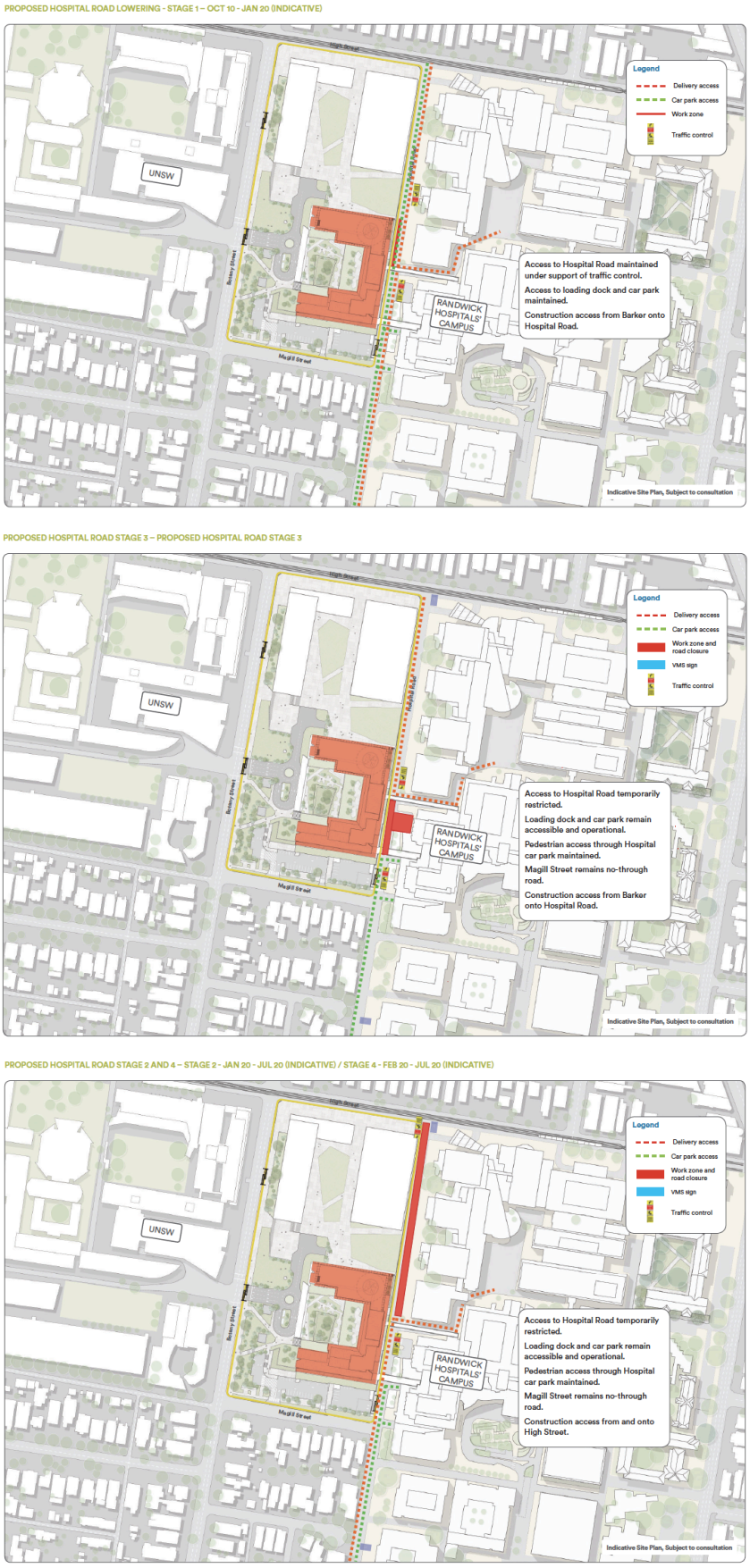


Figure 4: Proposed construction traffic flow around the site plus general traffic and work zones

Based on existing traffic volume data for the roads surrounding the site received from Arup on 22nd November 2017, the limit of increase in traffic volume can be predicted such that the resulting increase in traffic noise level over the existing is limited to +2dB. Further, considering the preliminary traffic volume data provided by Arup, Table 26 shows the indicative limits of increases in traffic volumes due to construction traffic to maintain an increase in traffic noise levels of less than 2 dB at each receiver.

Traffic Source	Existing Traffic Volume (Weekday Average, October 2017)		Limit of Increase in Traffic Volume (Weekday Average)	
	Day (7am-10pm)	Night (10pm-7am)	Day (7am-10pm)	Night (10pm-7am)
High Street	2498	440	1449	255
Botany Street	10991	1937	6375	1123
Hospital Road	3734	658	2166	382
Magill Street	440	78	255	45

Table 26: Indicative limit of increase in traffic volume due to addition of construction traffic, in order to maintain an increase in traffic noise level of less than 2 dB(A).

So long as construction traffic accessing the site results in increases of traffic volumes which are within the limits outlined in Table 26 , the increase of existing traffic noise levels will be less than 2 dB. Therefore, the RNP criteria will be met at all residential receivers for all time periods.

In order to facilitate the construction of the Hospital Road lowering, closure of Hospital Road is proposed in three stages. Following review of the Transport Assessment[28] prepared by Arup, we make the following comments:

- Stage 1 - During this stage of the project the northern side of Hospital Road will be occupied by a large 30t excavator to dig down and install the new sewer and stormwater pipe using a shoring box down to the middle of Delivery Drive. During this period logistics vehicles will access the Campus docks and the car park from Barker Street. This closure of Hospital Road will result in increased traffic volumes on Botany Street and Barker Street by up to a maximum increase of 19%.
- Stage 2 - Take possession of the southern portion of Delivery Drive and Hospital Road and complete road lowering. During this period logistics vehicles will access the Campus docks via High Street and all traffic will access the car park from Barker

[28] Reference: Randwick Campus Redevelopment – Integrated Acute Services Building (IASB) Addition, Transport Assessment Report prepared by Arup, 18 July 2019.

Street. This closure of Hospital Road will result in increased traffic volumes on Botany Street and Barker Street by up to a maximum increase of 19%.

- Stage 3 - Take possession of the northern portion of Delivery Drive and Hospital Road and complete road lowering. During this period logistics vehicles will access the Campus docks through the lowered Hospital Road and all traffic will access the car park from Barker Street. This closure of Hospital Road will result in increased traffic volumes on Botany Street and Barker Street by up to a maximum increase of 19%.

An increase in traffic volume by up to 19% during construction, as a result of the re-distribution of existing traffic, translates to an increase in traffic noise levels by a maximum of 1 dB in relation to the existing traffic noise levels. Therefore, the noise impacts due to the closure of Hospital Road in all three stages of construction are considered to be insignificant.

The proposed construction hours do not include the night-time period (10pm to 7am) and therefore, noise from construction traffic movements will not cause sleep disturbance. However, management of the timing of construction traffic movements shall be planned and managed wherever possible to: (a) avoid Magill Street and Hospital Road during early morning and out of standard hours; and (b) limit the frequency of construction vehicle movements to keep any increase in equivalent continuous traffic noise levels to a minimum. It is noted that construction vehicle access is not proposed along Magill Street.

8.2.5 Summary of Noise Assessment Findings and Discussion of Noise Controls During Construction

Based on the results of the preliminary high-level assessment, we make the following comments:

- Construction works noise impacts will be largest on buildings within the Randwick Hospitals Campus and nearby residential receivers on Magill Street. The individual and cumulative noise levels from operations of various plant and equipment are predicted to exceed the relevant criteria when at the closest position within the construction site boundaries to the affected receiver. However, when location of activities within the site boundary are further away from a particular receiver, compliance can be achieved depending on the distance to the receiver.
- The noise sensitive receivers at Residential Catchment B and Randwick Hospitals Campus buildings are the most sensitive. Noise from various plant and equipment operating individually are generally predicted to exceed the relevant criteria, due to the proximity to the nearest affected receivers. The worst-case exceedances are for excavators and demo / circular saws with noise levels predicted to exceed the relevant criteria by up to 32 dB(A) when used during recommended standard hours and up to 30 dB(A) when used outside recommended standard hours.

- For all other receivers, the noise generated from the construction works noise from individual equipment operating is generally able to achieve the relevant criteria.
- For construction works carried out outside standard recommended hours (i.e. Saturday - 1pm to 5pm), some plant/activities are predicted to exceed the outside standard hours criteria that would otherwise comply with the standard work hours criteria for residential receivers (see Table 7). In these cases, noisy activities are to be scheduled to less sensitive times so as to minimise potential noise impacts.
- The predictions above for noise levels exceeding the relevant criteria is not unusual given the heavy plant and equipment that must be used, such as excavators, and the proximity of sensitive receivers.
- Construction traffic along the roads surrounding the site will have no adverse noise impacts on nearby receivers during the day-time period.
- The noise impacts as a result of the re-distribution of existing traffic, due to closure of Hospital Road in all three stages of construction, are considered to be insignificant.
- Therefore, management of the timing of construction traffic movements shall be planned and managed wherever possible to: (a) avoid Magill Street and Hospital Road during early morning and out of standard hours; and (b) limit the frequency of construction vehicle movements to keep any increase in equivalent continuous traffic noise levels to a minimum. It is noted that construction vehicle access is not proposed along Magill Street.

It is important to recognise that the actual noise levels generated during the construction works are likely to vary considerably depending on many factors including:

- Number of items of plant and equipment operating simultaneously.
- Location of equipment on the site – relative to the noise-sensitive receivers.
- Shielding of noise provided by structures and hoardings on and around the site.
- Reflections provided by existing structures on and around the site.
- Meteorological conditions.

When construction and excavation works are likely to exceed stated criteria at nearest sensitive receivers, particularly when works occur in the areas closer to the nominated receiver, all feasible and reasonable noise control measures are to be considered.

If, during construction works, an item of equipment exceeds either the noise criteria at any location or the equipment noise level limits, the following noise control measures, together with construction best practices presented in Section 8.4 shall be considered to minimise the noise impacts on the neighbourhood:

- Schedule noisy activities to occur outside of the most sensitive times of the day for each nominated receiver. For example, avoiding works during sleeping times (that is 6am to 7am of the night-time period) at nearby residential receivers.
- Consider implementing equipment-specific temporary screening for noisy equipment, or other noise control measures recommended in Appendix E of AS2436. This is most likely to apply to noisier items such as jackhammers.
- For large work areas, solid screening or hoarding as part of the worksite perimeters would be beneficial.
- Locate specific activities such as carpentry areas (use of circular saws etc) to internal spaces or where shielding is provided by existing structures or temporary screening.
- Limit the number of trucks and heavy vehicles on site at any given time (through scheduling deliveries at different times).
- Unnecessary idling of vehicles and equipment is to be avoided.
- Traffic routes are to be prepared to minimise the noise impact on the community.
- When loading and unloading trucks, adopt best practice noise management strategies to avoid materials being dropped from a height.
- Adopt quieter methodologies. For example, where possible, use concrete sawing and removal of sections as opposed to jackhammering
- Ensure that any miscellaneous equipment (extraction fans, hand tools, etc), not specifically identified in this assessment, incorporates silencing/shielding equipment as required to meet the noise criteria.

Implementation of all reasonable and feasible mitigation measures for all works will ensure that any adverse noise impacts to surrounding residential, commercial and recreational receivers are minimised when noise goals cannot be met due to safety or space constraints.

It is recommended that a CNVMP is prepared further to this assessment at the detailed design stage. The Contractor would be required to prepare a final CNVMP based on their proposed plant, equipment and construction methodology.

8.3 Construction Vibration

When considering the vibration impact associated with construction works, the following is to be taken into account.

- The type of vibration generating equipment.
- Geotechnical characteristics of the site.
- The layout of the site, including the location of static sources of vibration.
- Techniques used in construction to minimise generated vibration levels.

- Hours of work with regard to the nature of operations in the affected buildings and the duration of the works.

8.3.1 Summary of Vibration Assessment and Discussion of Vibration Controls During Construction

Works associated with the Project include construction of the IASB.

Equipment used for these works will generate lower levels of vibration when compared to equipment used for demolition.

A detailed vibration assessment has not been carried out at this stage, as actual vibration levels experienced will be dependent upon

- Site and strata characteristics.
- Specific construction equipment used.
- Vibration requirements of sensitive equipment.

Based on the scope of works and typical equipment required, some structural and human perception vibration impacts are expected – particularly from the use of piling rigs during piling works and excavators with hammers during excavation works. In addition, there is potential for vibration impacts on sensitive equipment within existing Randwick Hospitals Campus and UNSW buildings. The significance of these impacts will need to be determined as part of the CNVMP prepared by the Contractor.

Therefore, it is recommended that, prior to the commencement of the construction stage, vibration surveys be carried out of each key vibration-generating-activity / equipment.

In addition to the Catchment A and Catchment B residential receivers, the CNVMP prepared by the Contractor must ensure, at the relevant UNSW and Randwick Hospitals campus areas where sensitive equipment is operated, that the equipment-specific vibration criteria are set and managed accordingly.

The Contractor shall carry out a vibration assessment at the commencement of operations for each vibration generating activity to determine whether the existence of significant vibration levels justifies a more detailed investigation.

If the assessment indicates that vibration levels might exceed the relevant criteria then vibration mitigation measures will need to be put in place to ensure vibration impacts are minimised using all reasonable and feasible measures and will allow for the planning of works around the use of sensitive buildings within the Randwick Hospitals Campus and on the UNSW campus.

A more detailed investigation would involve methods of constraining activities that generate high vibration levels. A method of monitoring vibration levels must then be put in place. Additionally, vibration monitors must also be put in place to manage sensitive areas. Vibration mitigation measures and vibration criteria will then need to be reviewed.

All practical means are to be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on site.

The following considerations shall be taken into account:

- Modifications to construction equipment used.
- Modifications to methods of construction.
- Rescheduling of activities to less sensitive times.

If the measures given above cannot be implemented or have no effect on vibration levels or impact generated, a review of the vibration criteria is to be undertaken and the vibration management strategy amended.

Catchments A and B residences plus Randwick Hospitals Campus buildings and some UNSW buildings present the most stringent vibration criteria, particularly given their proximity to the Project site. Controlling vibration at these receivers will also ensure that vibration criteria at all other receivers will also be satisfied.

It is recommended that a CNVMP is prepared further to this assessment at the detailed design stage when a Contractor is engaged. The Contractor would be required to prepare a final CNVMP based on their proposed plant, equipment and construction methodology.

8.4 Control elements

8.4.1 Noise

As a general rule, prevention is to be applied as universal work practice at any time of day, but especially for the occasional construction works to be undertaken at critical times outside normal daytime/weekday periods.

It is noted that the reduction of noise at the source and the control of the transmission path between the construction site and the receiver(s) are the preferred options for noise mitigation/minimisation. Construction noise shall be managed by implementing the strategies listed below:

- Plant and equipment
  - Use quieter methods.
  - Use quieter equipment.
  - Operate plant in a quiet and effective manner.
  - Where appropriate, limit the operating noise of equipment.
  - Maintain equipment regularly.
  - Where appropriate, obtain acoustic test certificates for equipment.
- On-site noise management
  - Strategically locate equipment and plant.
  - Avoid the use of reversing alarms or provide for alternative systems.

    - Maximise shielding in the form of existing structures or temporary barriers.
    - Schedule the construction of barriers and structures so they can be used as early as possible.
    - Brief Project staff and workers on the noise sensitivity of the neighbours to the site, particularly the residents nearby. The staff and workers need to be mindful of the noise from their discussions, particularly in sensitive periods, for example, during the pre-start times or "toolbox talk" as they gather to commence for work in the morning.
- Consultation, notification and complaints handling
    - Provide information to neighbours before and during construction.
    - Maintain good communication between the community and Project staff.
    - Have a documented complaints process and keep register of any complaints.
    - Give complaints a fair hearing and provide for a quick response.
    - Implement all feasible and reasonable measures to address the source of complaint.
- Work scheduling
    - Schedule activities to minimise noise impacts.
    - Ensure periods of respite are provided in the case of unavoidable maximum noise levels events.
    - Keep truck drivers informed of designated routes, parking locations and delivery hours.

8.4.2 Vibration

At this stage, we anticipate that construction works will result in some structural and human perception vibration impacts at surrounding receivers.

The Contractor shall carry out a vibration assessment at the commencement of operations for each vibration-generating-activity / equipment to determine whether the existence of significant vibration levels justifies a more detailed investigation.

A more detailed investigation will involve methods of constraining activities generating high vibration levels. A method of monitoring vibration levels will then need to be put in place. An additional review of vibration mitigation measures and vibration criteria may then be necessary.

All practical means are to be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on-site.

The following considerations shall be taken into account:

- Modifications to excavation and construction equipment used.
- Modifications to methods of excavation and construction.

- Rescheduling of activities to less sensitive times.

If the measures given above cannot be implemented or have no effect on vibration levels or impact generated, a review of the vibration criteria is to be undertaken and the vibration management strategy amended.

8.4.3 Vibration surveys

Since the actual vibration levels experienced will be dependent upon the site characteristics and the specific equipment being used, early vibration level checks are to be carried out on site at the outset of each key vibration generating activity (if vibration is considered to be an issue).

Shortly before the commencement of each activity, the background vibration level is to be measured and again once the activity has begun. If the survey indicates levels of vibration exceeding those expected, the vibration management strategy for that process is to be re-assessed.

8.4.4 Additional Noise and Vibration Control Measures

If, during construction, an item of equipment exceeds ether the noise criteria at any location or the equipment noise level limits, the following noise control measures, together with construction best practices presented in Section 8.4.1, shall be considered to minimise the noise impacts on the neighbourhood.

- Schedule noisy activities to occur outside of the most sensitive times of the day for each nominated receiver.
- Consider implementing equipment-specific screening or other noise control measures recommended in Appendix E of AS2436.
- Limit the number of trucks on site at the commencement of site activities to the minimum required by the loading facilities on site.
- When loading trucks, adopt best practice noise management strategies to avoid materials being dropped from height into dump trucks.
- Avoid unnecessary idling of trucks and equipment.
- Ensure that any miscellaneous equipment (extraction fans, hand tools, etc) not specifically identified in this assessment incorporates silencing/shielding equipment as required to meet the noise criteria.
- Minimise noise from workers as discussed in Section 8.4.1.

Implementation of all reasonable and feasible mitigation measures for all construction works will ensure that any adverse noise impacts to surrounding residential, commercial and recreational receivers are minimised when noise goals cannot be met due to safety or space constraints.

8.5 Noise and vibration monitoring

8.5.1 Noise monitoring

The Contractor is to consider implementing environmental noise monitoring at the locations described below.

- South boundary facing nearest residential receivers on Magill Street.
- North boundary facing nearest residential receivers on High Street.
- West boundary of construction site, nearest to the educational receivers at UNSW.
- East boundary of the site facing the nearest Randwick Hospitals Campus receivers.

An allowance of 1.5 days per week, at least, is to be dedicated to monitoring of noise and vibration for the first four weeks of construction works. Further monitoring is to be reviewed after this time or sooner should it be deemed necessary by the acoustic consultant and the Project Manager. This is to take place mainly at the above locations although other locations and plant and equipment monitoring are to take place as and when necessary. If results indicate vibration levels exceeding allowable limits appropriate action is to be taken.

8.5.2 Vibration monitoring

A vibration monitoring system is to be implemented if required. This system would monitor vibration levels when there is potential for them to change. This could happen in various situations, such as, changes in equipment and activities or changes to work procedures that might affect existing vibration control measures. The monitoring procedure would be carried out with appropriate equipment so that results obtained are readily comparable with results obtained earlier. If results indicate vibration levels exceeding allowable limits appropriate action is to be taken.

8.5.3 Reporting

The Contractor is to prepare a noise monitoring report each month for review by the Project Manager. The reports are to summarise and interpret the results of the noise and vibration monitoring carried out during the past month.

8.6 Communication and complaints

The Contractor is to establish a communications register for recording incoming complaints. The registration of a particular item will remain open until the complaint has been appropriately dealt with.

In addition the following procedures are an example of the procedures that are to be specifically adopted for complaints relating to noise.

Upon receipt of a complaint the Contractor is to:

- Try to ascertain from the complaint which appliance is causing the problem i.e. inside or outside the site and in what position.
- Establish from the monitoring equipment if the allowable noise levels have been complied with.
- Establish if the appliance positioning has previously been highlighted as a problem area. If not and the noise levels are above the allowable limit, then the equipment and its position shall be noted.
- Move machinery if the allowable levels have been exceeded or take other acoustic remedial action.

The Site Supervisor is to ensure that a report of any incident is provided to the Project Manager.

The Project Manager is to provide a report on the incident to the relevant stakeholders.

The Contractor is to provide a 24-hour telephone contact number and this number is to be prominently displayed on the site.

8.7 Non-compliances

Non-compliance reports can be used as appropriate to deal with failures to meet the construction noise and vibration management and control requirements.

9 Discussion and Recommendations

A construction and operational noise and vibration impact assessment (the assessment) has been prepared for the proposed IASB Addition (the proposed development).

The existing noise environment has been established based on long-term and short-term monitoring data.

Appropriate criteria for both noise and vibration have been established based on relevant guidelines and standards. A summary of the outcomes and recommendations of this noise and vibration assessment are as follows:

- Operational Noise

  Once completed, the IASB will operate 24 hours a day, seven days per week.

  Mechanical Plant

  The following are recommended external noise controls where allowances are to be made for buildings services for the proposed development:

  D. Plant Rooms
  Including, but not limited to, the following:
    - Level 05 AHU plant – attenuation / acoustic louvres.
    - Level 09
      - Chillers – attenuation / acoustic louvres
      - AHU Plant – attenuation / acoustic louvres
      - FCU Plant – attenuation / acoustic louvres.

  E. Cooling Towers and Emergency Generators

  No additional cooling towers or emergency generators have been proposed as part of the Project and there will be no changes to the selections for the ASB cooling towers and emergency generators as a result of the integration. Sections 6.1.1.2 and 6.1.1.3 of the Noise and Vibration Impact Assessment for SSD, dated 8 August 2018[29], report provide recommended external noise controls for the ASB cooling towers and emergency generators; these recommendations remain unchanged and are to continue to be implemented.

[29] Report Reference: Randwick Campus Redevelopment, Noise and Vibration Impact Assessment for SSD - ASB – 20180808 AUR.0003.Rep.

F. Fans (Levels 05 & 09)

Fans will generally need to allow for a minimum 1 m of internally lined duct plus 1 lined mitred bend as follows:

- Discharge for Exhaust Air Fan (EAF), Toilet Exhaust Fan (TEF) and Smoke Exhaust Fan / Return Air Fan (SEF / RAF).

Traffic Noise Generation

There will be no changes to the operation of the ambulance bay, loading dock / waste collection, Emergency Department (ED) drop-off area and emergency helicopters as a result of the IASB Addition and so the associated noise impacts require no further assessment. Therefore, these items have been excluded from this assessment.

B. General Traffic Noise

- When compared with the approved ASB, there is no increase in traffic volumes during the day-time as a result of the IASB Addition. Consequently, traffic noise impacts at Magill Street residences during the day-time will be the same as the approved ASB and, therefore, require no further assessment.
- When compared with the approved ASB, there will be no additional traffic using Magill Street during the night-time period (6pm to 7am). Consequently, traffic noise impacts at Magill Street residences as a result of the IASB Addition during the night-time will be the same as the approved ASB and, therefore, require no further assessment.

In addition:

- The car park exit on to Hospital Road is currently closed between 6pm and 6am. A boom-gate is proposed at the intersection of Magill Street and Hospital Road which will be closed between 10pm and 7am in order to help mitigate potential noise impacts during the night-time, particularly from Magill Street through-traffic and traffic accessing the car park via Magill Street.
- As cars depart the ASB drop-off to proceed to park, drivers will be advised via signage that access to the car park after 6pm is via Barker Street and Easy Street.
- Staff accessing the car park will be aware of the 6am to 7am closure of the boom-gate at the intersection of Magill Street and Hospital Road and proceed as usual via Barker Street.

- Arup Transport Planning has noted that, with appropriate installation of road and site signage and given the distance between respective ASB driveways and the Magill Street / Botany Street intersection, vehicle acceleration events affecting Magill Street are unlikely to increase significantly relative to current (pre-ASB) occurrences. Therefore, instances of vehicle acceleration events are expected to remain low and, in any case, the likelihood of vehicle acceleration events and associated noise impacts will be the same as the approved ASB.

- Based on the above, general traffic noise generated on surrounding roads as a result of the operations of the IASB Addition will be the same as the approved ASB during all time periods (Day, Evening and Night).

- Construction Noise

  Proposed construction hours for the Project are as follows:

  - Monday to Friday - 7:00am to 6:00pm.
  - Saturday - 8:00am to 5:00pm.
  - Sunday and Public Holidays – No works.

  In addition to the regular working hours above, forty weekends of works will be required over 18 months to ensure operational continuity of the loading dock during core working hours during the week. These works are to take place during those weekends between,

  - Friday – 6:00pm to 10:00pm
  - Saturday and Sunday 8:00am to 10:00pm.

  Based on the results of the assessment of construction activities, we make the following comments:

  - The noise sensitive receivers at Residential Catchment B and the existing Randwick Hospitals Campus buildings fronting Hospital Road are the most sensitive receivers to the site as they are closer to the construction works. Existing buildings at UNSW and Residential Catchment A are also identified as sensitive receivers.
  - There will be times / situations when construction works are likely to exceed stated criteria, particularly when works occur in the areas closest to sensitive receivers. The extent of exceedances may vary depending on the activities, equipment used, plus the times and locations of the works.
  - Construction works activities / plant are predicted to exceed the relevant criteria by up to 32 dB(A) when used during recommended standard hours and up to 30 dB(A) when used outside recommended standard hours. The worst-case exceedances are for excavators and demo / circular saws. In

these cases, noisy activities are to be scheduled to less sensitive times to minimise potential noise impacts.

- The predictions for noise levels exceeding the relevant criteria are not unusual given the heavy plant and equipment that must be used, such as excavators, and the proximity of those sensitive receivers.
- Construction traffic along the roads surrounding the site will have no adverse noise impacts on nearby receivers during all time periods.
- The noise impacts as a result of the re-distribution of existing traffic, due to closure of Hospital Road in all three stages of construction, are considered to be insignificant.
- However, management of the timing of construction traffic movements shall be planned and managed wherever possible to: (a) avoid Magill Street and Hospital Road during early morning and out of standard hours; and (b) limit the frequency of construction vehicle movements to keep any increase in equivalent continuous traffic noise levels to a minimum. It is noted that construction vehicle access is not proposed along Magill Street.
- If, during construction works, an item of equipment exceeds the stated airborne noise criteria at any sensitive location, the additional noise control measures presented in Section 8.4.4, together with construction best practices presented in Section 8.4.1, are to be reviewed and implemented to minimise the noise impacts on the neighbourhood.
- It is recommended that a Construction Noise and Vibration Management Plan (CNVMP) is prepared by the Contractor at the detailed design stage. The Contractor would be required to prepare a final CNVMP based on their proposed plant, equipment and construction methodology.

- Construction Vibration

  Based on the scope of works and typical equipment required, some structural and human perception vibration impacts are expected – particularly from the use of piling rigs during piling works and excavators with hammers during excavation works. In addition, there is potential for vibration impacts on sensitive equipment within existing Randwick Hospitals Campus and UNSW buildings. The significance of these impacts will need to be determined as part of the CNVMP prepared by the Contractor. In addition to the Catchment A and Catchment B residential receivers, the CNVMP prepared by the Contractor must ensure, at the relevant UNSW and Randwick Hospitals Campus areas where sensitive equipment is operated, that the equipment-specific vibration criteria are set and managed accordingly.
  The Contractor shall carry out a vibration assessment at the commencement of operations for each vibration generating activity to determine whether the existence of significant vibration levels justifies a more detailed investigation. If the assessment indicates that vibration levels are to exceed the relevant criteria then

appropriate vibration mitigation measures will need to be put in place to ensure vibration impacts are minimised using all reasonable and feasible measures and will allow for the planning of works around the use of sensitive buildings within the Randwick Hospitals Campus and on the UNSW campus.

A more detailed investigation would involve constraining activities which generate high vibration levels. A method of monitoring vibration levels could then be put in place. Vibration mitigation measures and vibration criteria will then need to be reviewed.

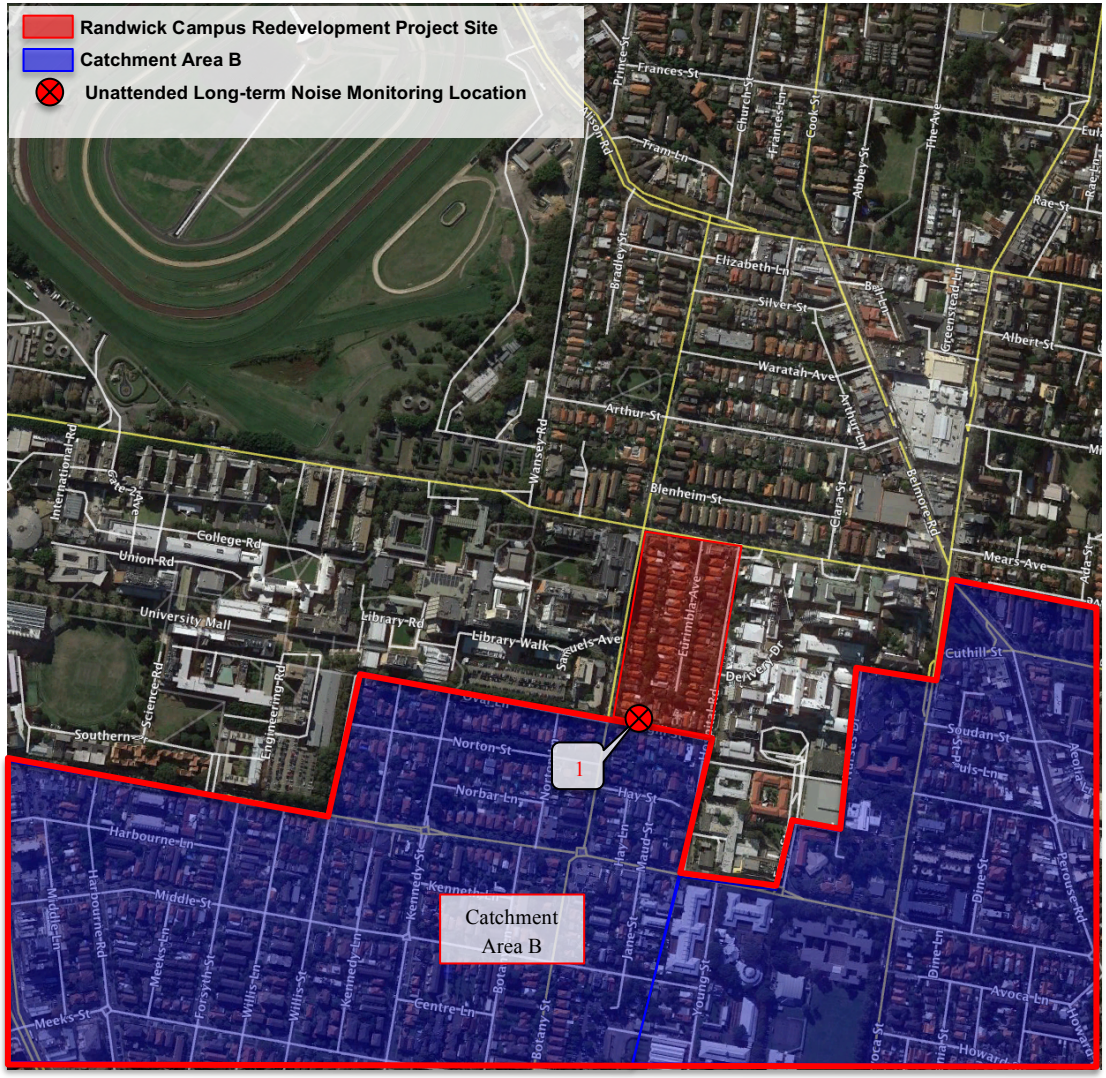
All practical means are to be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on site.

The following considerations shall be taken into account:

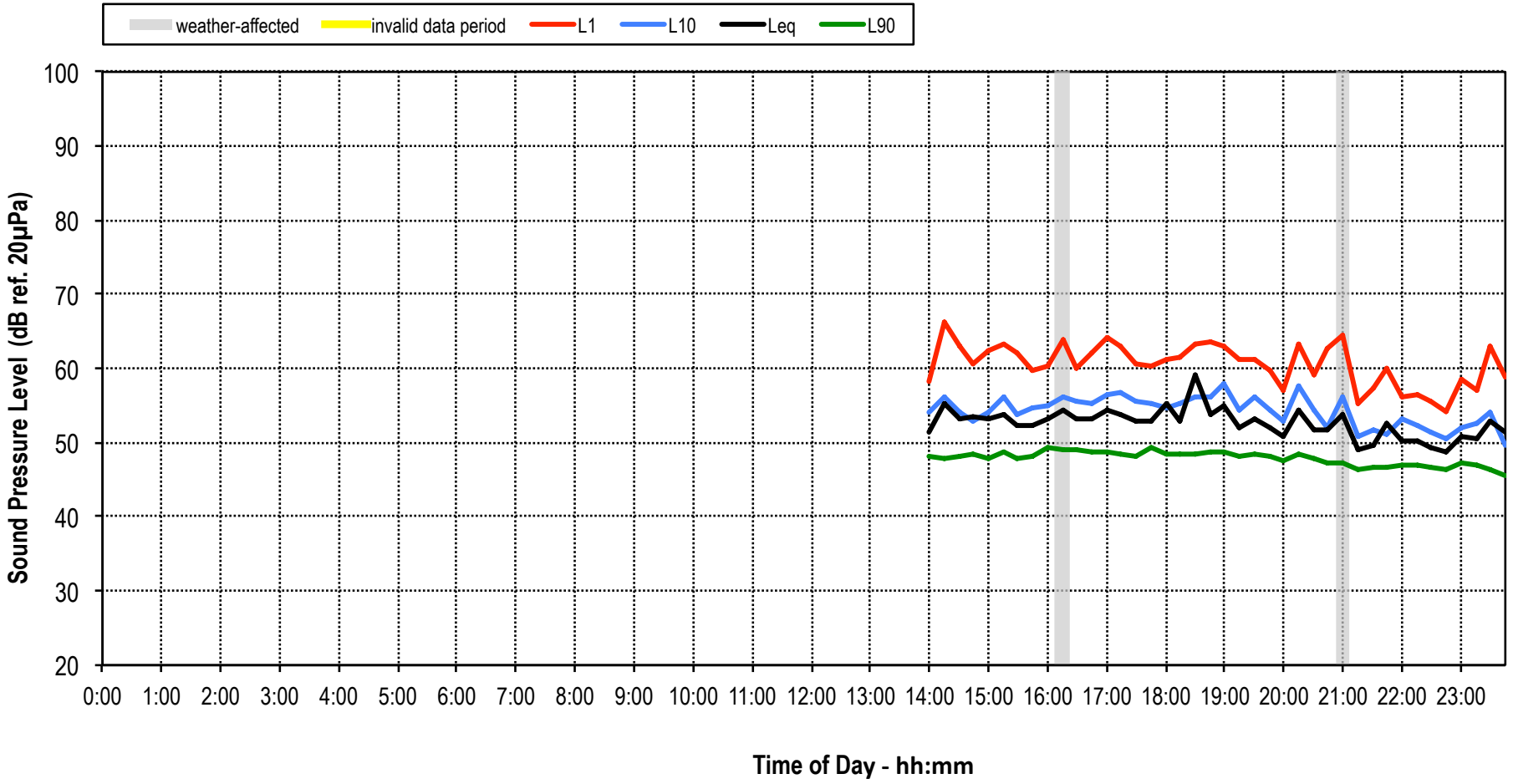
- Modifications to excavation and construction equipment used.
- Modifications to methods of excavation and construction.
- Rescheduling of activities to less sensitive times.

Appendix A – Ambient Noise Monitoring Data

Location 1


Randwick Campus Redevelopment Project Site
Catchment Area B
Unattended Long-term Noise Monitoring Location
1
Catchment Area B
Frances-St
Prince-St
Tram-Ln
Church-St
Cook-St
Abbey-St
The-Ave
Rae-St
Elizabeth-Ln
Silver-St
Bradley-St
Albert-St
Waratah-Ave
Arthur-St
Wansey-Rd
International-Rd
College-Rd
Union-Rd
University-Mall
Library-Rd
Library-Walk
Samuels-Ave
Blenheim-St
Cara-St
Belmore-Rd
Mears-Ave
Eurimbla-Ave
Euthill-St
Science-Rd
Engineering-Rd
Southern-Ln
Norton-St
Norbar-Ln
Hay-St
Harbourne-Ln
Middle-St
Kennedy-St
Jane-St
Maud-St
Dine-St
Perouse-Rd
Avoca-Ln
Howard-St
Meeks-St
Forsyth-St
Willis-St
Centre-Ln
Botany-St
Young-St

POW, 101 Botany St (Ambient, Background & Helicopter) - Wednesday 18 October 2017



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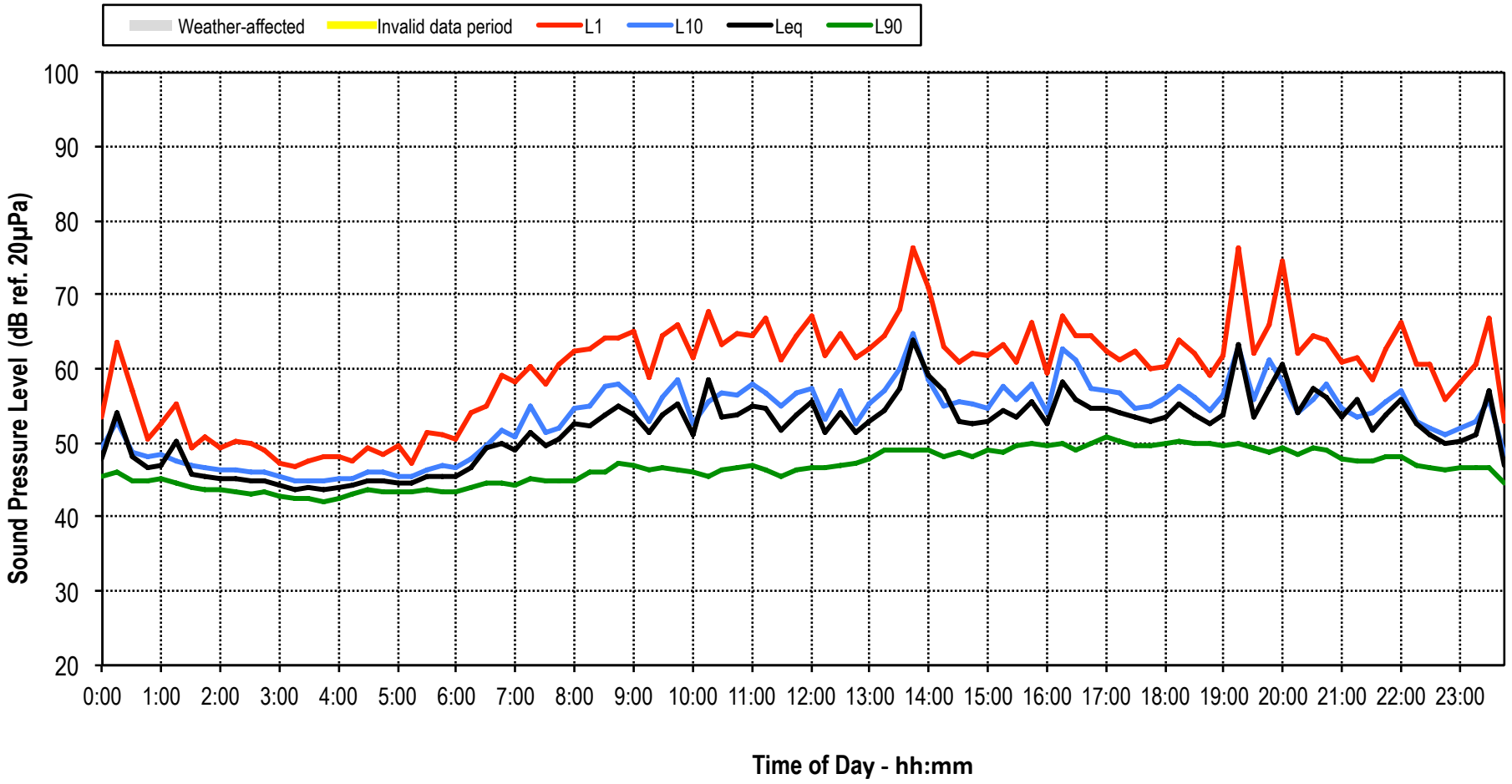

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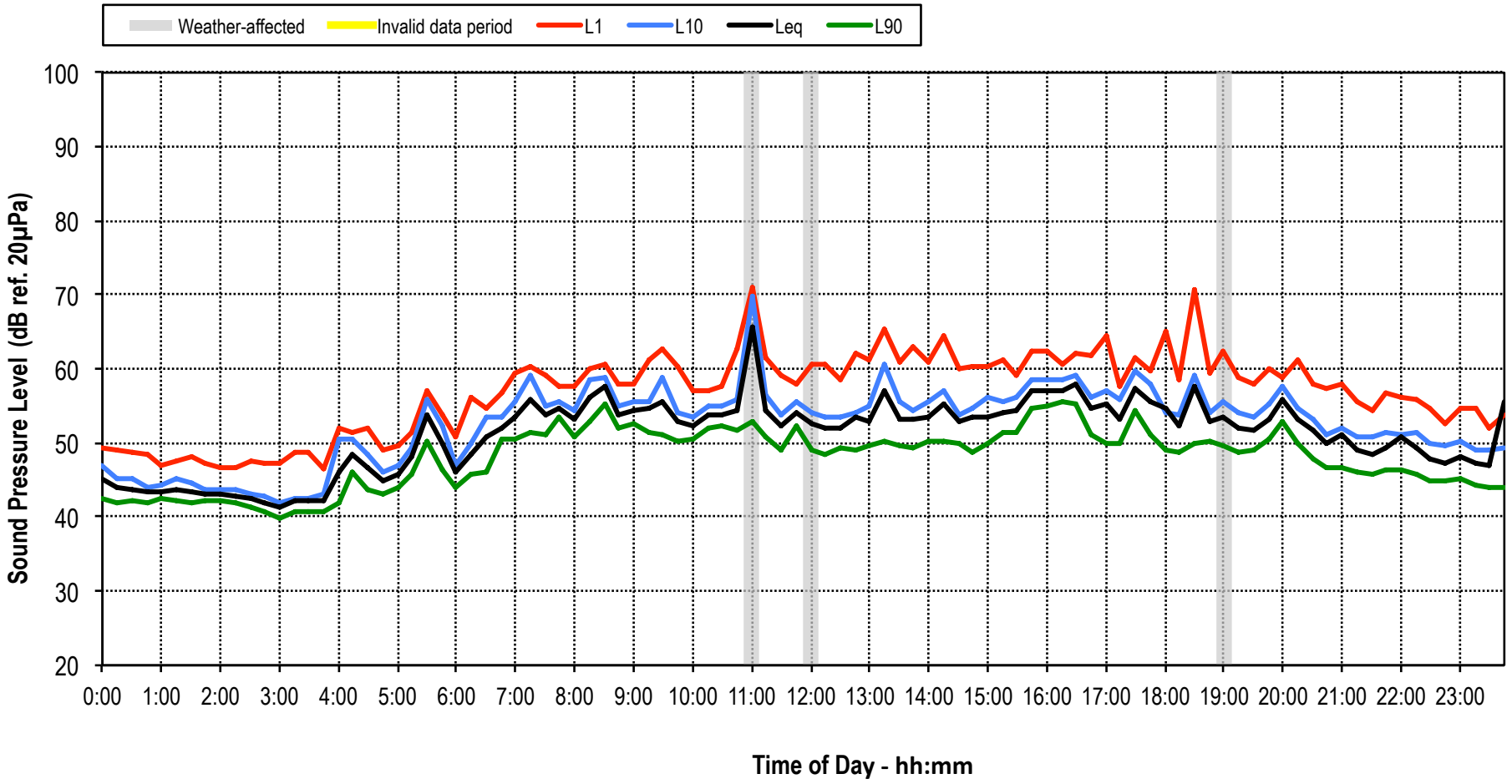

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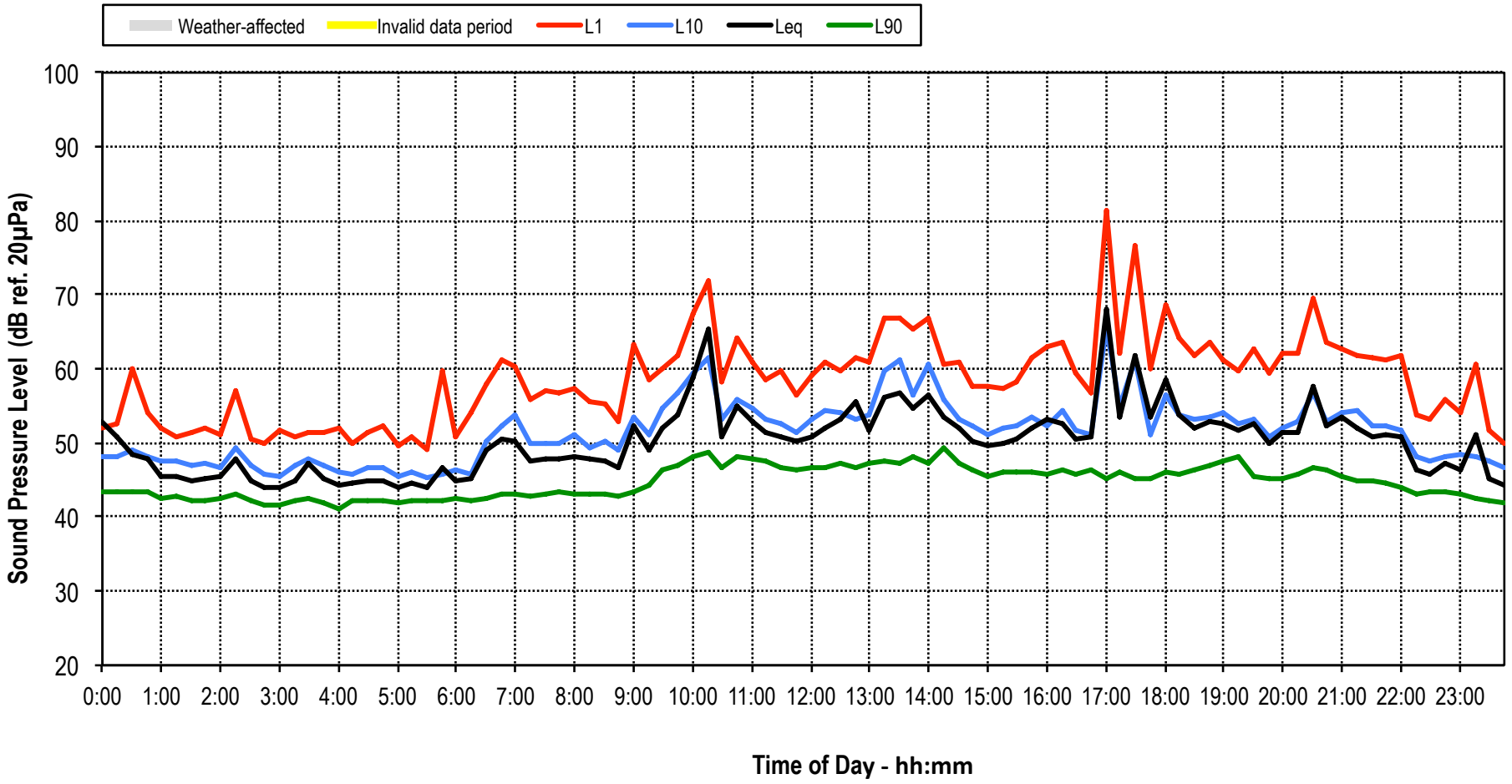

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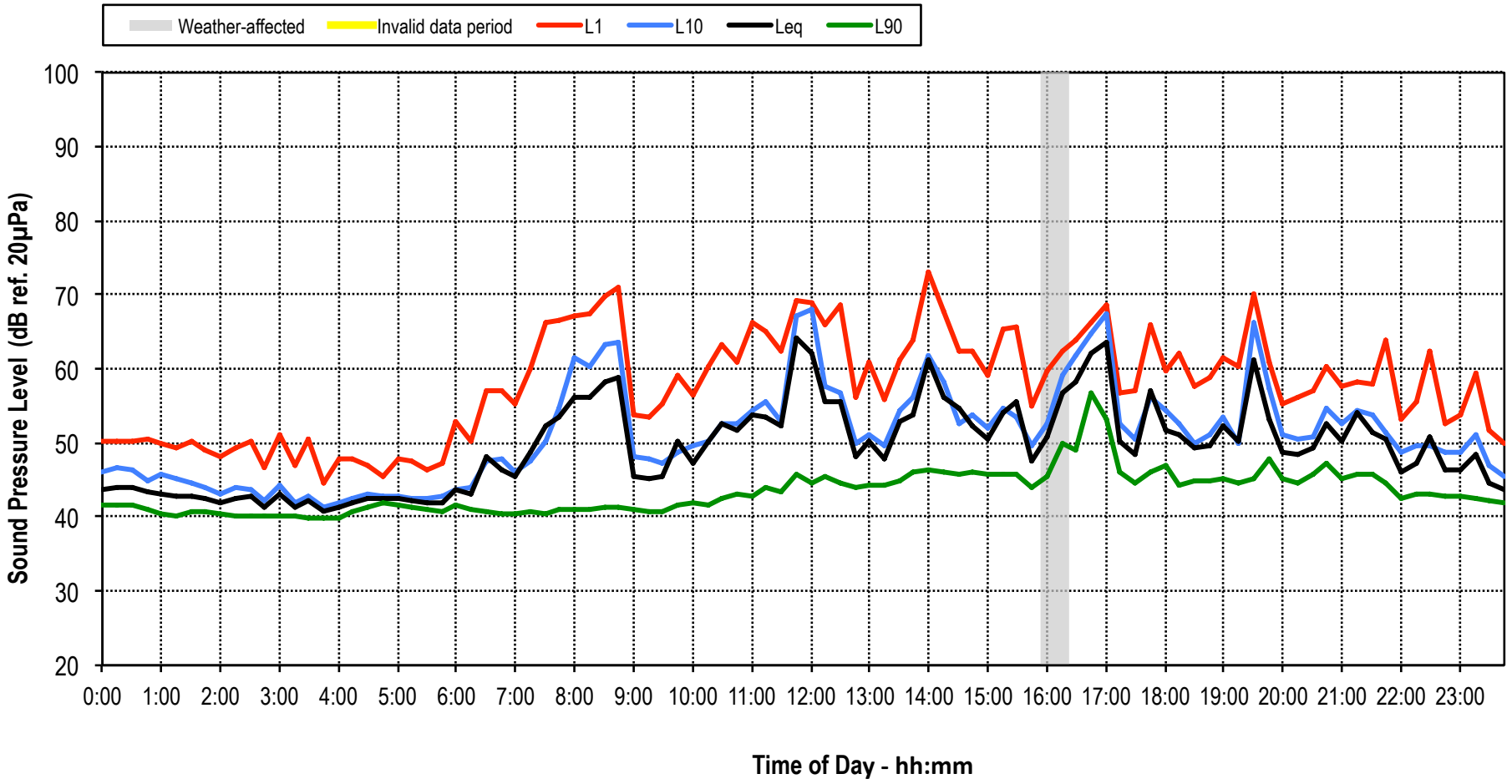

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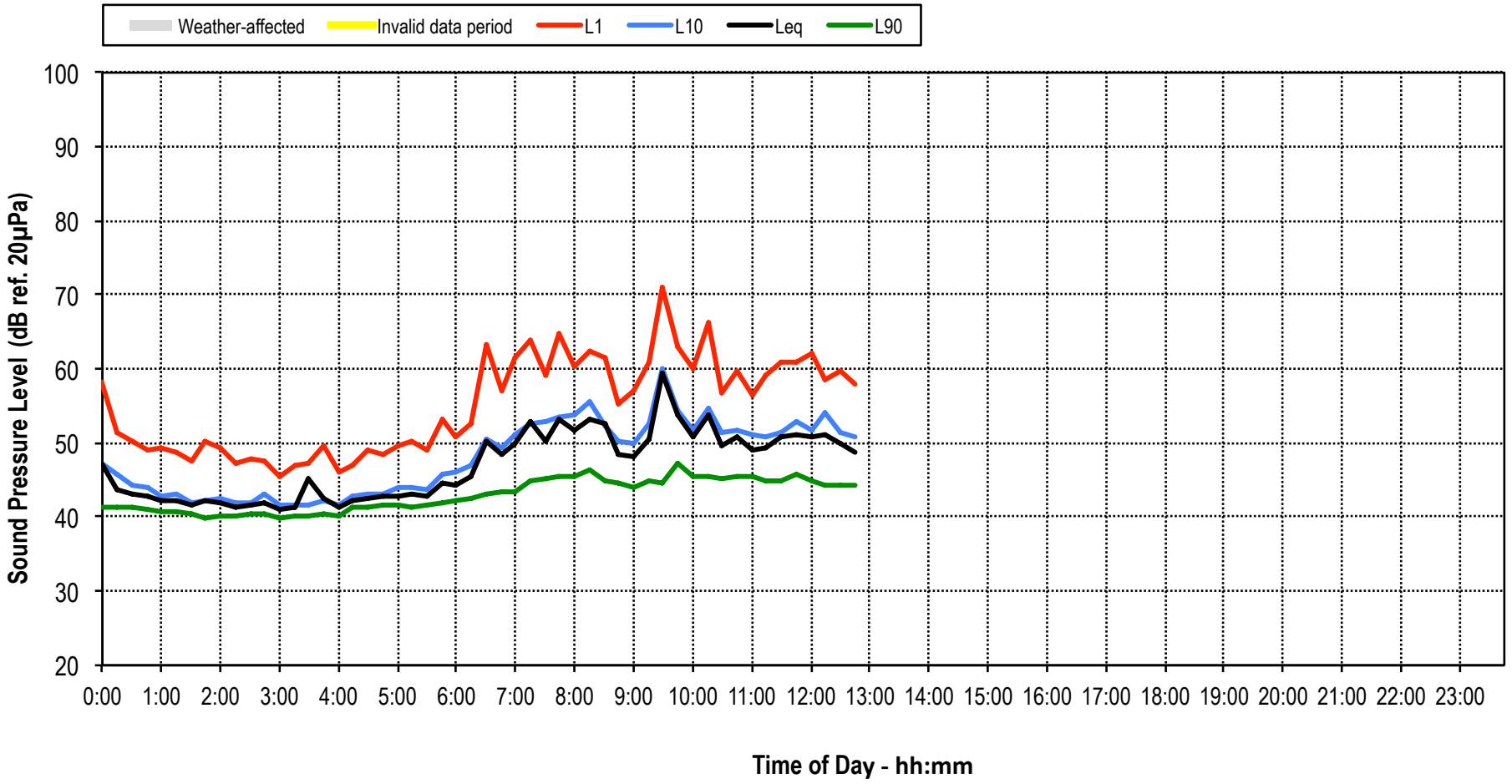

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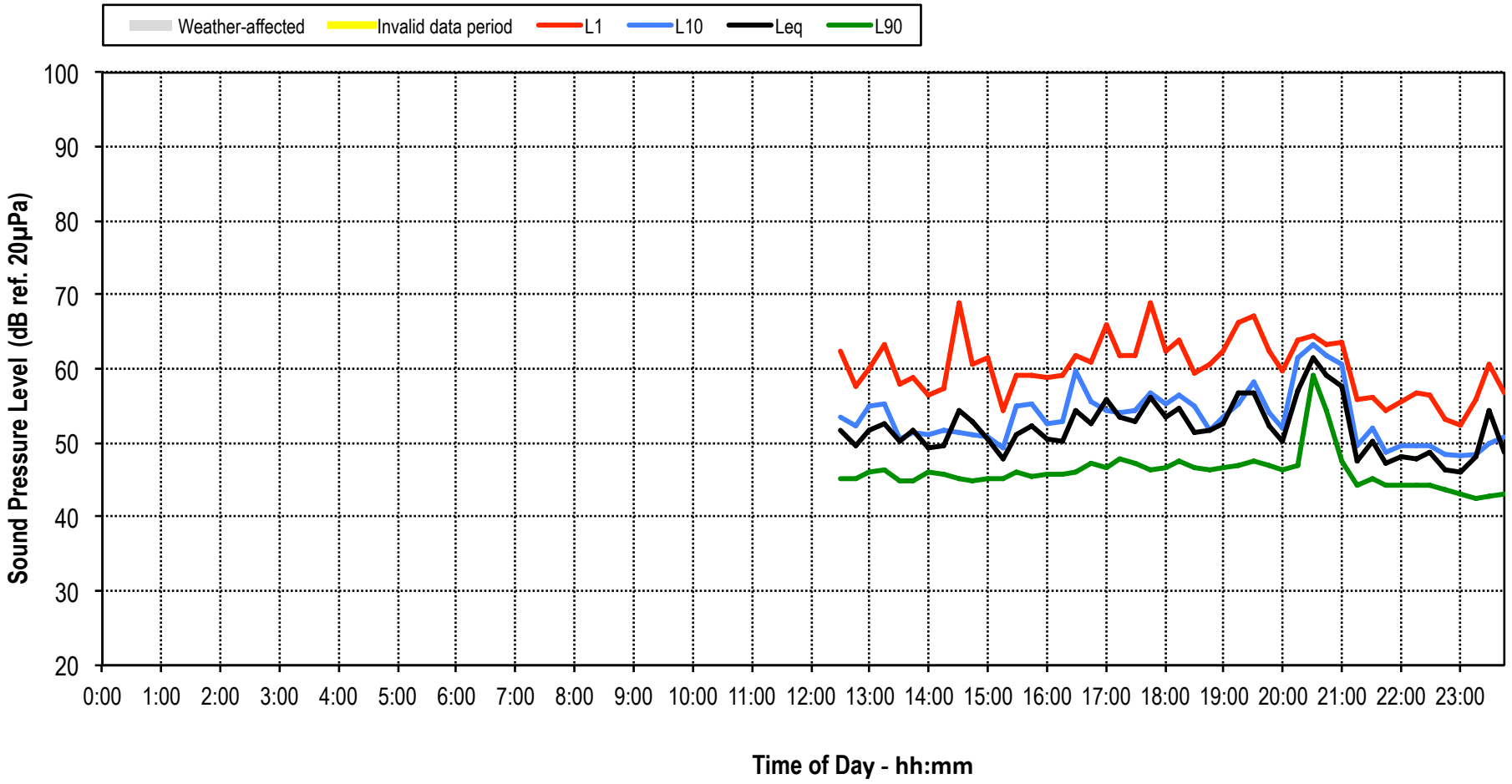

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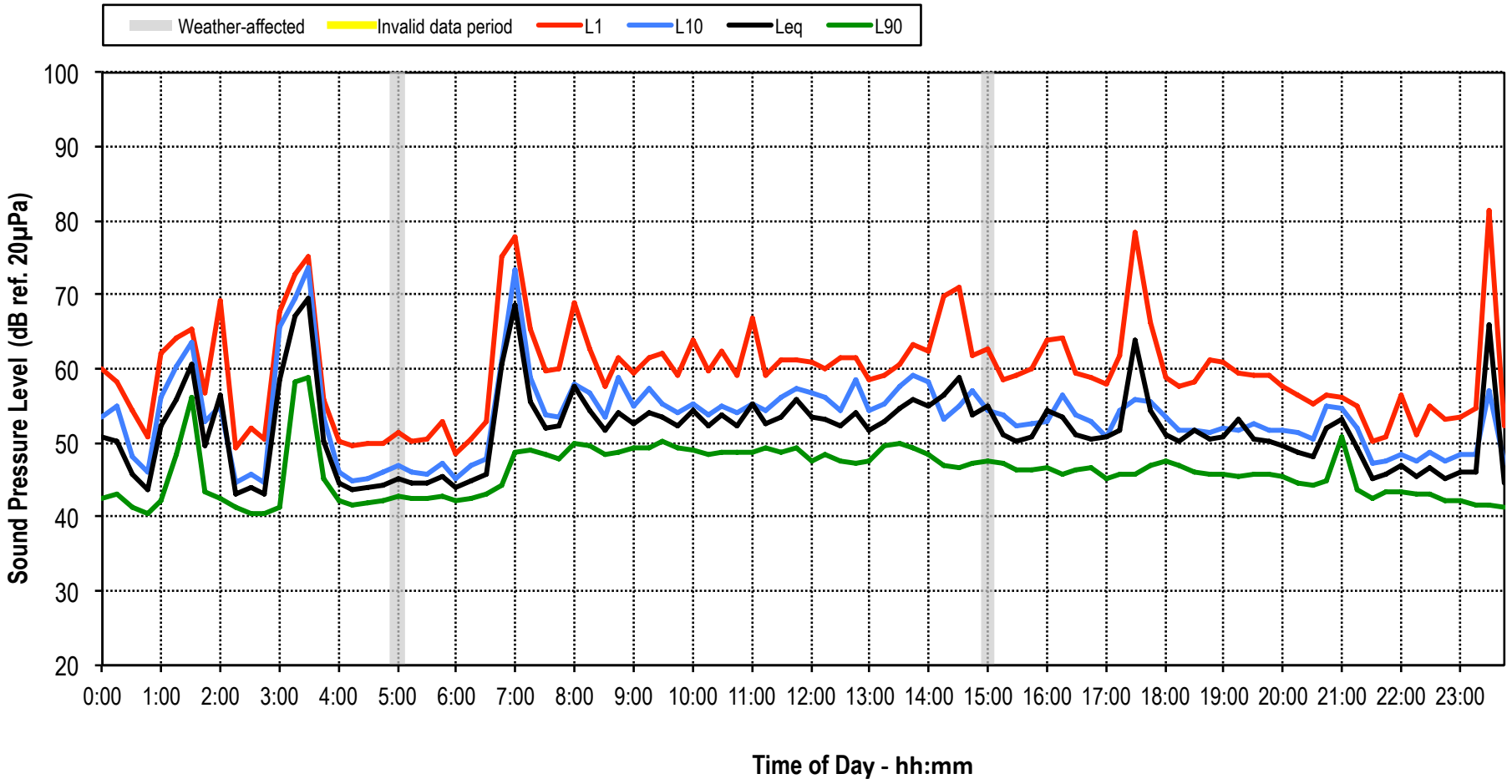

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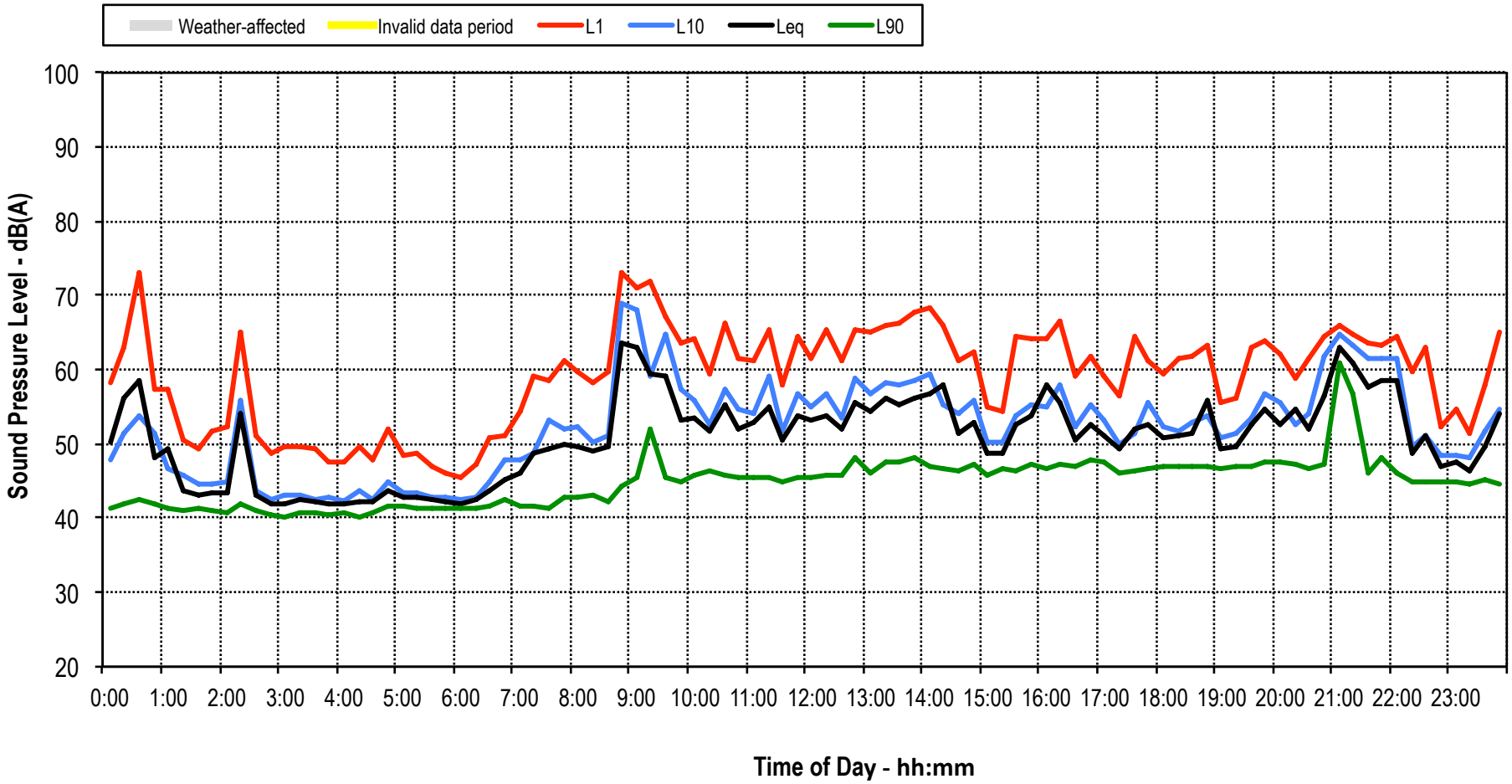

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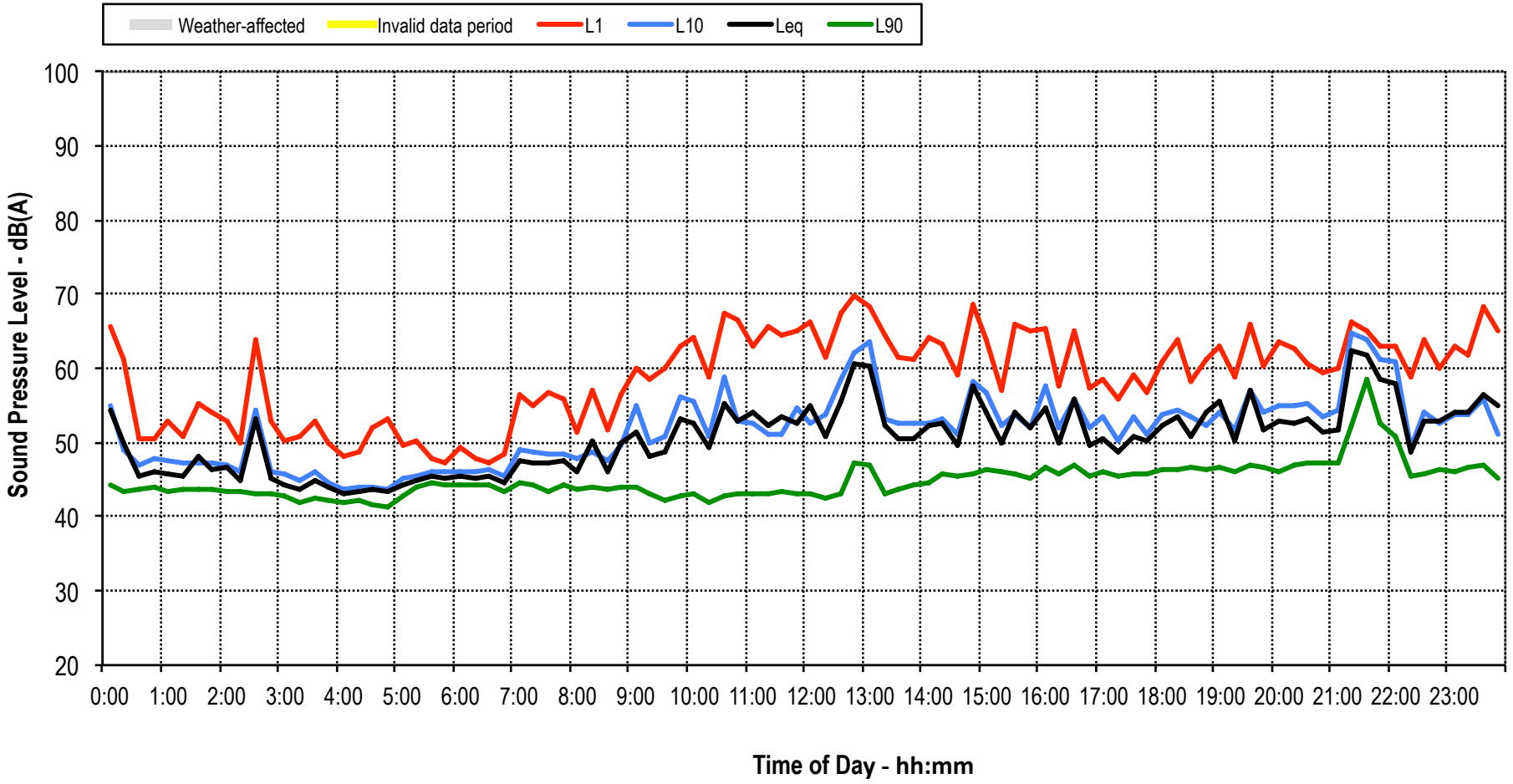

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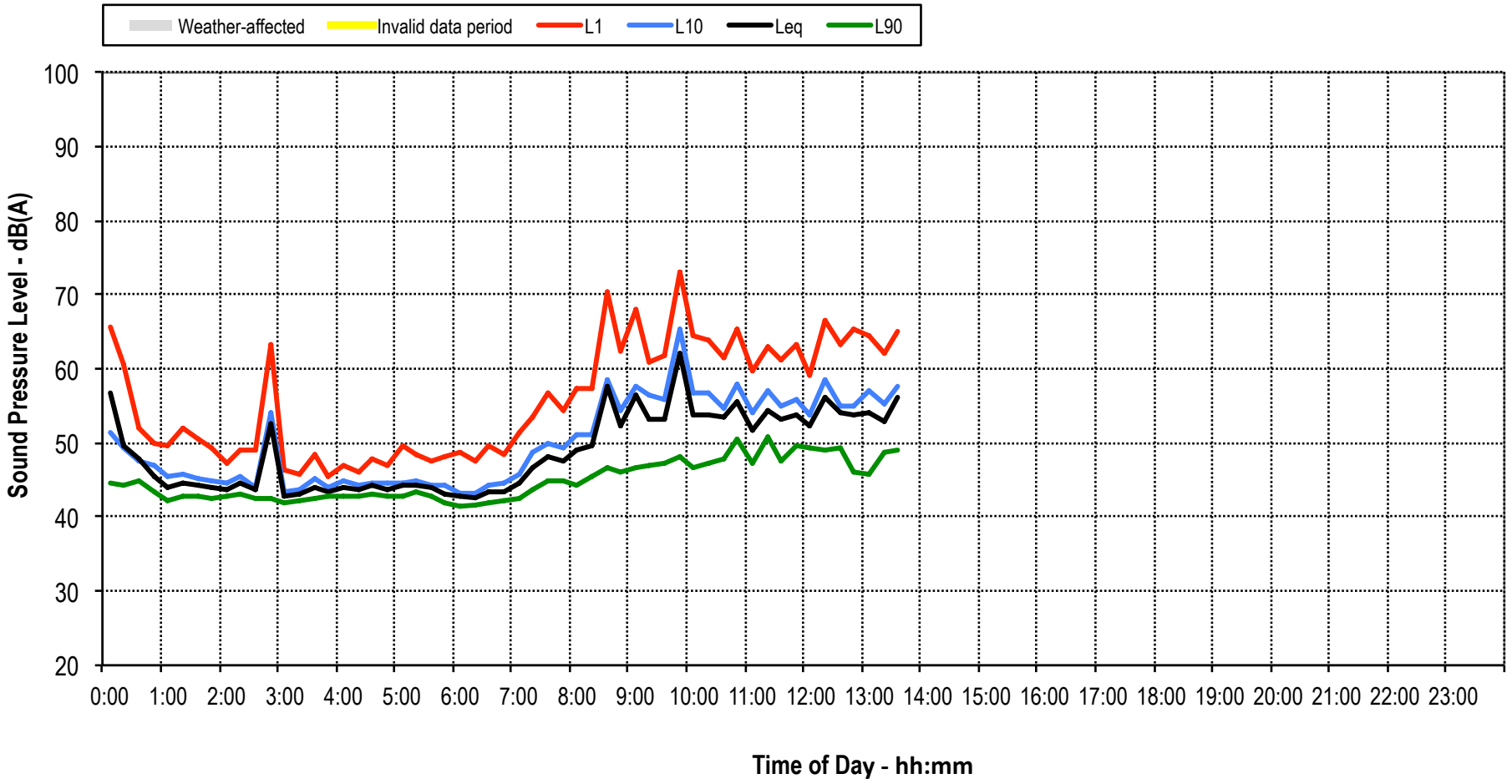
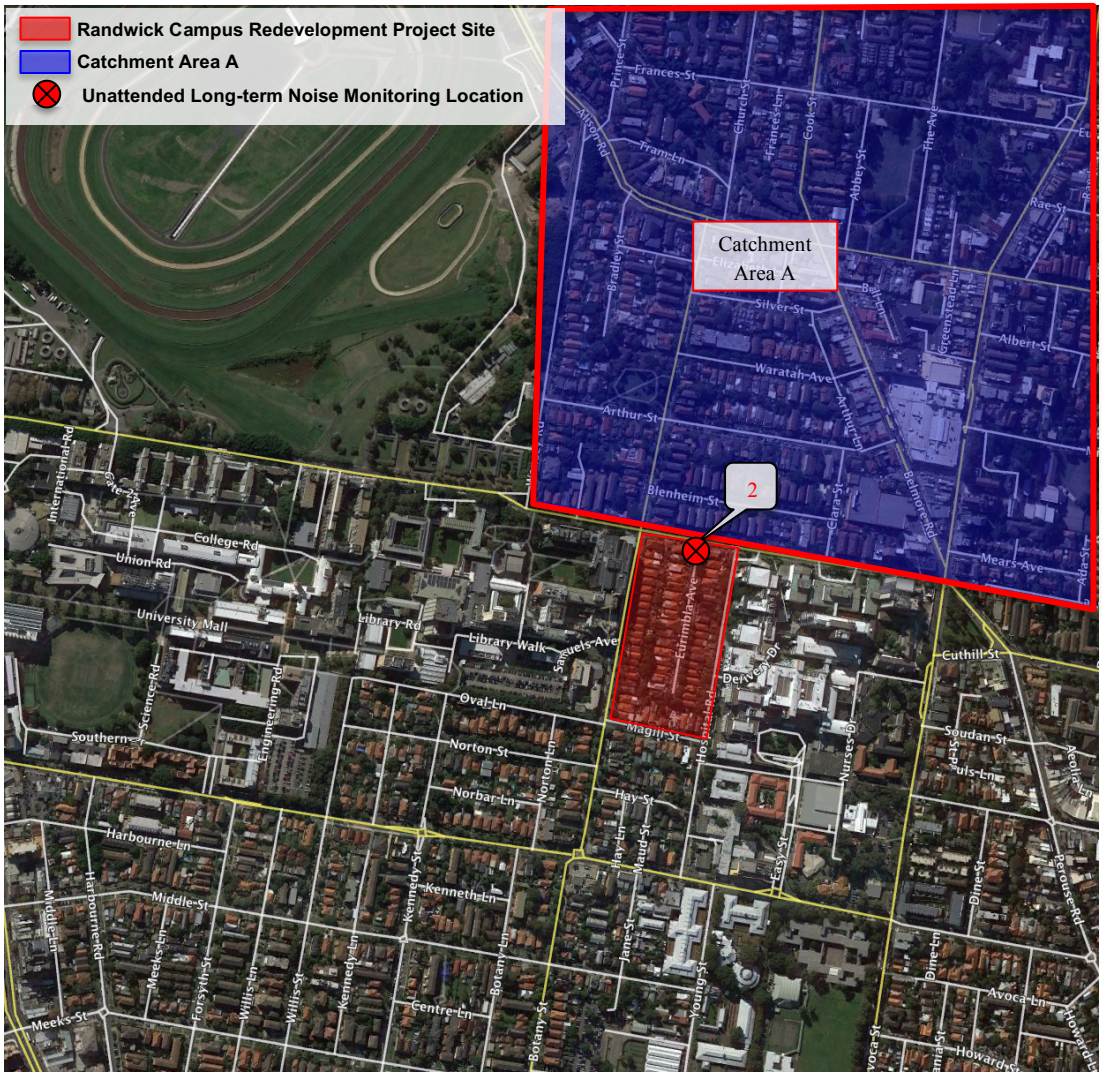
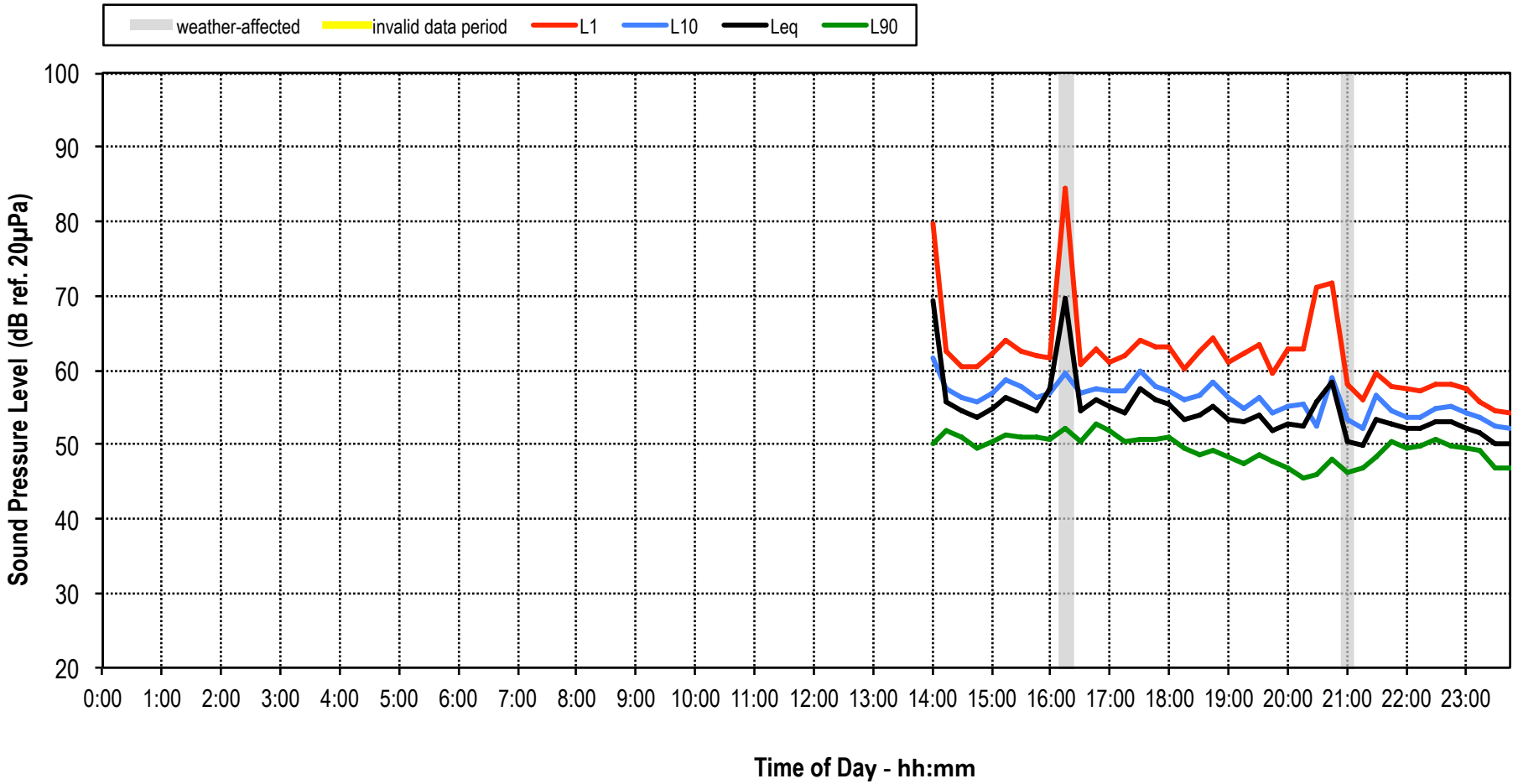


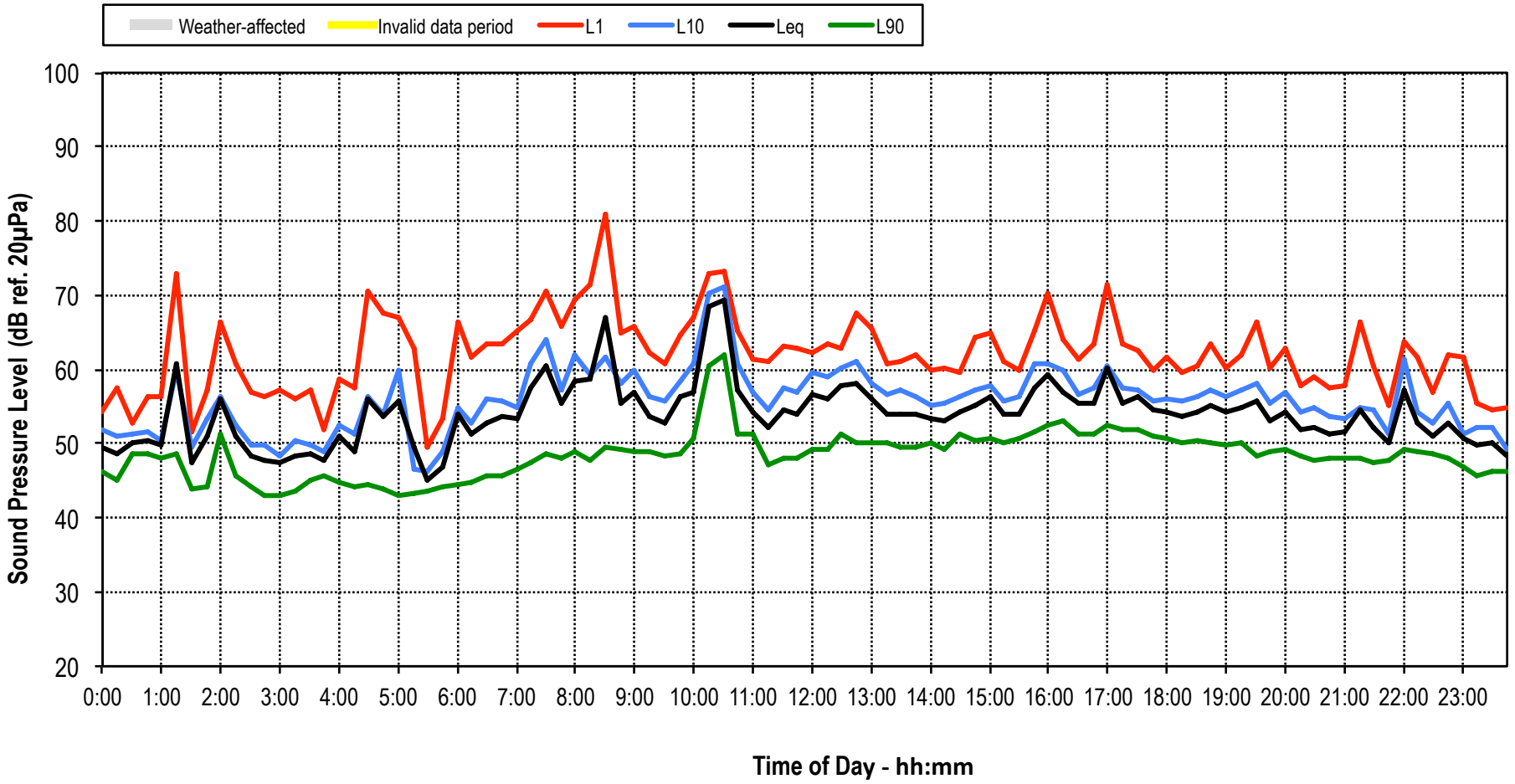
Location 2


Randwick Campus Redevelopment Project Site
Catchment Area A
Unattended Long-term Noise Monitoring Location
Catchment Area A
2
Frances-St
Prince-St
Alison-Rd
Tram-Ln
Church-St
Frances-Ln
Cook-St
Abbey-St
The-Ave
Rae-St
Bradley-St
Silver-St
Albert-St
Waratah-Ave
Arthur-St
Blenheim-St
Cara-St
Belmore-Rd
Mears-Ave
International-Rd
College-Rd
Union-Rd
University-Mall
Library-Rd
Library-Walk
Samuels-Ave
Eurimbla-Ave
Euthill-St
Oval-Ln
Science-Rd
Engineering-Rd
Southern-Ln
Norton-St
Norton-Ln
Norbar-Ln
Magill-St
Hay-St
Hay-Ln
Maud-St
Harbourne-Ln
Middle-St
Kenneth-Ln
Kennedy-St
Meeks-St
Forsyth-St
Willis-Ln
Willis-St
Centre-Ln
Botany-St
Jane-St
Young-St
Nurses-Dr
Easy-St
Dine-St
Perouse-Rd
Avoca-Ln
Howard-St

POW, 1-3 Eurimbla Avenue (Traffic, Ambient and Background) - Wednesday 18 October 2017



POW, 1-3 Eurimbla Avenue (Traffic, Ambient and Background) - Thursday 19 October 2017



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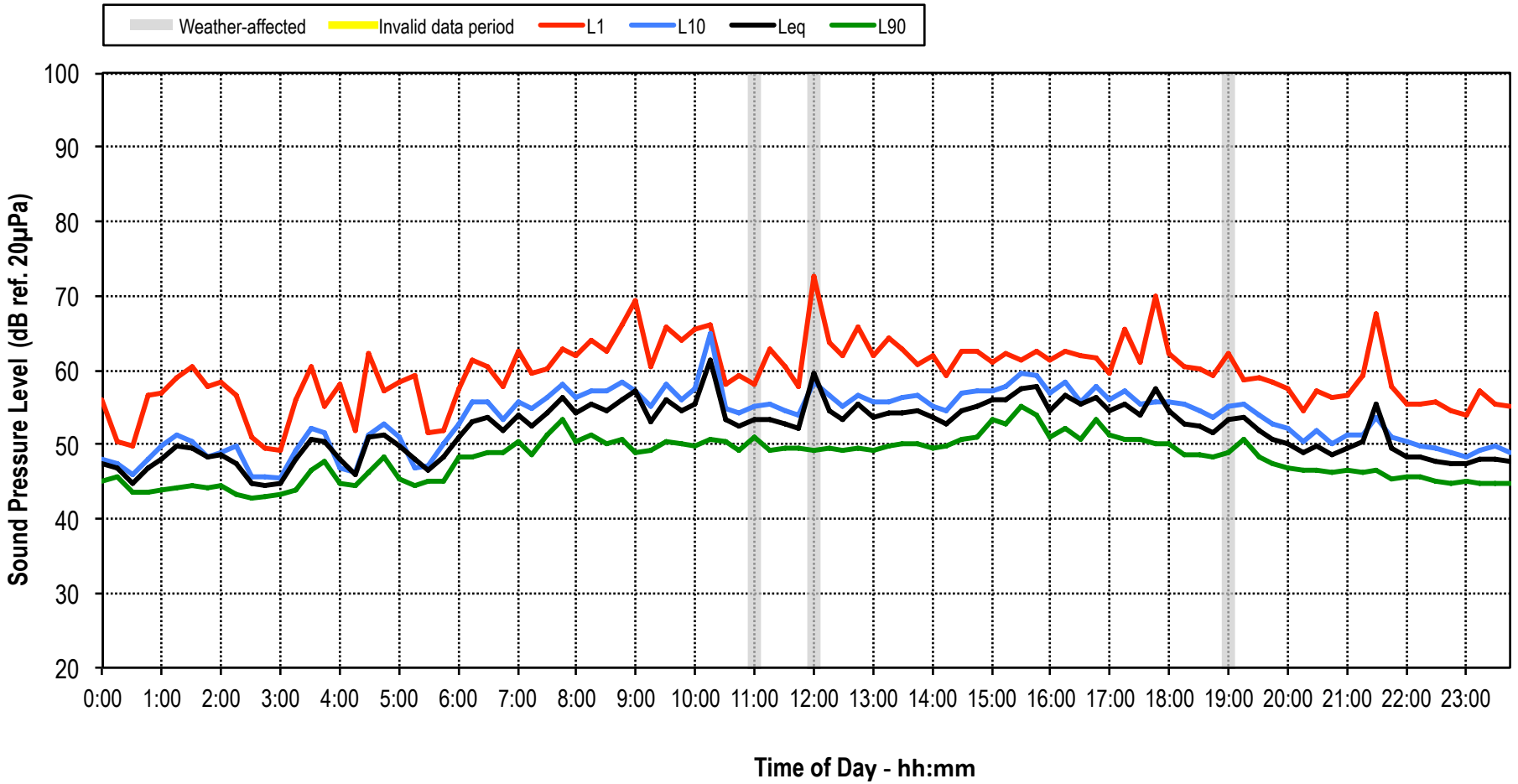
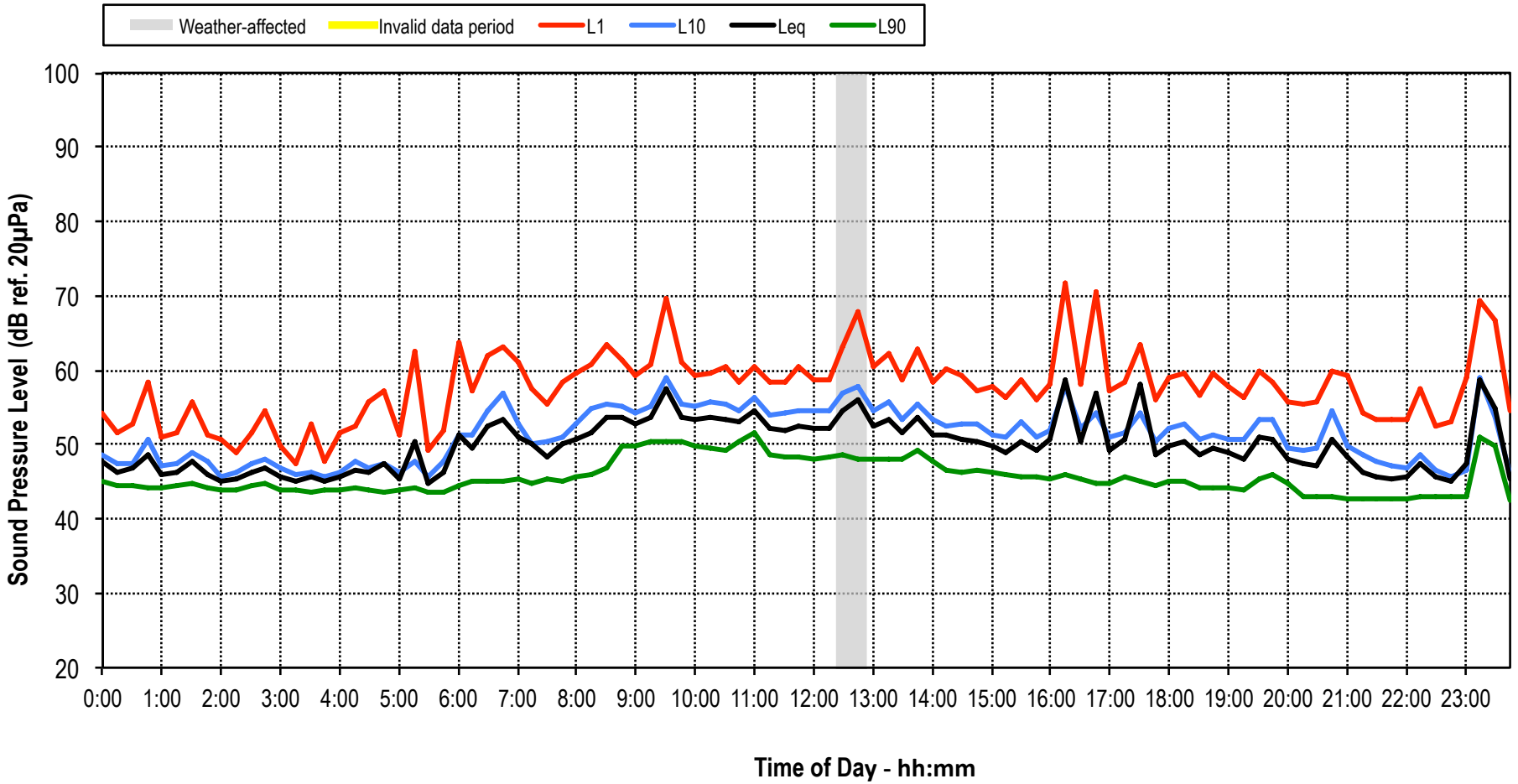
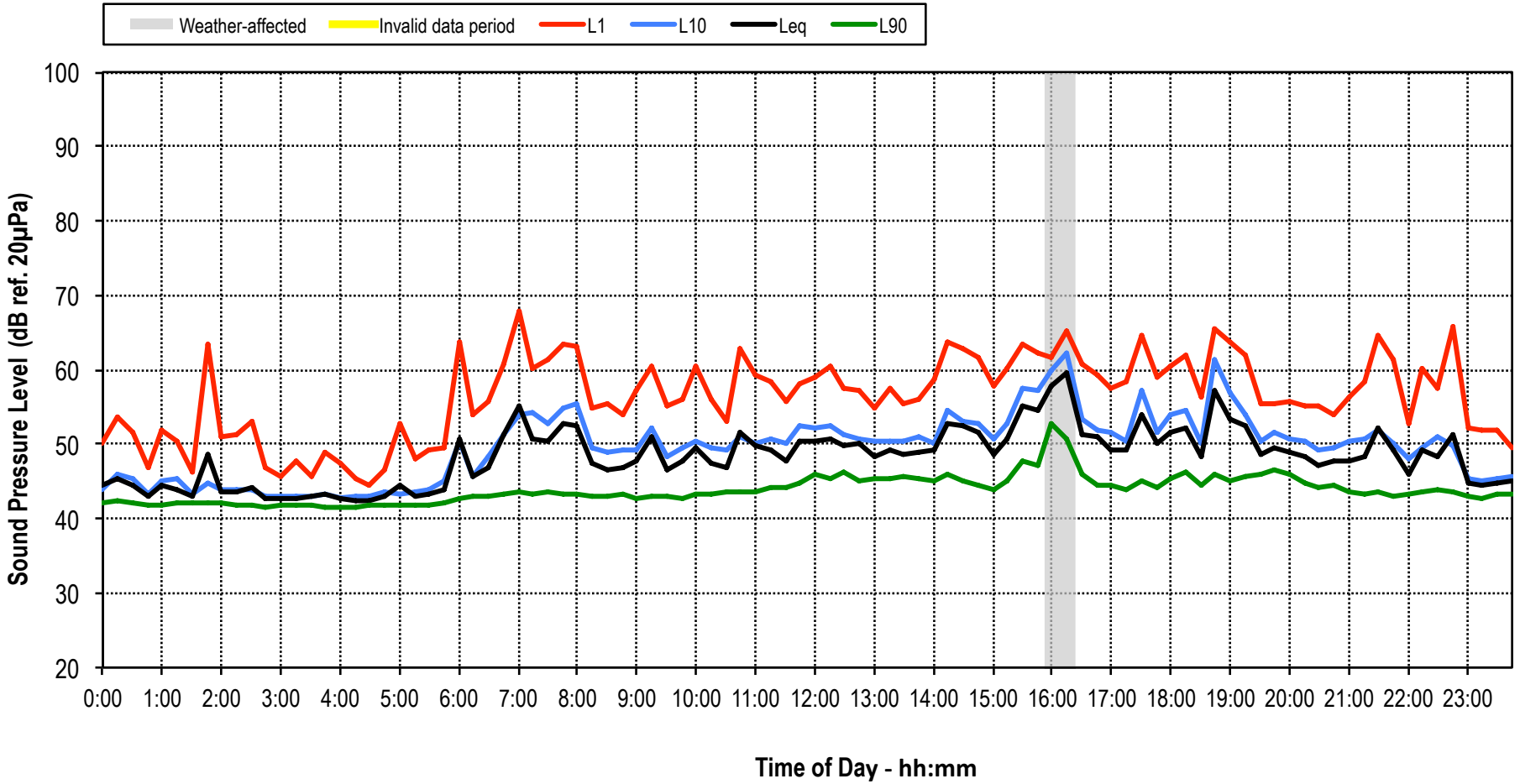


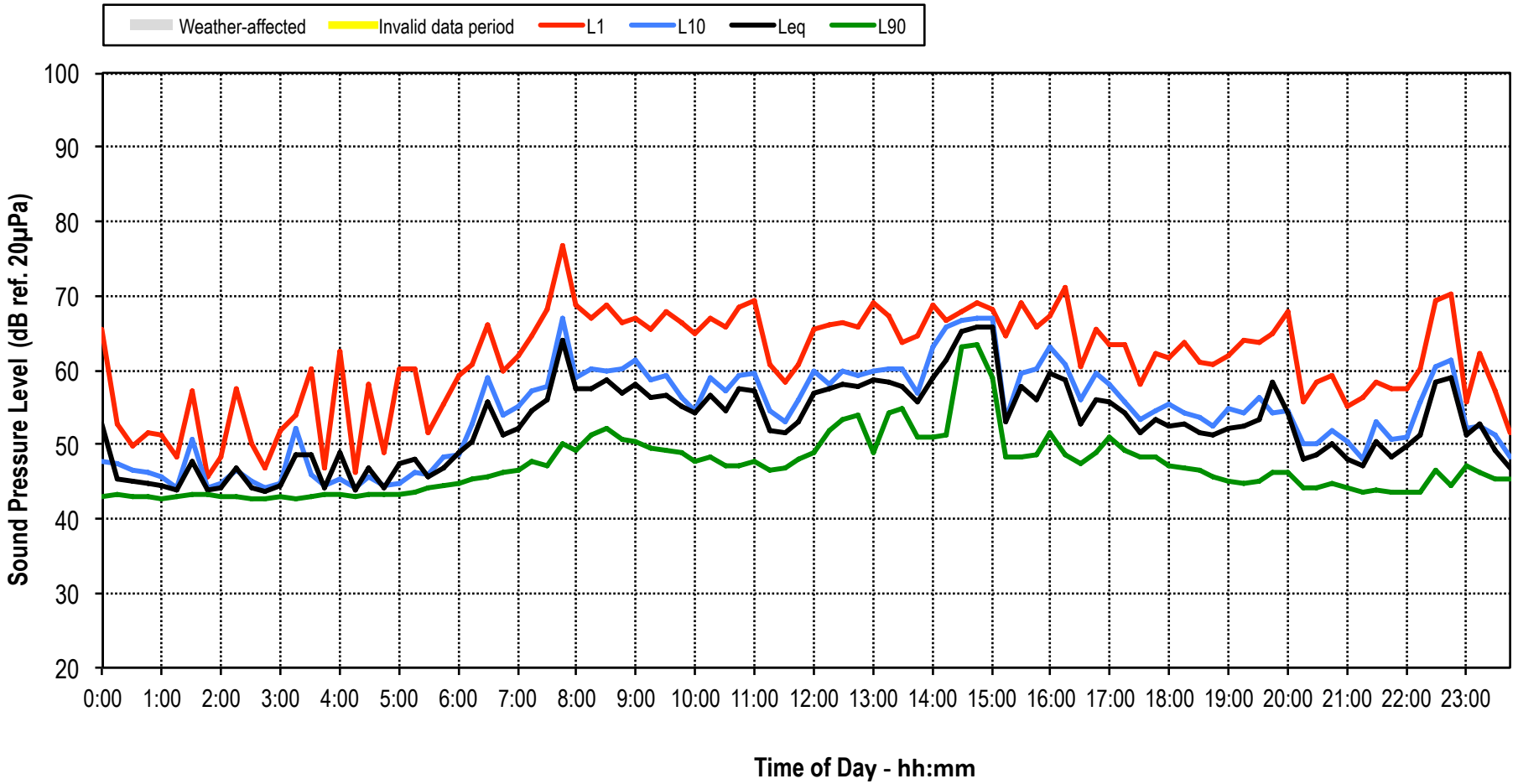
POW, 1-3 Eurimbla Avenue (Traffic, Ambient and Background) - Saturday 21 October 2017



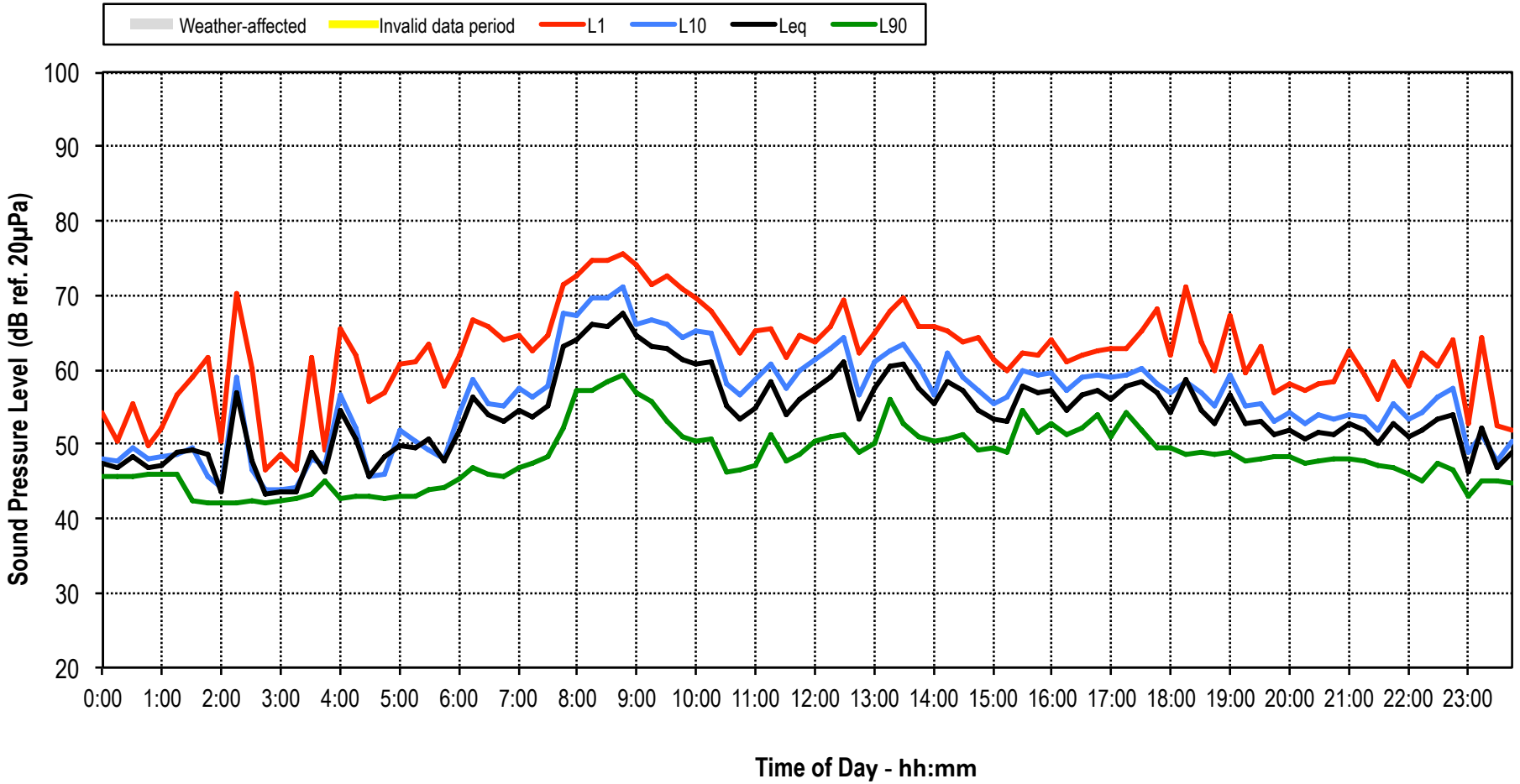
POW, 1-3 Eurimbla Avenue (Traffic, Ambient and Background) - Sunday 22 October 2017



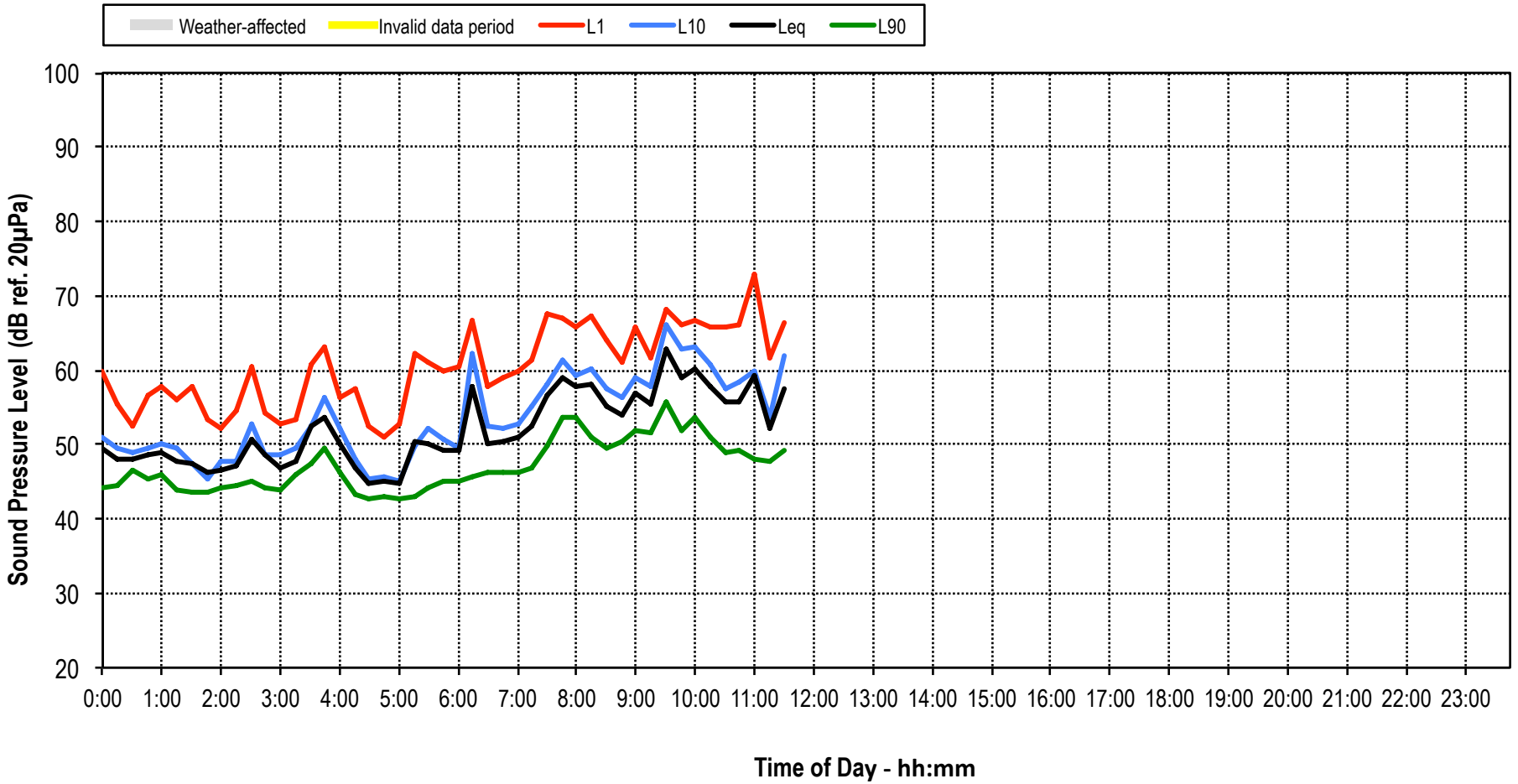
POW, 1-3 Eurimbla Avenue (Traffic, Ambient and Background) - Monday 23 October 2017



POW, 1-3 Eurimbla Avenue (Traffic, Ambient and Background) - Tuesday 24 October 2017



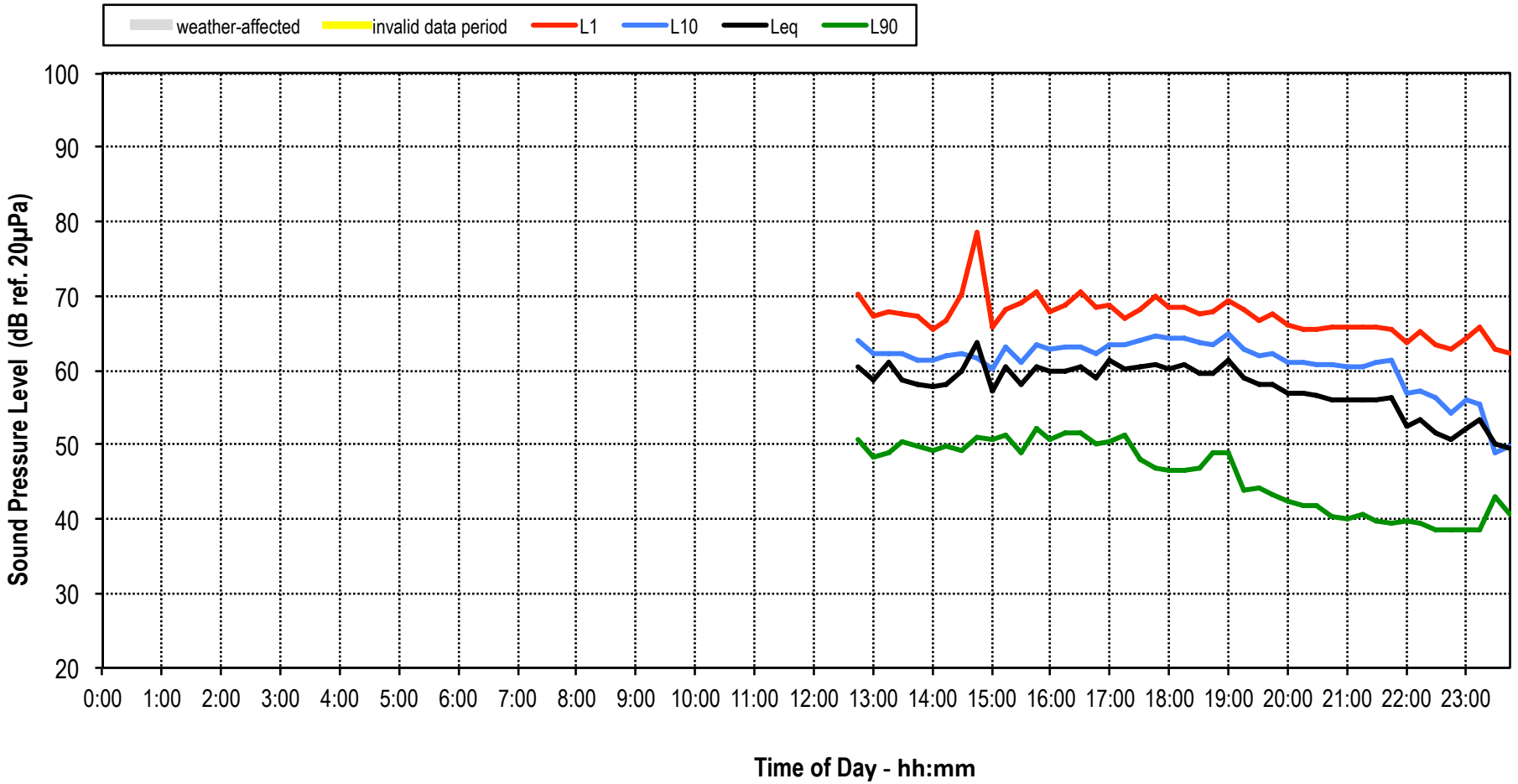
POW, 1-3 Eurimbla Avenue (Traffic, Ambient and Background) - Wednesday 25 October 2017



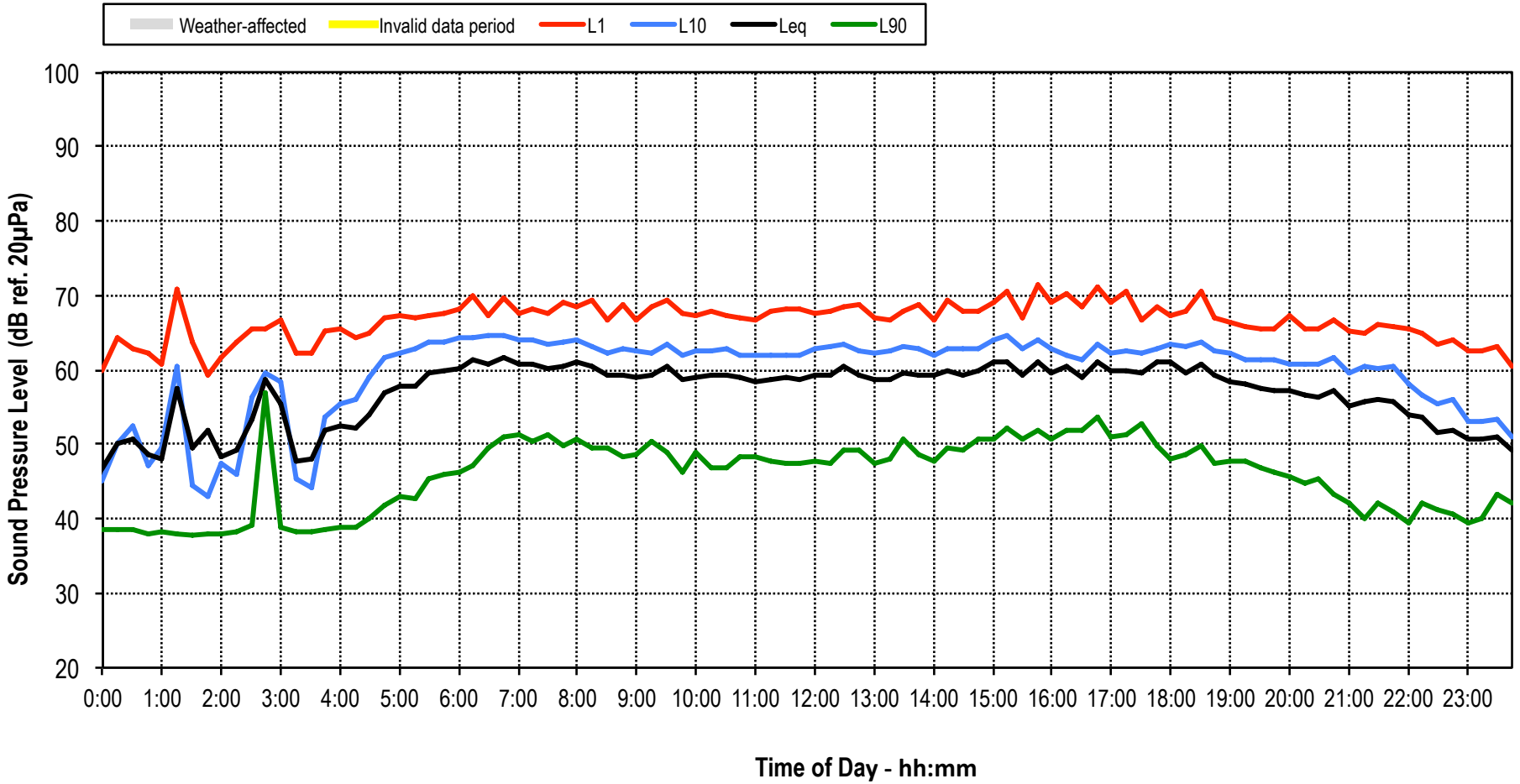
Location 3


Randwick Campus Redevelopment Project Site
Catchment Area D
Unattended Long-term Noise Monitoring Location
Catchment Area D
3
Frances-St
Prince-St
Church-St
Cook-St
Abbey-St
The-Ave
Rae-St
Elizabeth-Ln
Silver-St
Albert-St
Waratah-Ave
Arthur-St
Blenheim-St
Mears-Ave
Euthill-St
Sudan-St
College-Rd
Union-Rd
Library-Rd
Library-Walk
Science-Rd
Engineering-Rd
Southern-Ln
Norton-St
Norbar-Ln
Hay-St
Magill-St
Harbourne-Ln
Middle-St
Kenneth-Ln
Kennedy-St
Meeks-St
Centre-Ln
Botany-St
Young-St
Jane-St
Maud-St
Dine-St
Avoca-Ln
Howard-St
Wansey-Rd
Bradley-St
Eurimbla-Ave
Nurses-Dr
Perouse-Rd

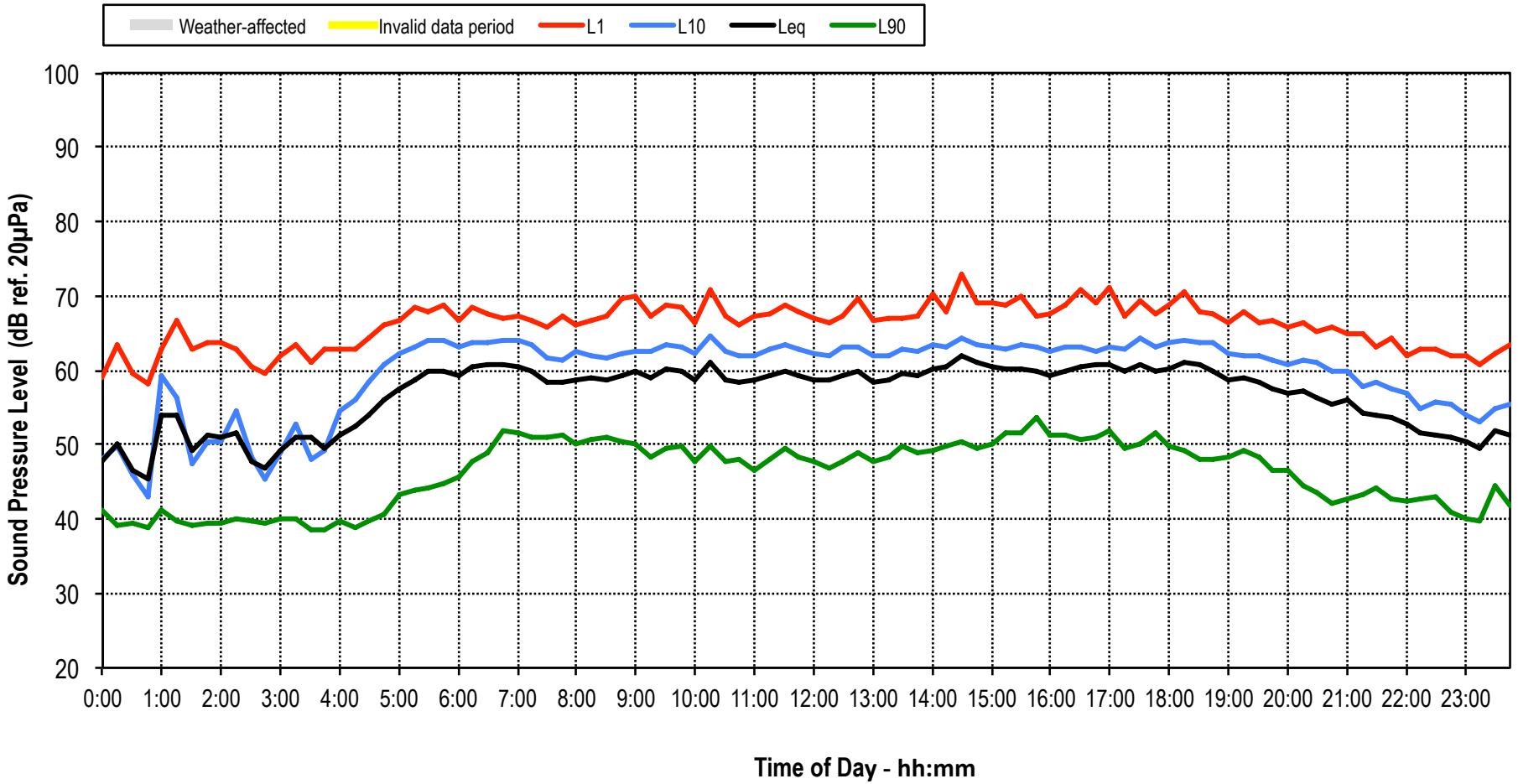
POW, 79 Botany St (Traffic, Ambient and Background) - Monday 23 October 2017



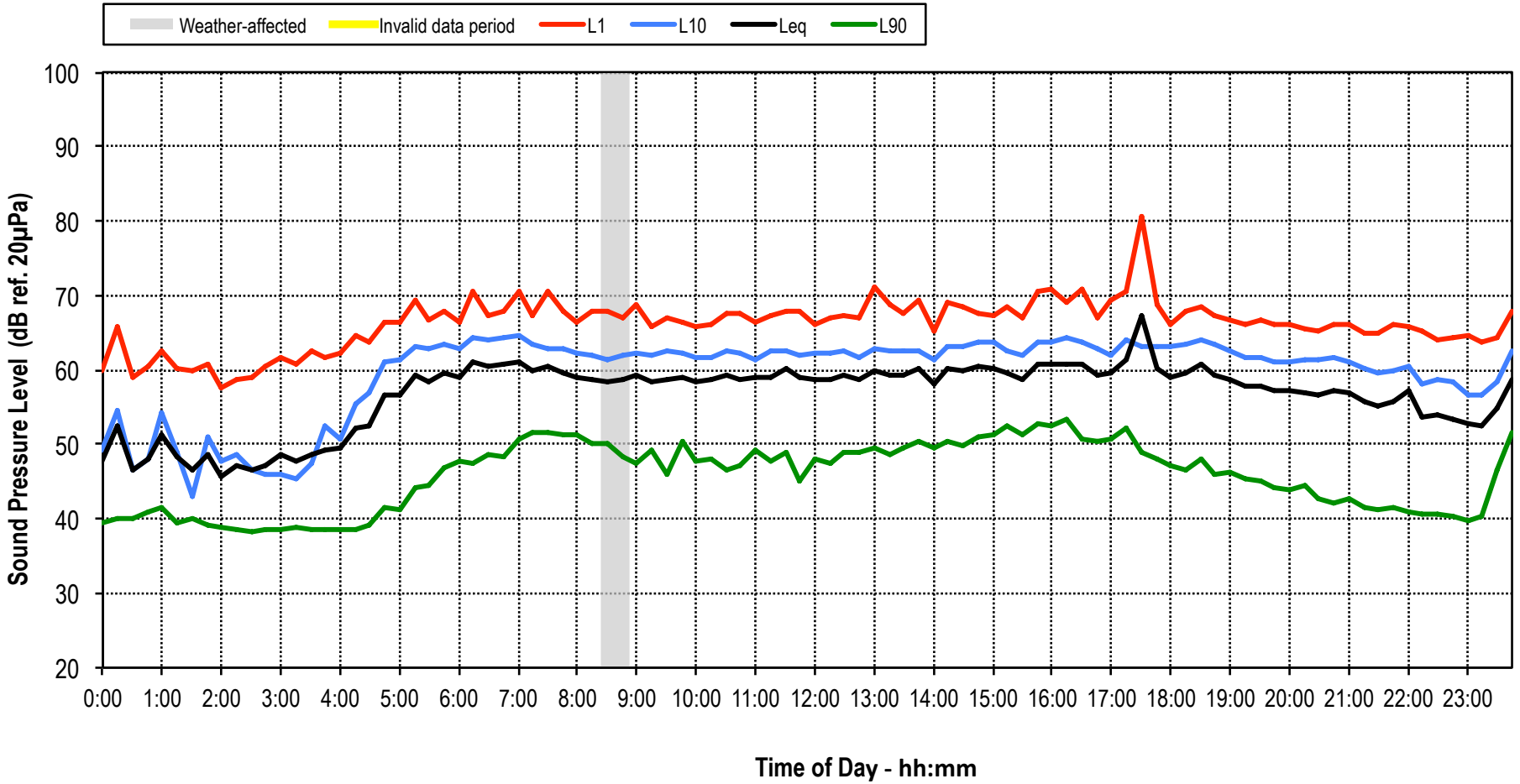
POW, 79 Botany St (Traffic, Ambient and Background) - Tuesday 24 October 2017



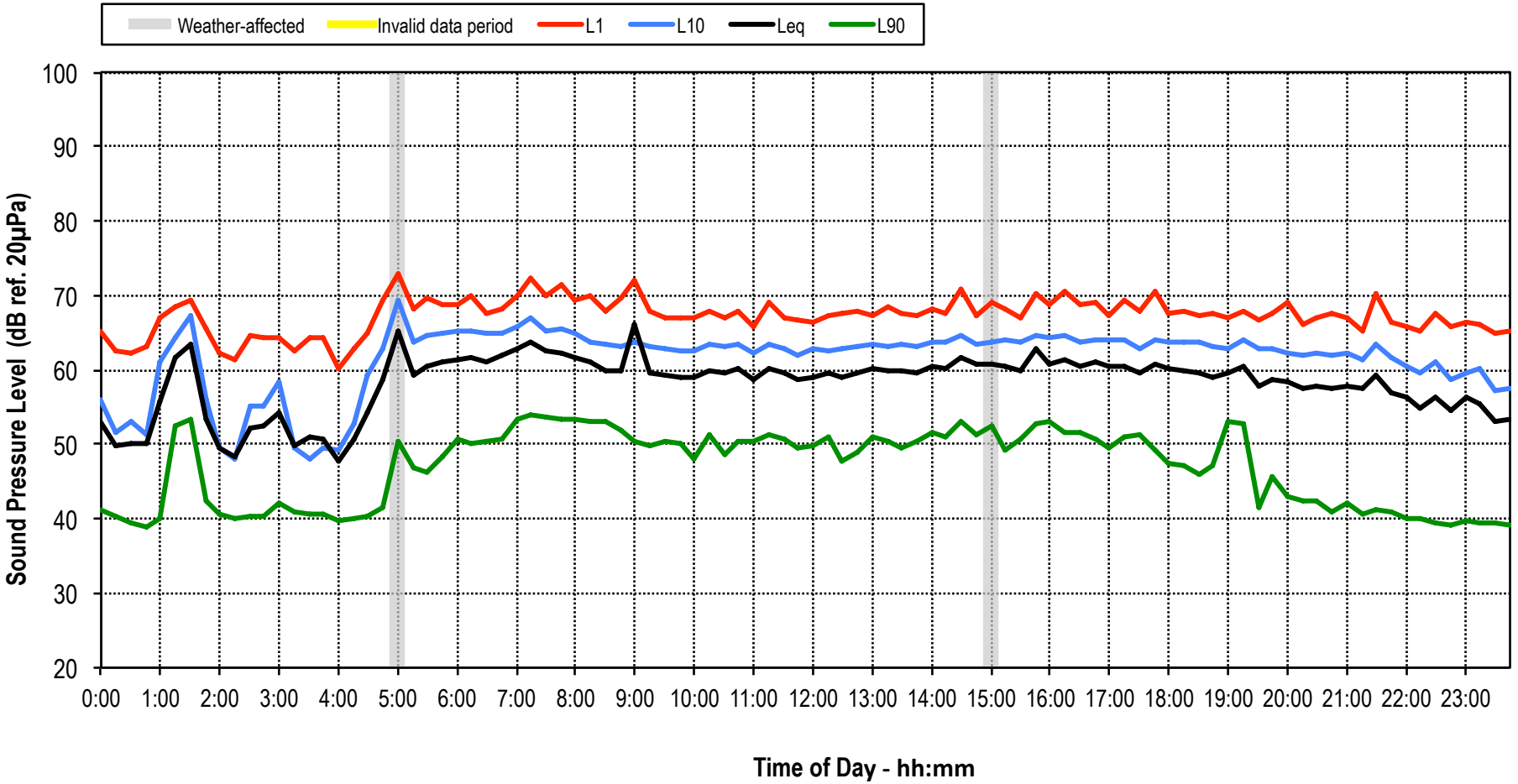
POW, 79 Botany St (Traffic, Ambient and Background) - Wednesday 25 October 2017



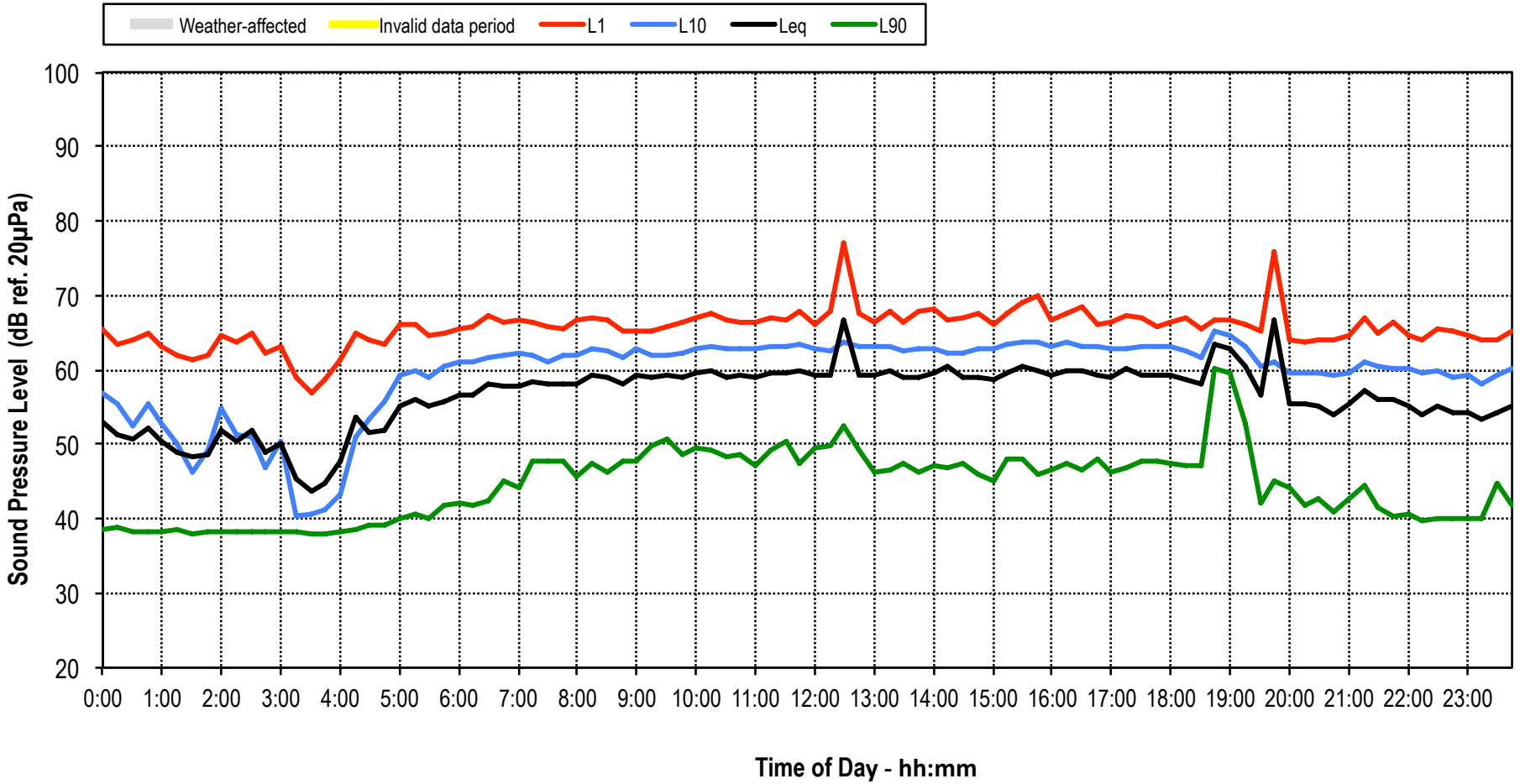
POW, 79 Botany St (Traffic, Ambient and Background) - Thursday 26 October 2017



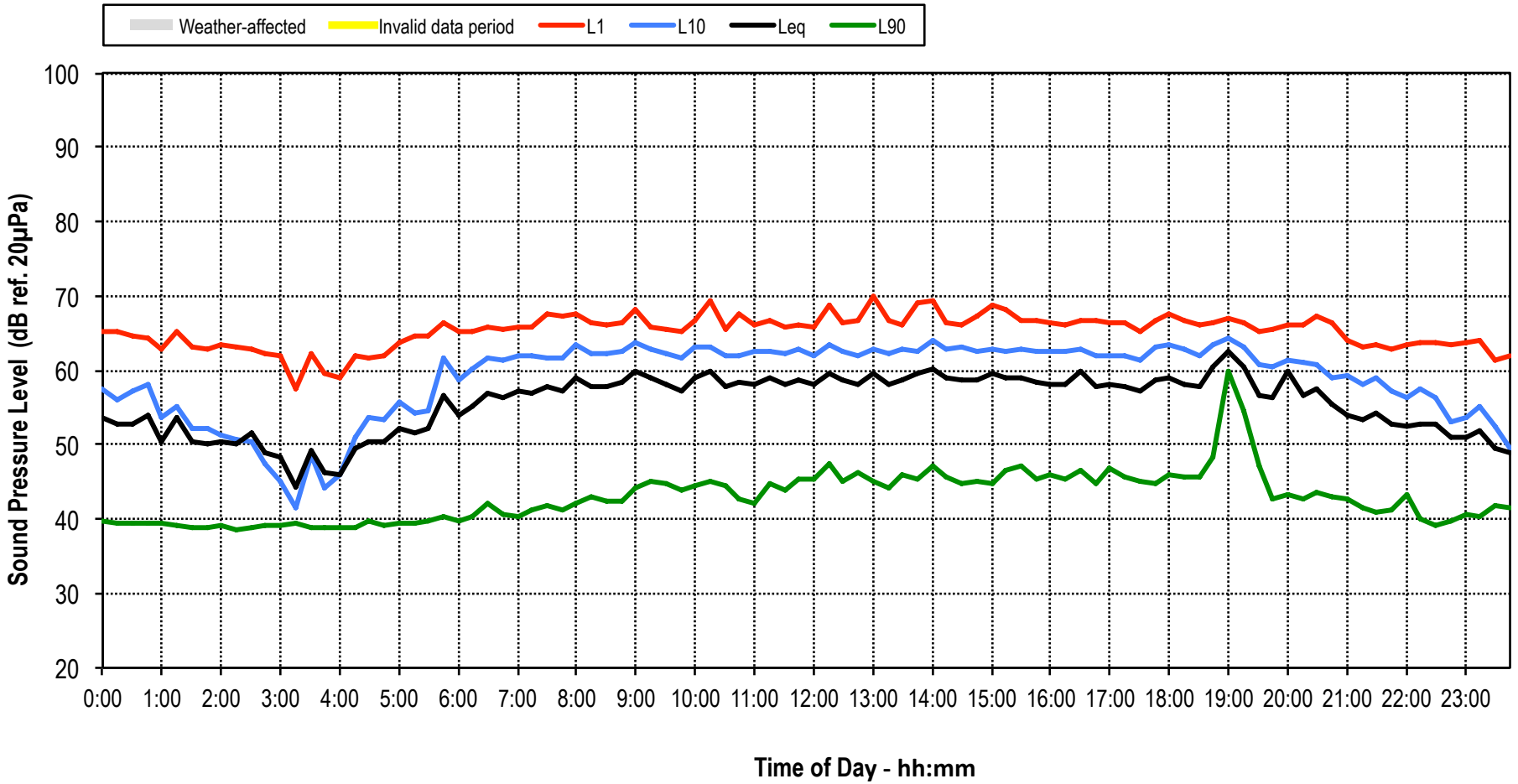
POW, 79 Botany St (Traffic, Ambient and Background) - Friday 27 October 2017



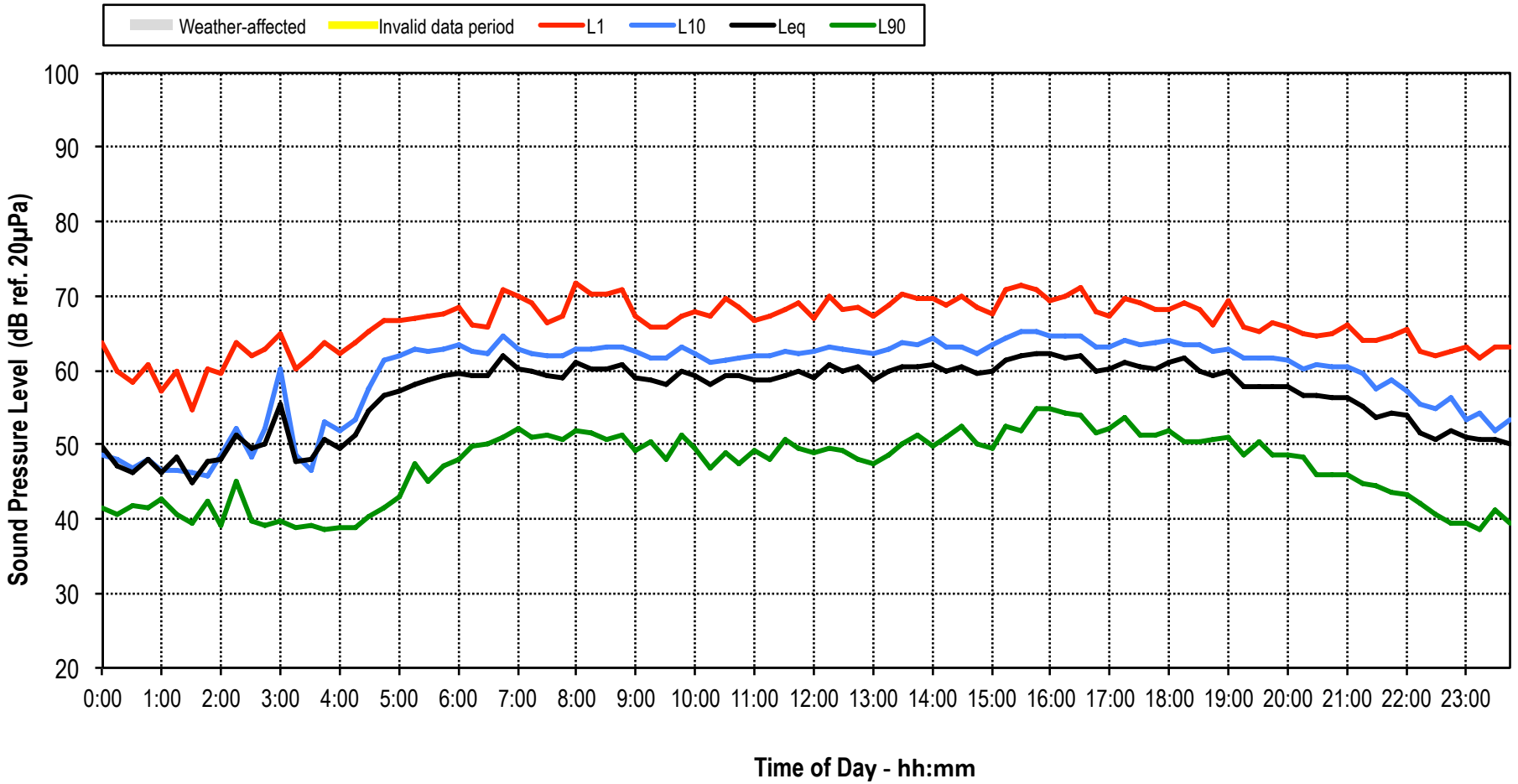
POW, 79 Botany St (Traffic, Ambient and Background) - Saturday 28 October 2017



POW, 79 Botany St (Traffic, Ambient and Background) - Sunday 29 October 2017



POW, 79 Botany St (Traffic, Ambient and Background) - Monday 30 October 2017



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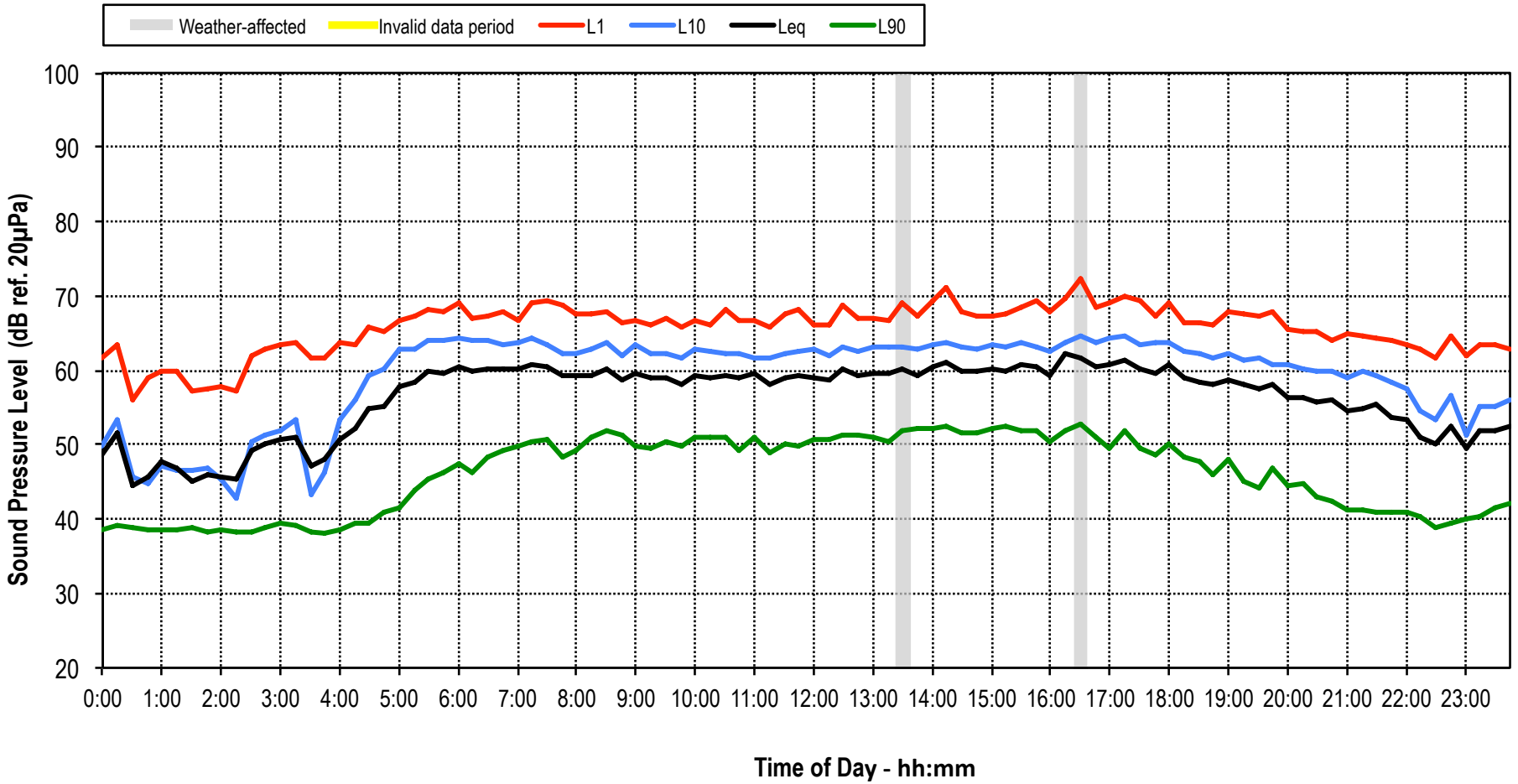
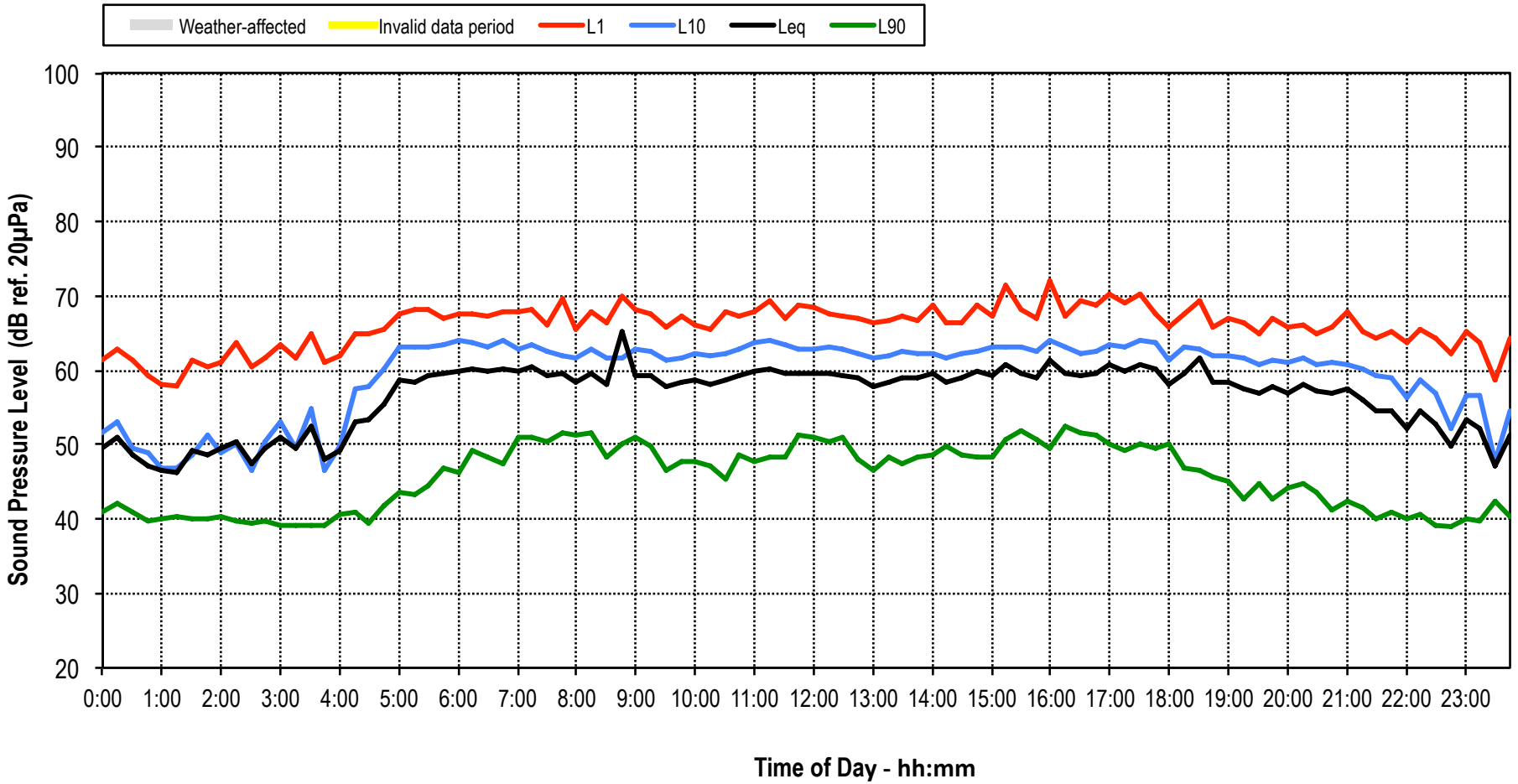
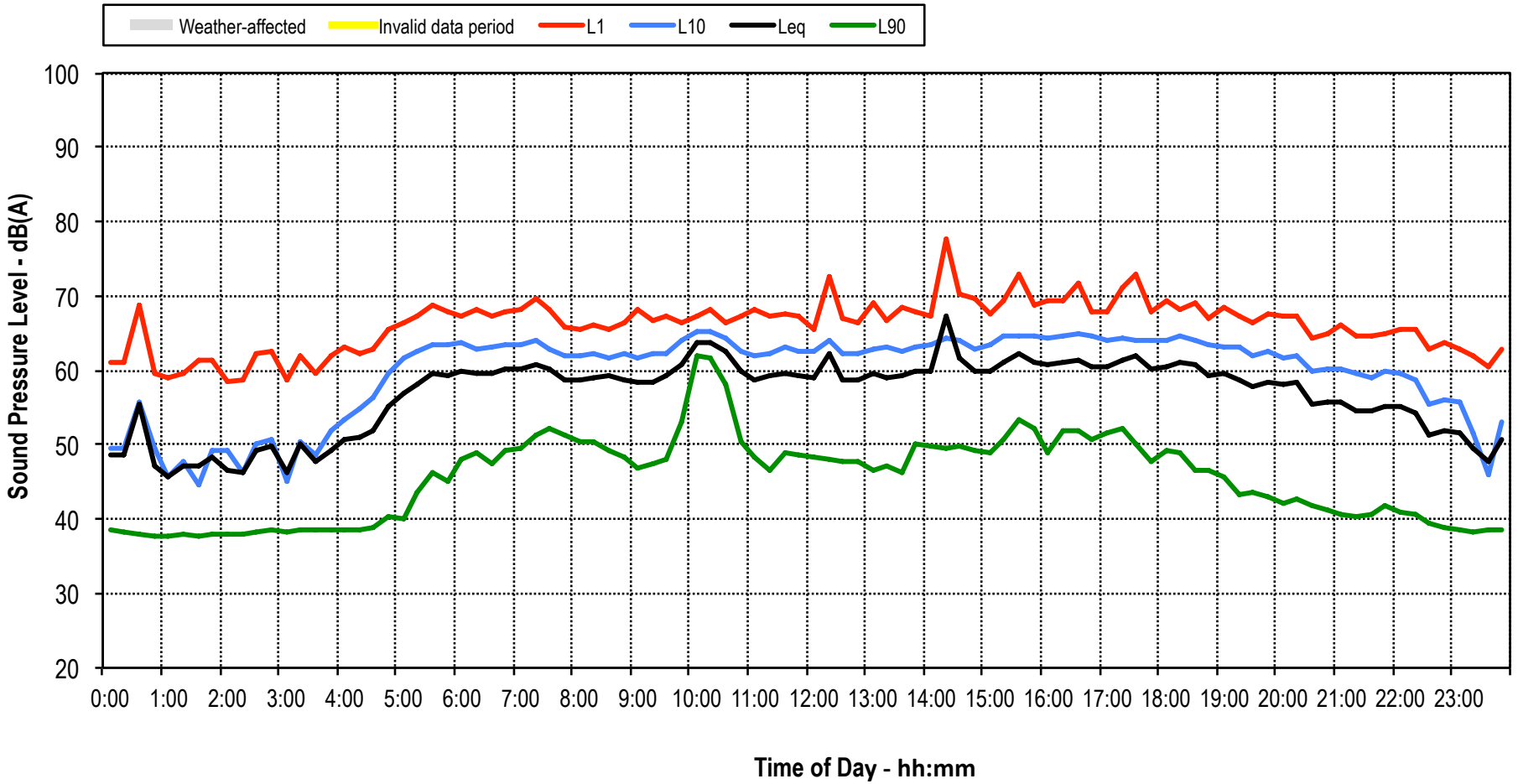


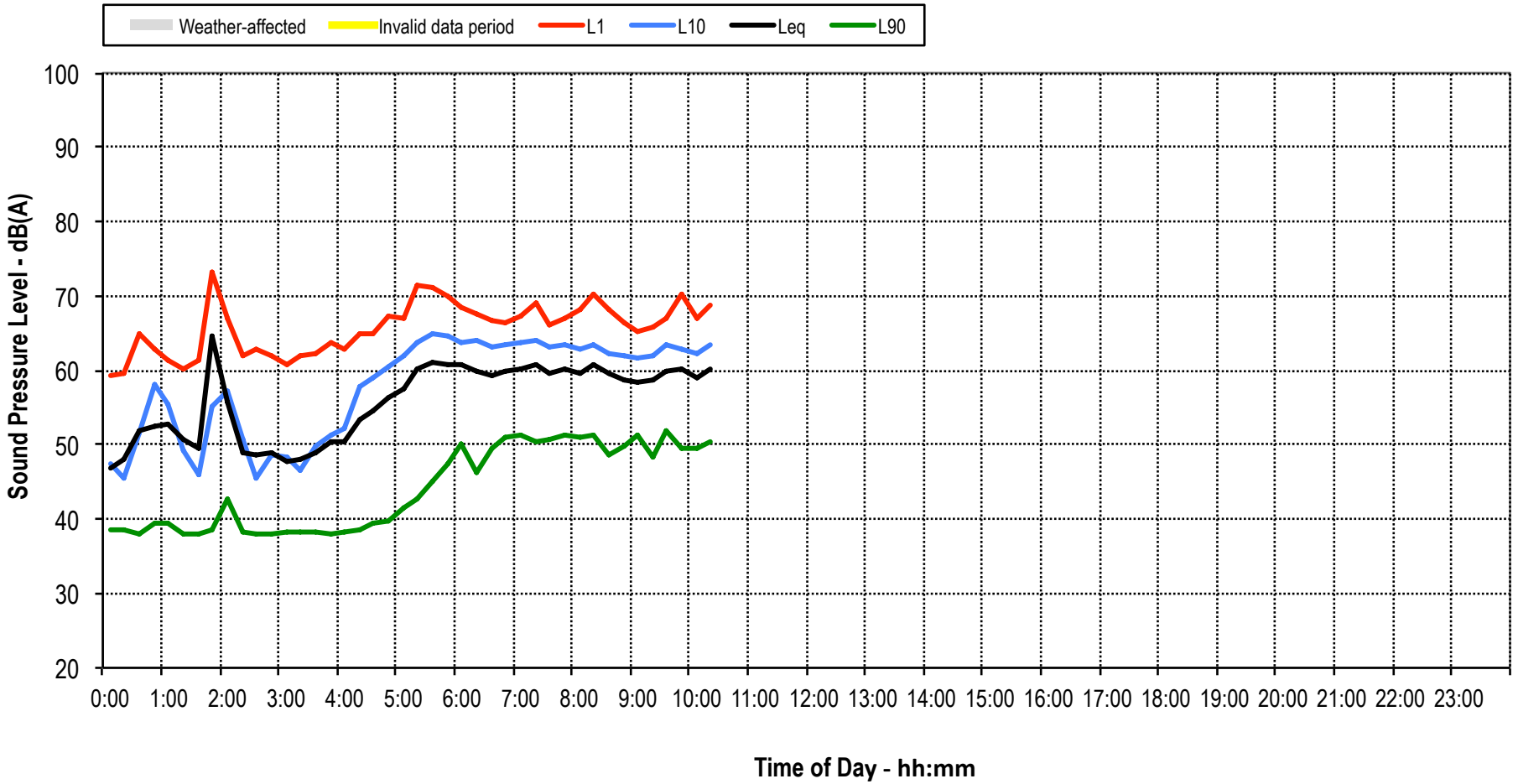
POW, 79 Botany St (Traffic, Ambient and Background) - Wednesday 01 November 2017



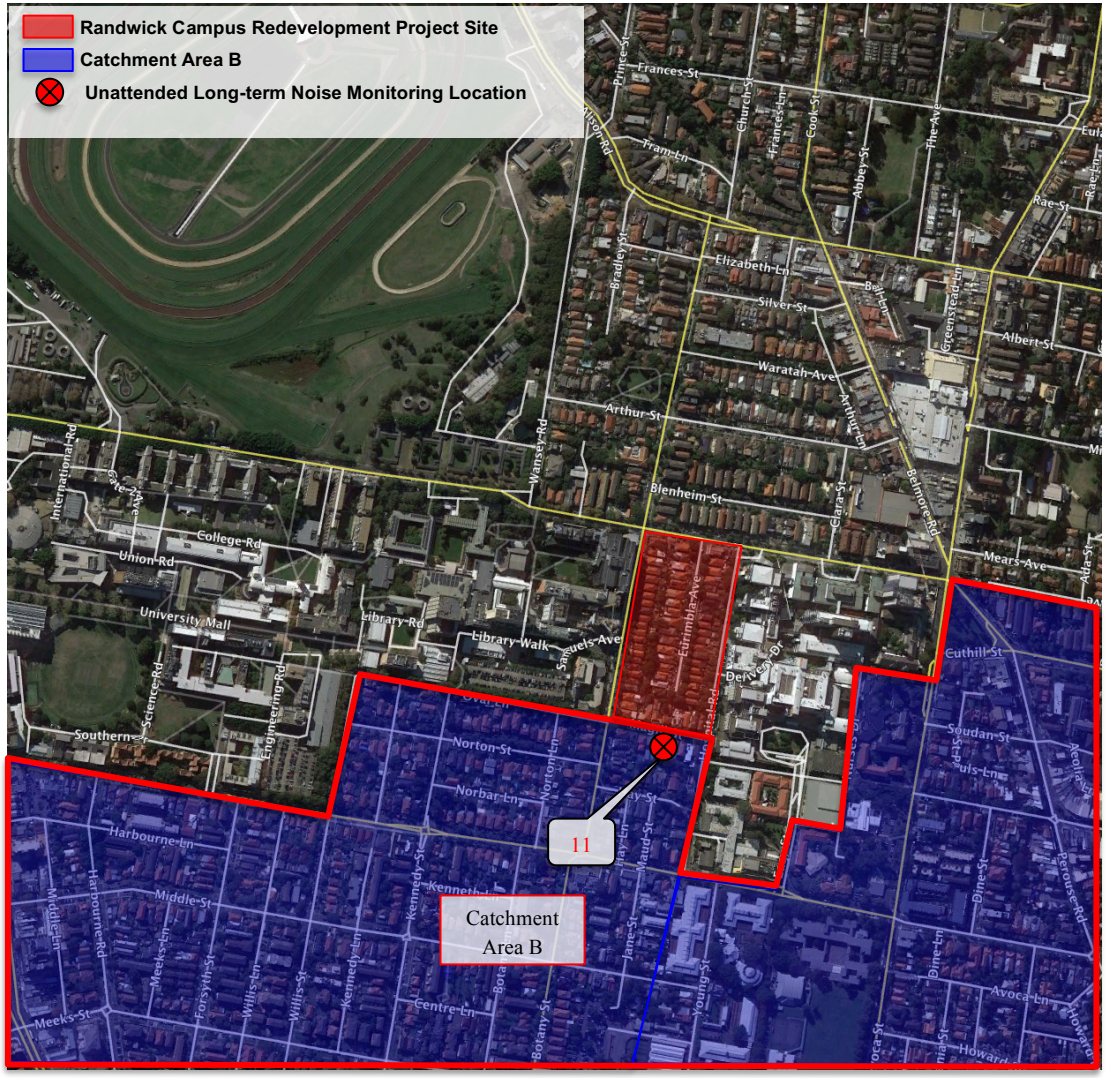
POW, 79 Botany St (Traffic, Ambient and Background) - Thursday 02 November 2017



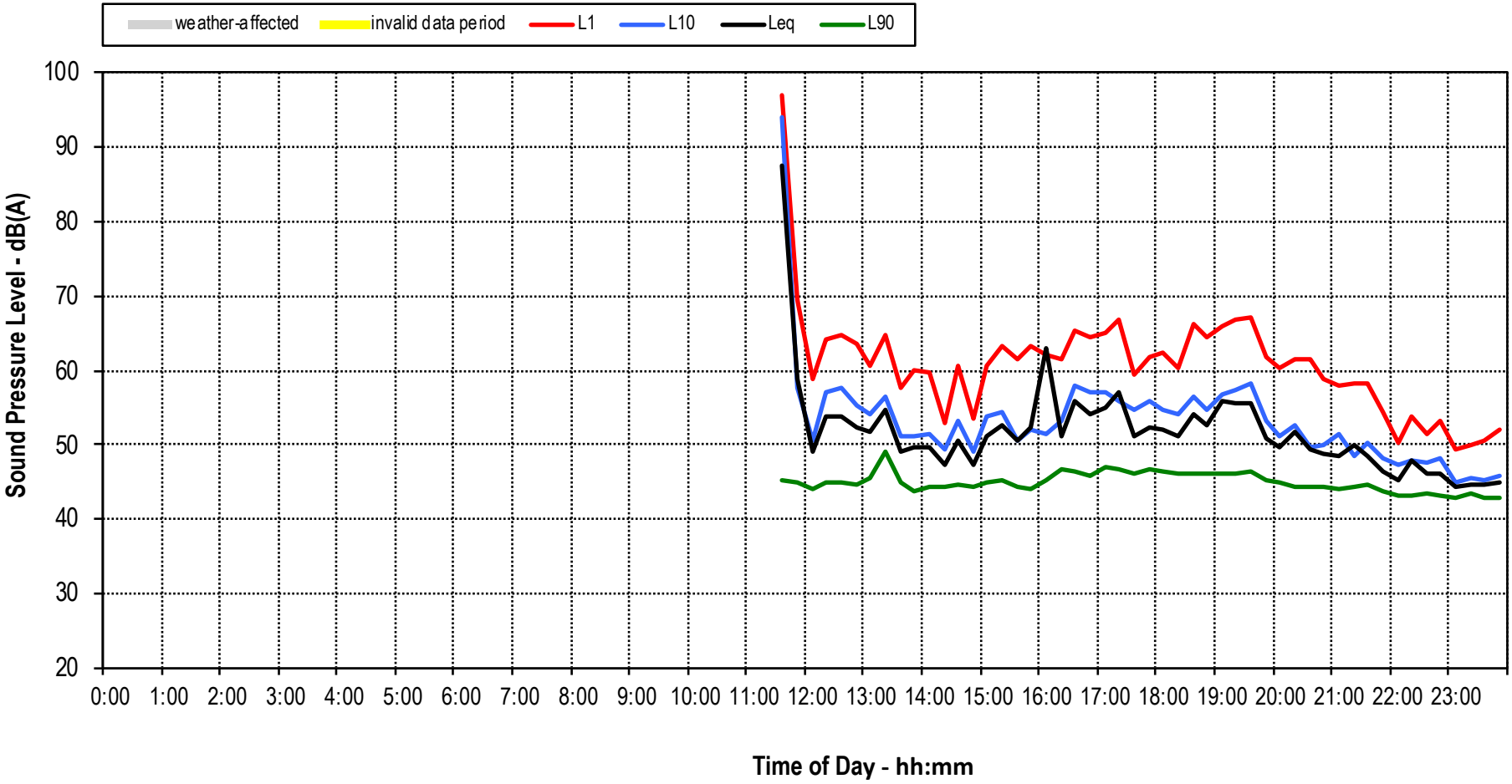
POW, 79 Botany St (Traffic, Ambient and Background) - Friday 03 November 2017



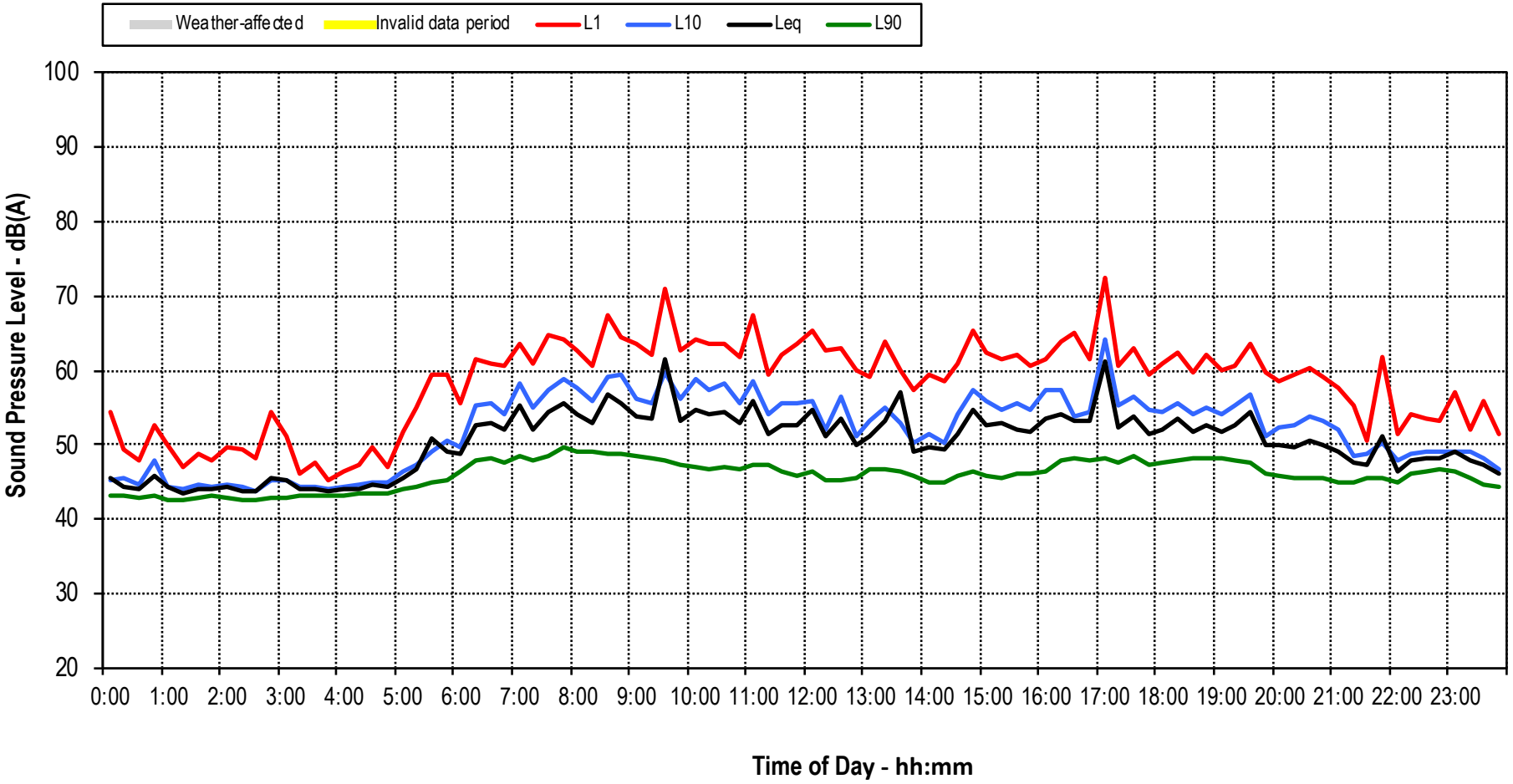
Location 11


Randwick Campus Redevelopment Project Site
Catchment Area B
Unattended Long-term Noise Monitoring Location
11
Catchment Area B
Frances-St
Prince-St
Tram-Ln
Church-St
Cook-St
Abbey-St
The-Ave
Rae-St
Elizabeth-Ln
Silver-St
Bradley-St
Albert-St
Waratah-Ave
Arthur-St
Wansey-Rd
Blenheim-St
Mears-Ave
College-Rd
Union-Rd
University-Mall
Library-Rd
Library-Walk
Samuels-Ave
Science-Rd
Engineering-Rd
Southern-Ln
Norton-St
Norbar-Ln
Harbourne-Ln
Middle-St
Kennedy-St
Meeks-St
Centre-Ln
Botany-St
Jane-St
Maud-St
Euthill-St
Dine-St
Avoca-Ln
Howard-St

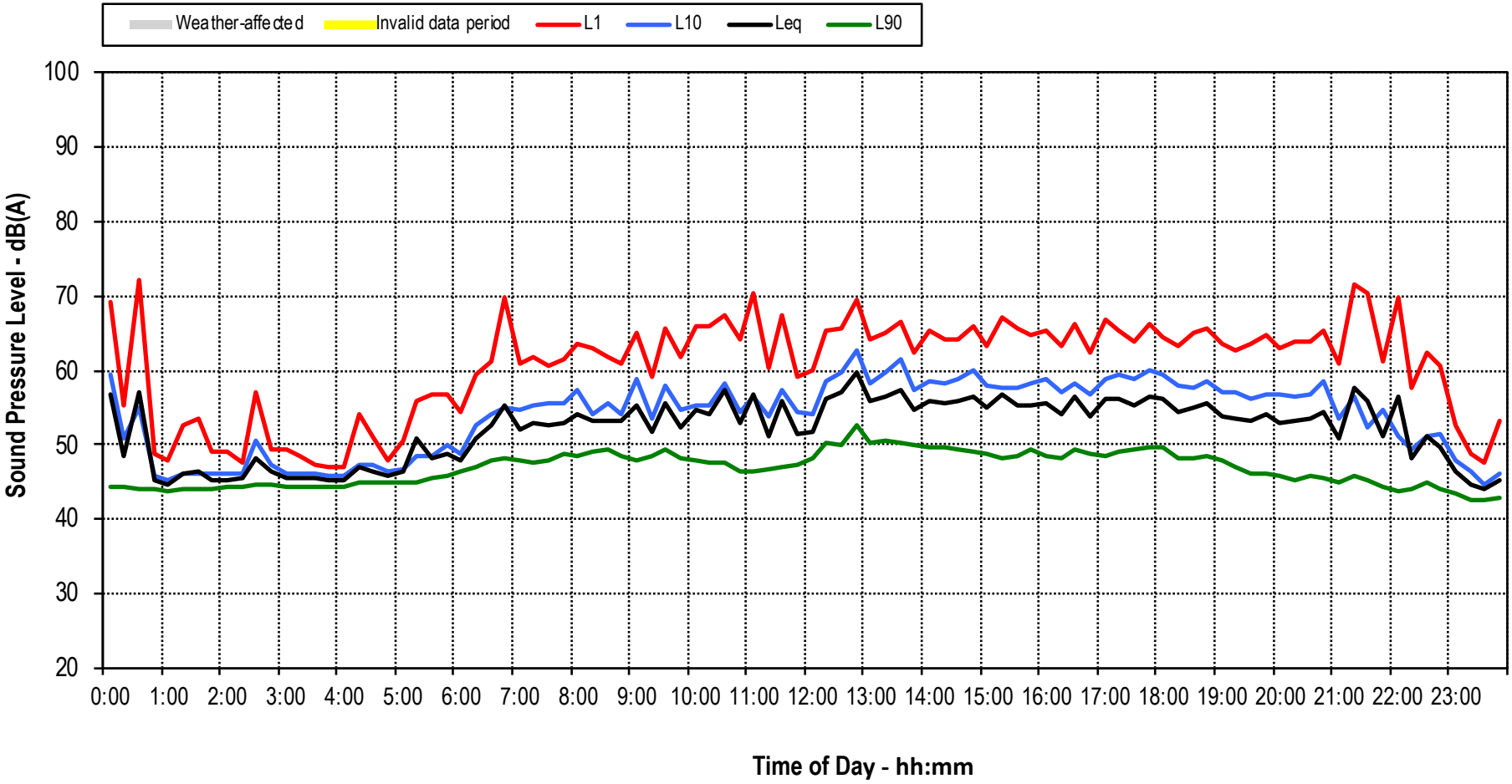
POW, 7 Magill St (Ambient and Background) - Wednesday 18 July 2018



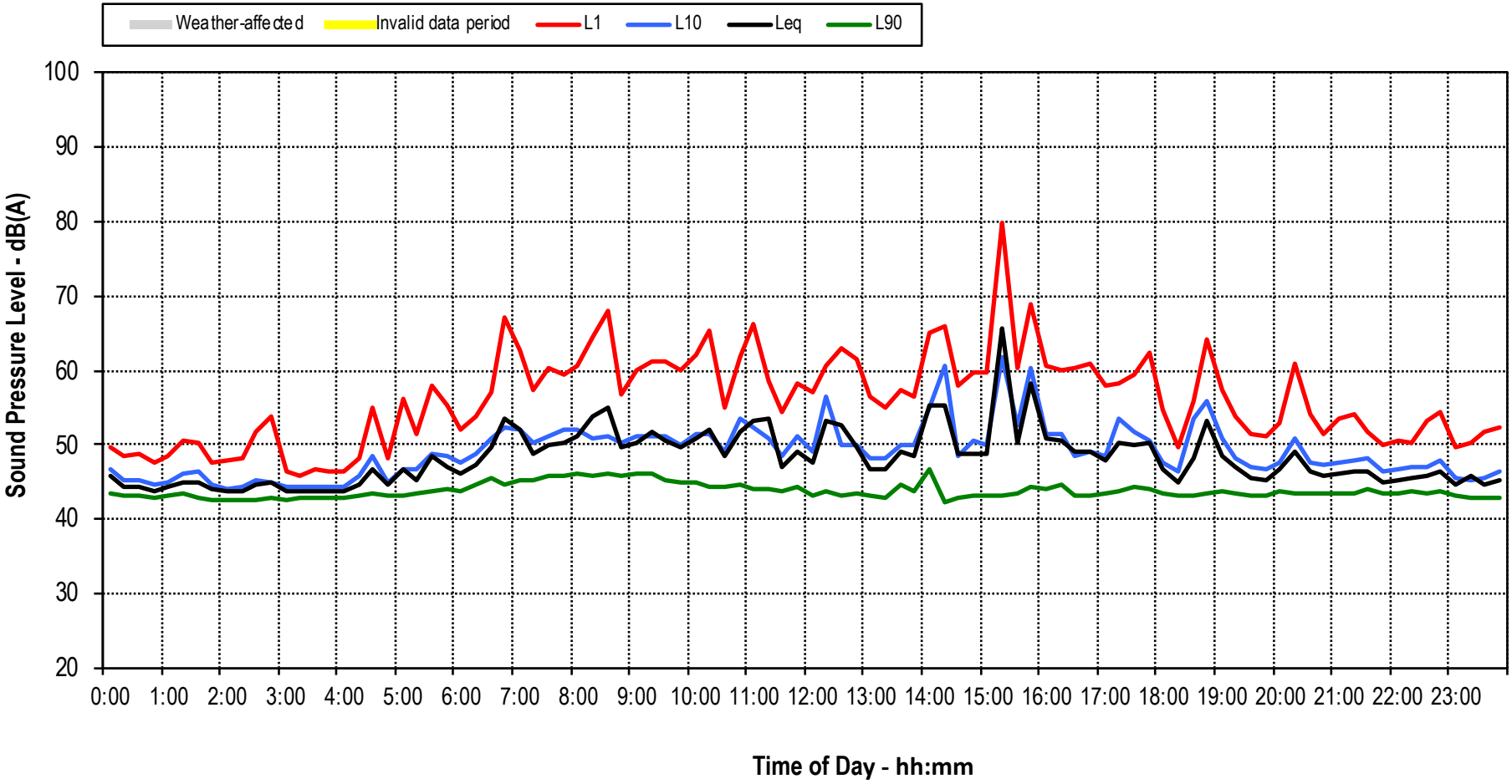
POW, 7 Magill St (Ambient and Background) - Thursday 19 July 2018



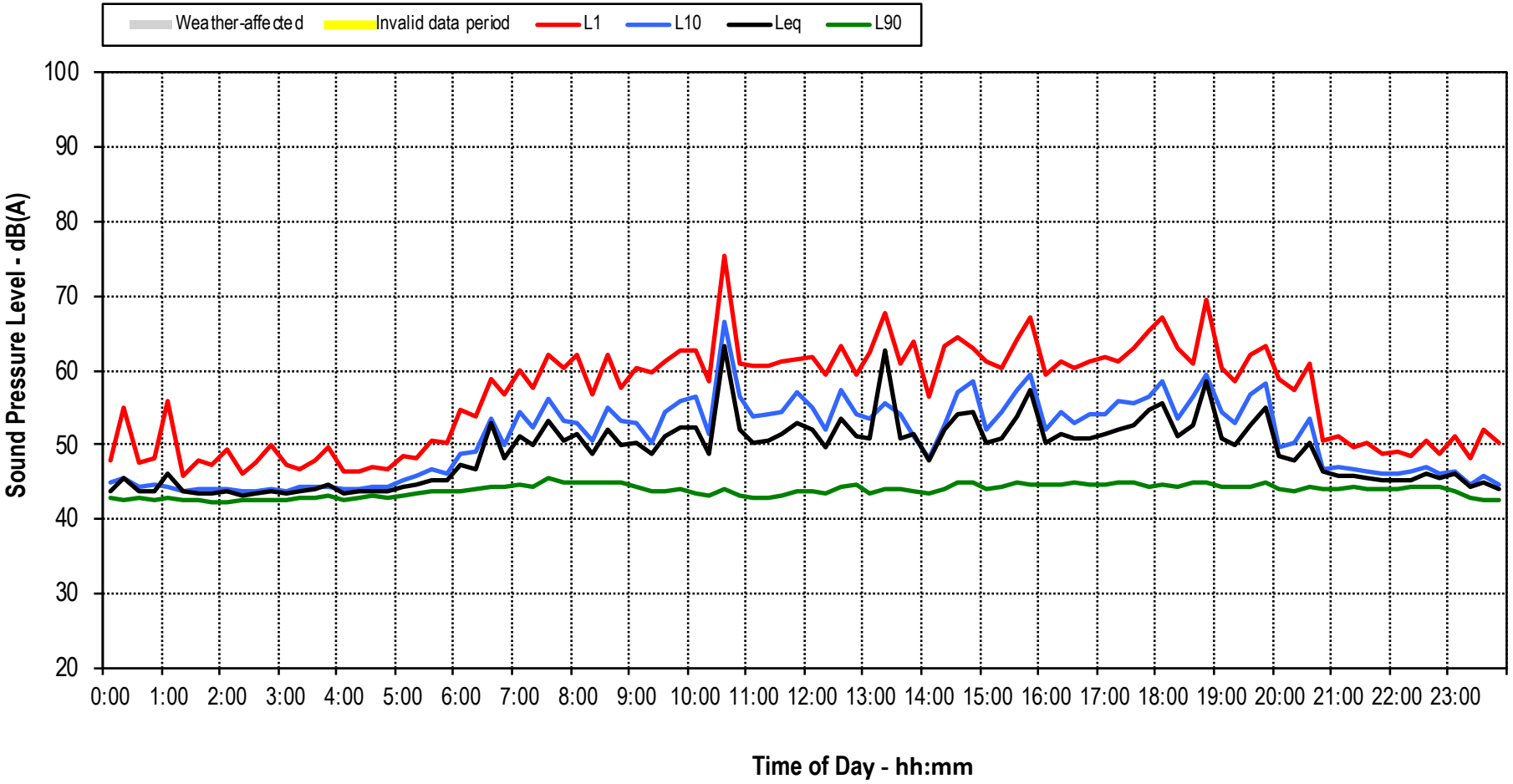
POW, 7 Magill St (Ambient and Background) - Friday 20 July 2018



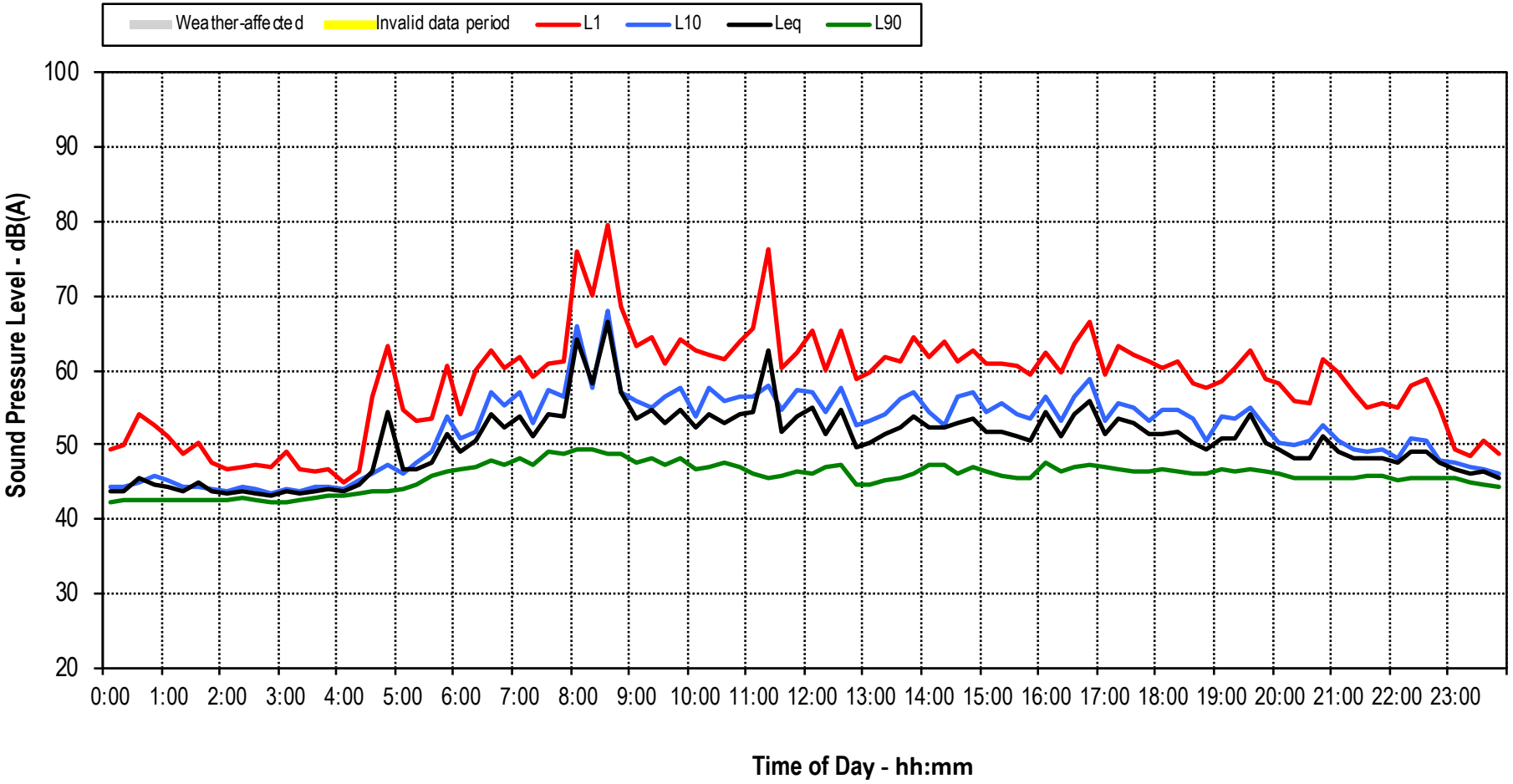
POW, 7 Magill St (Ambient and Background) - Saturday 21 July 2018



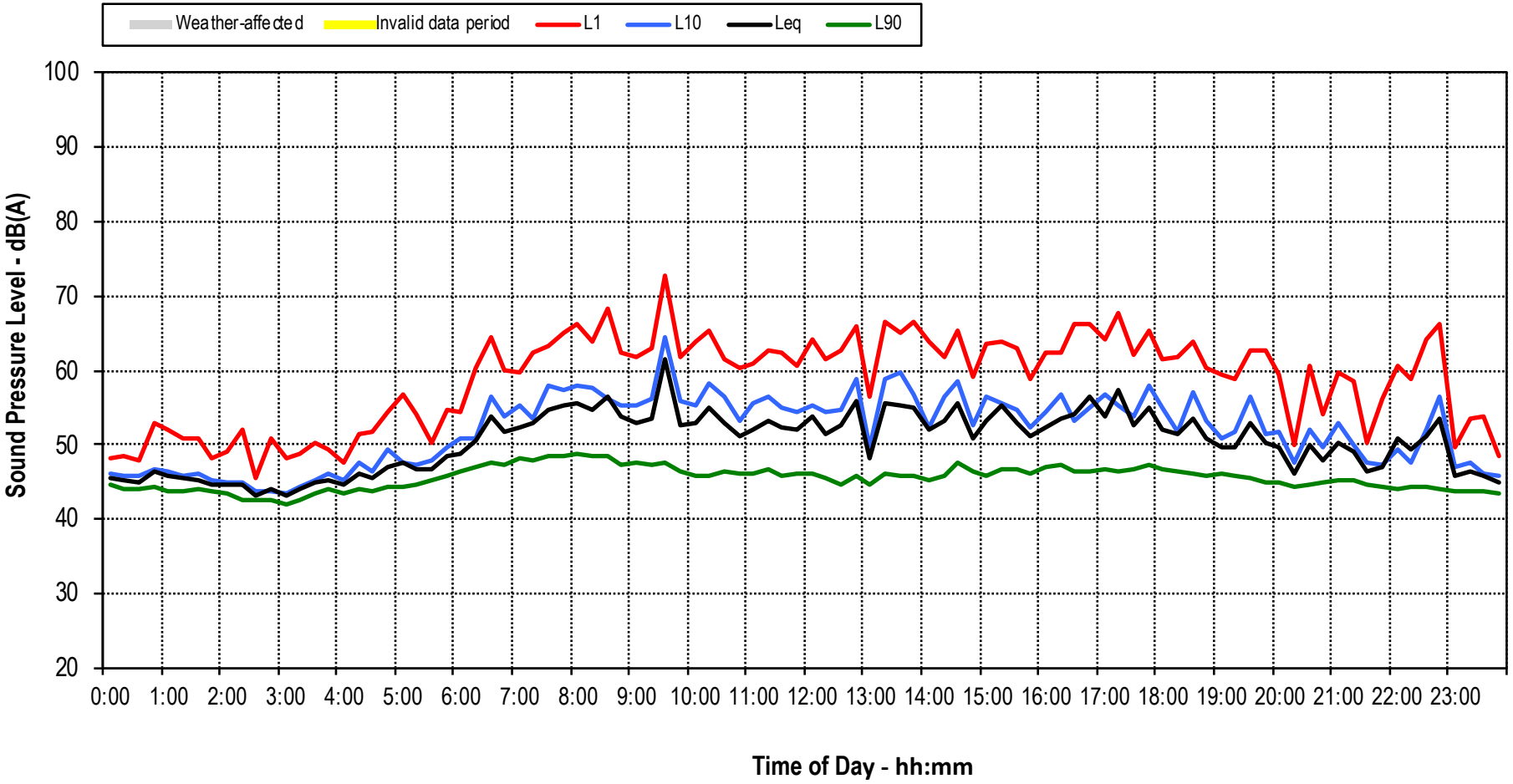
POW, 7 Magill St (Ambient and Background) - Sunday 22 July 2018



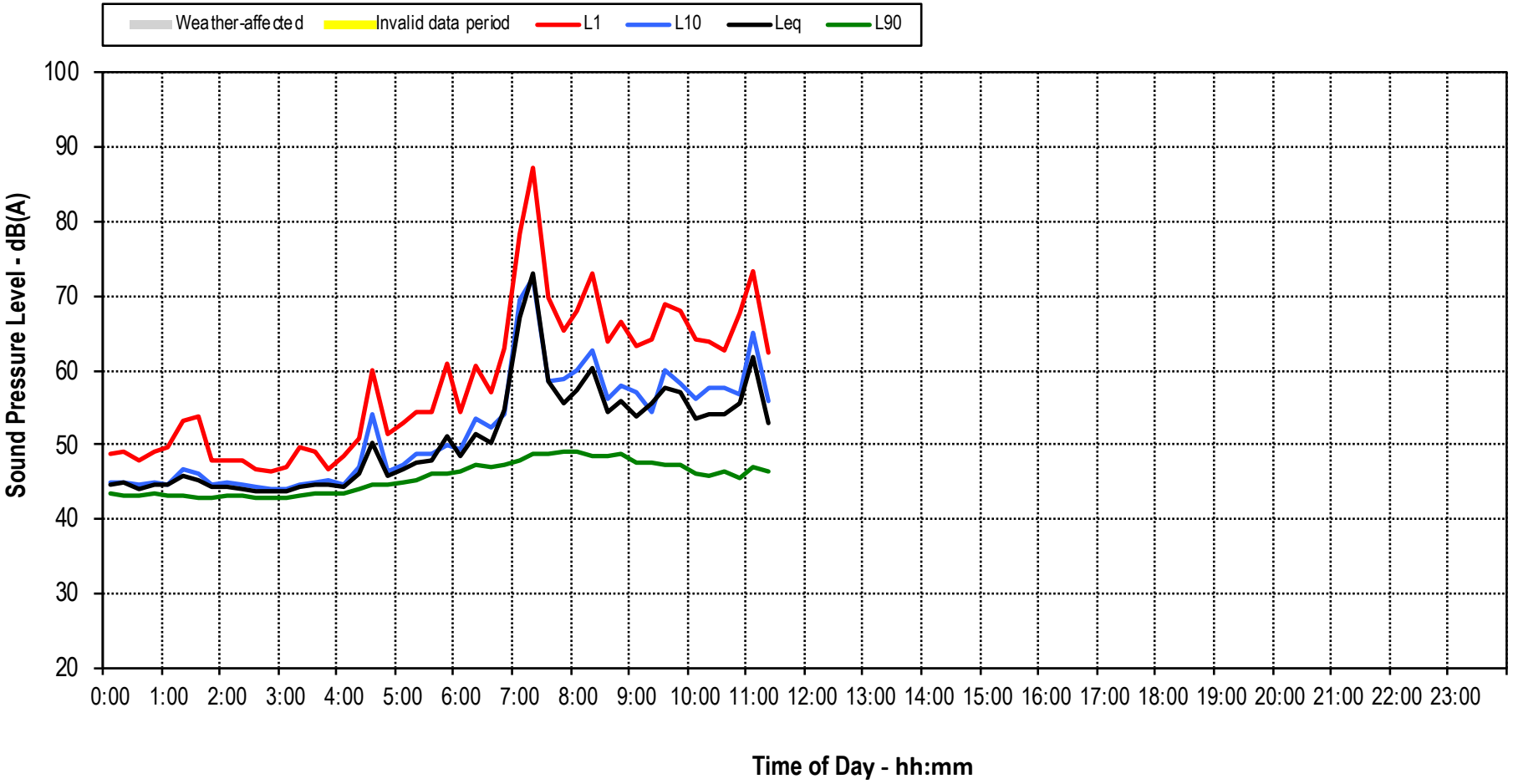
POW, 7 Magill St (Ambient and Background) - Monday 23 July 2018



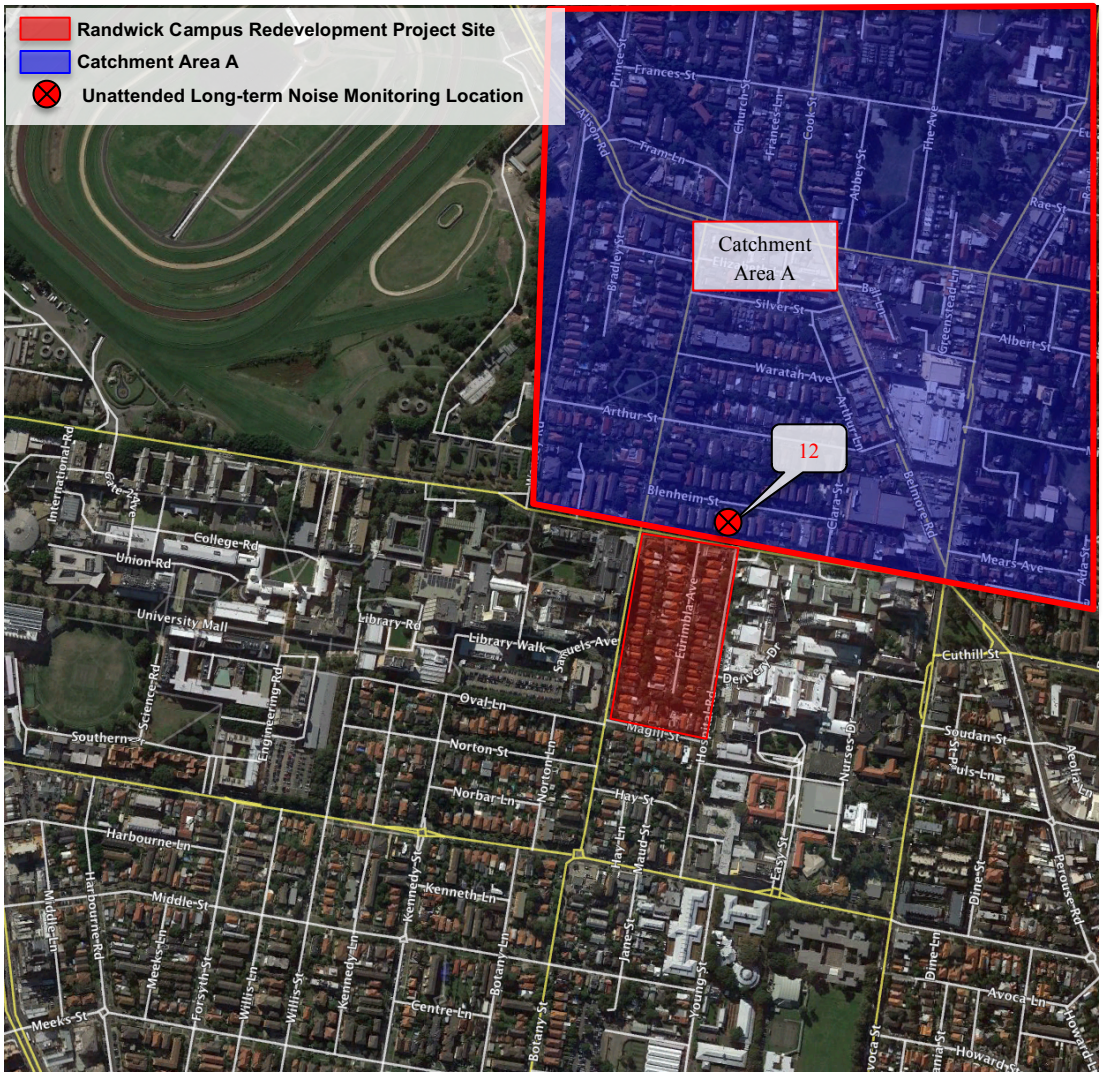
POW, 7 Magill St (Ambient and Background) - Tuesday 24 July 2018



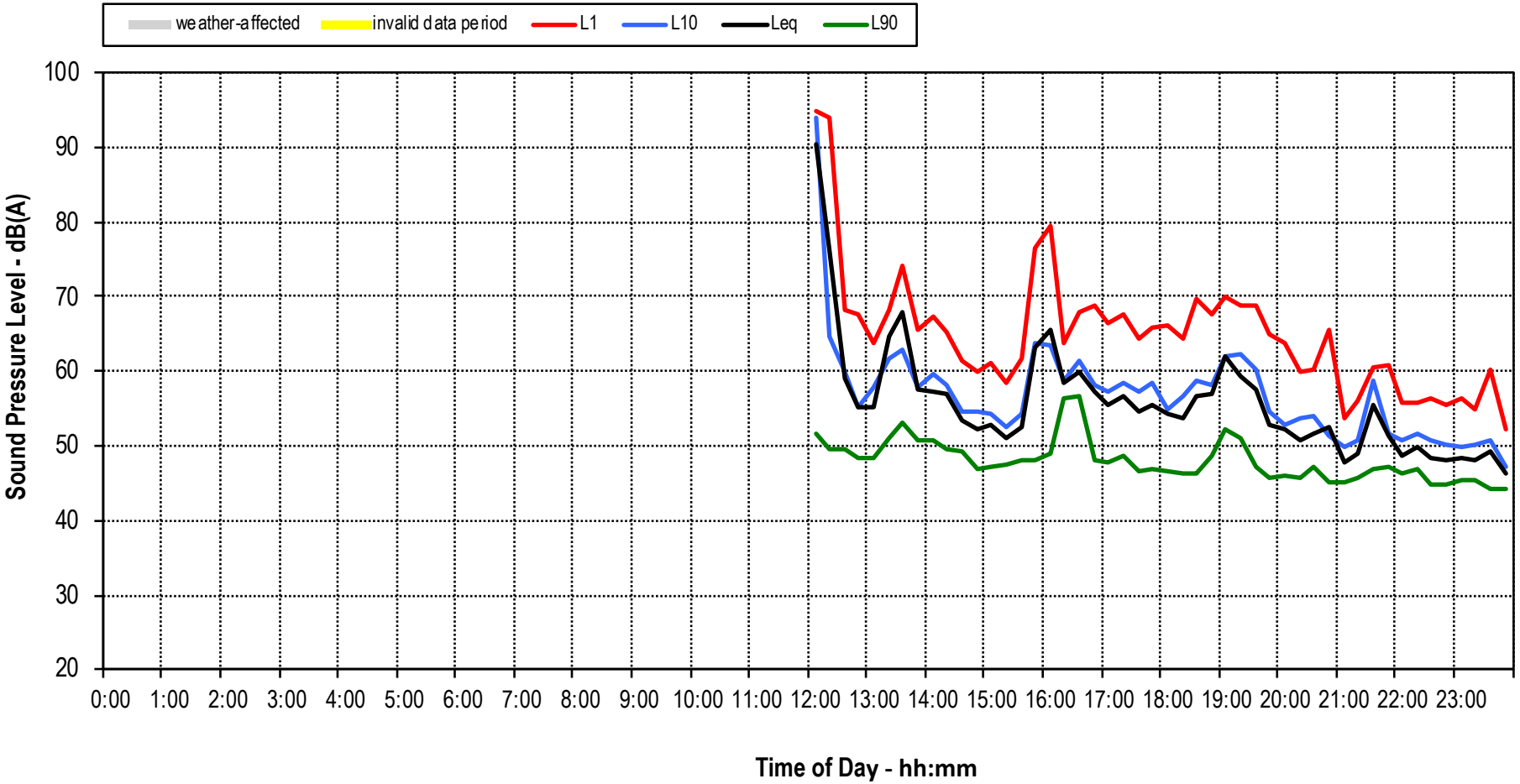
POW, 7 Magill St (Ambient and Background) - Wednesday 25 July 2018



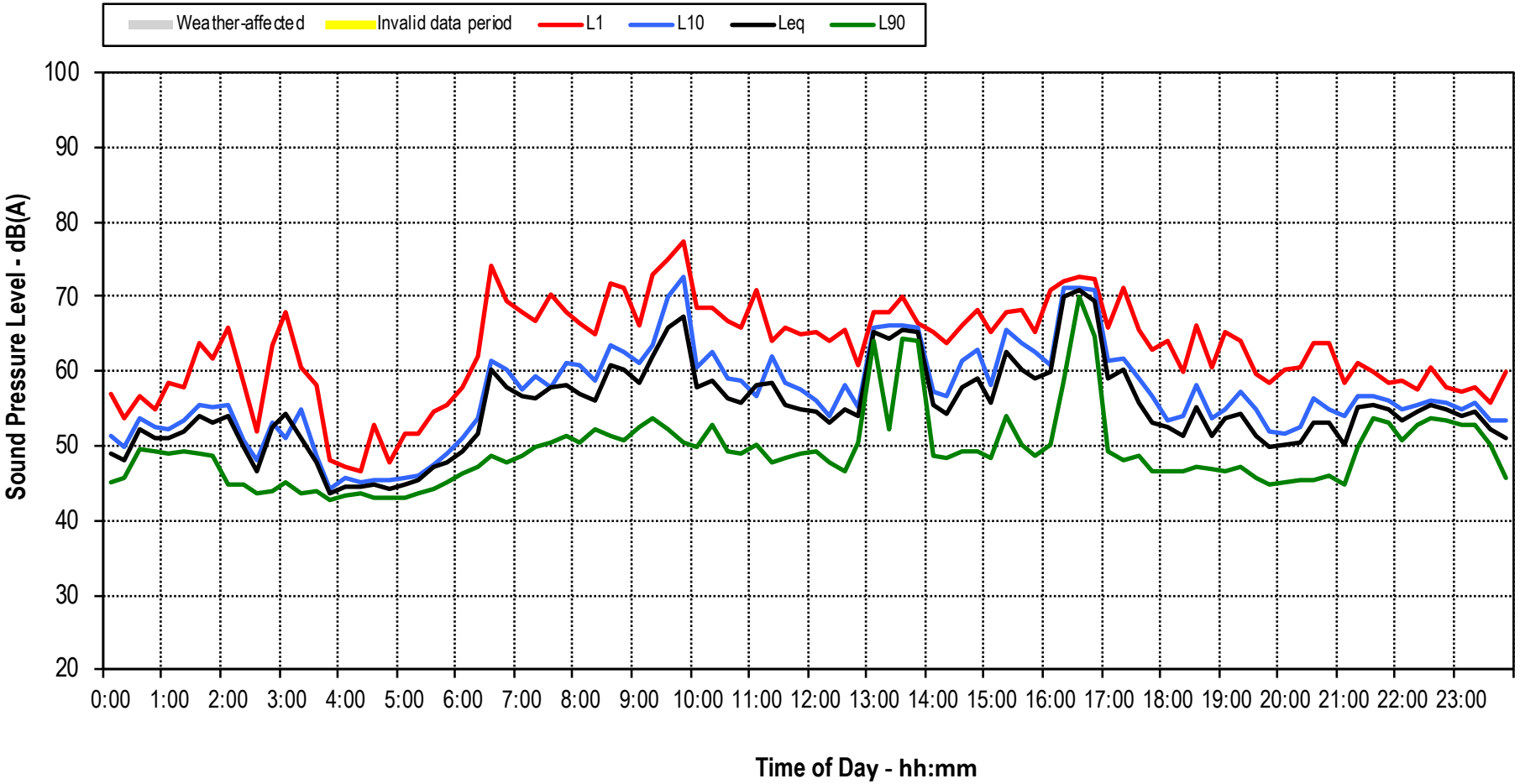
Location 12


Randwick Campus Redevelopment Project Site
Catchment Area A
Unattended Long-term Noise Monitoring Location
Catchment Area A
12
Frances-St
Prince-St
Church-St
Cook-St
Abbey-St
The-Ave
Rae-St
Tram-Ln
Alison-Rd
Bradley-St
Silver-St
Albert-St
Waratah-Ave
Arthur-St
Blenheim-St
Cara-St
Belmore-Rd
Mears-Ave
Euthill-St
International-Rd
College-Rd
Union-Rd
University-Mall
Library-Rd
Library-Walk
Samuels-Ave
Eurimbla-Ave
Oval-Ln
Science-Rd
Engineering-Rd
Southern-Ln
Norton-St
Norton-Ln
Norbar-Ln
Magill-St
Hay-St
Harbourne-Ln
Middle-St
Kenneth-Ln
Kennedy-St
Meeks-St
Centre-Ln
Botany-St
Jane-St
Maud-St
Young-St
Nurses-Dr
Dine-St
Perouse-Rd
Avoca-Ln
Howard-St

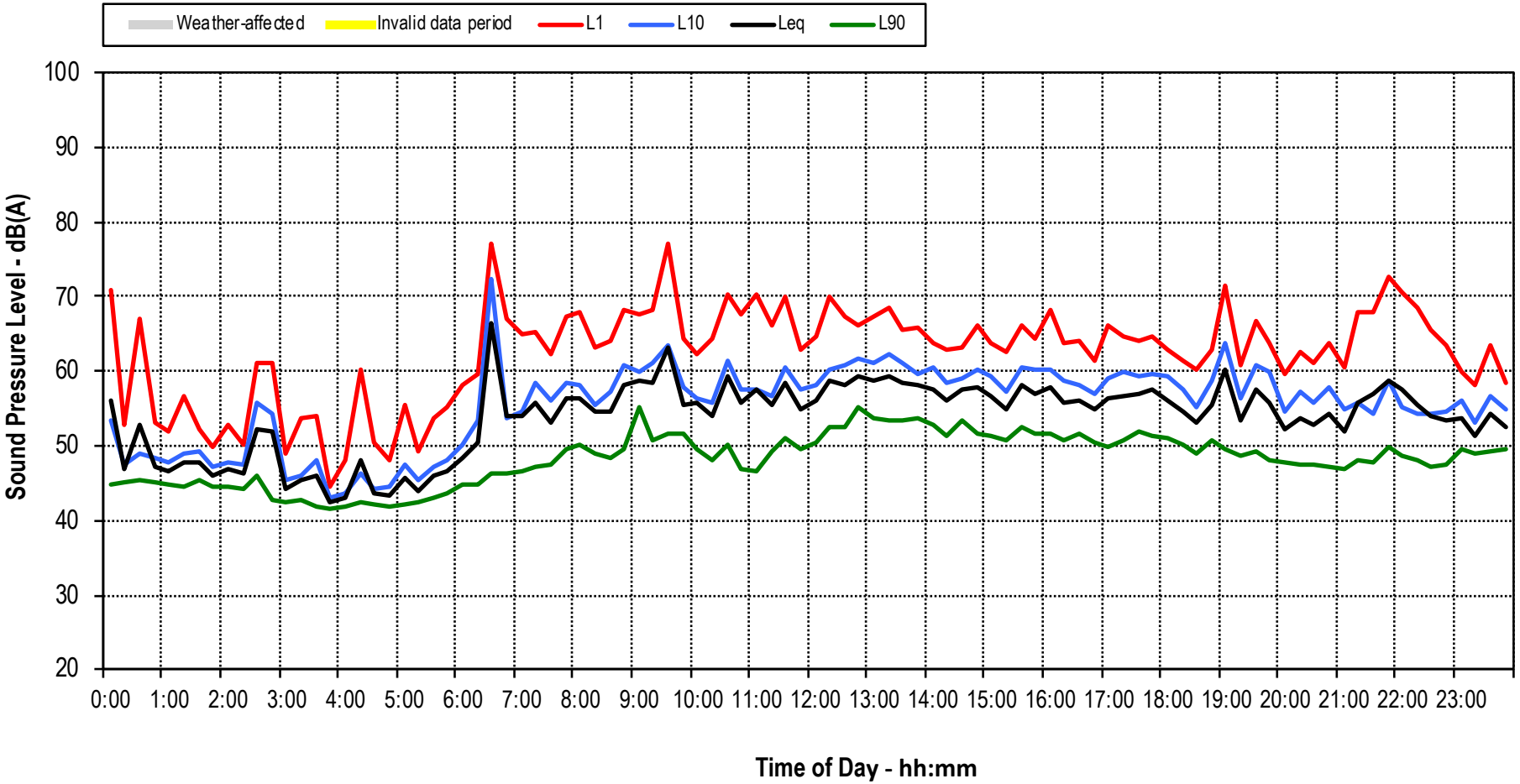
POW, 12 Blenheim St (Ambient and Background) - Wednesday 18 July 2018



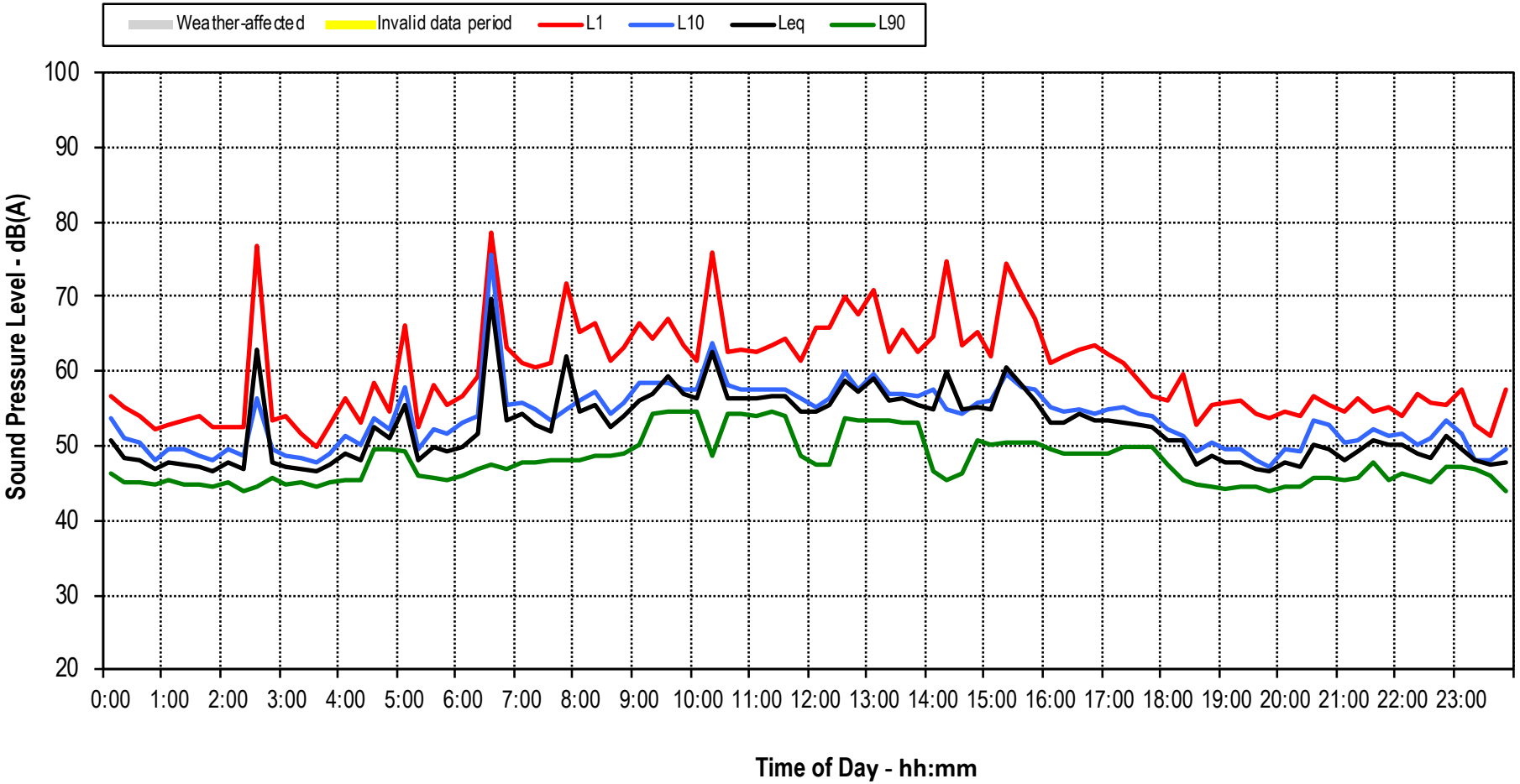
POW, 12 Blenheim St (Ambient and Background) - Thursday 19 July 2018



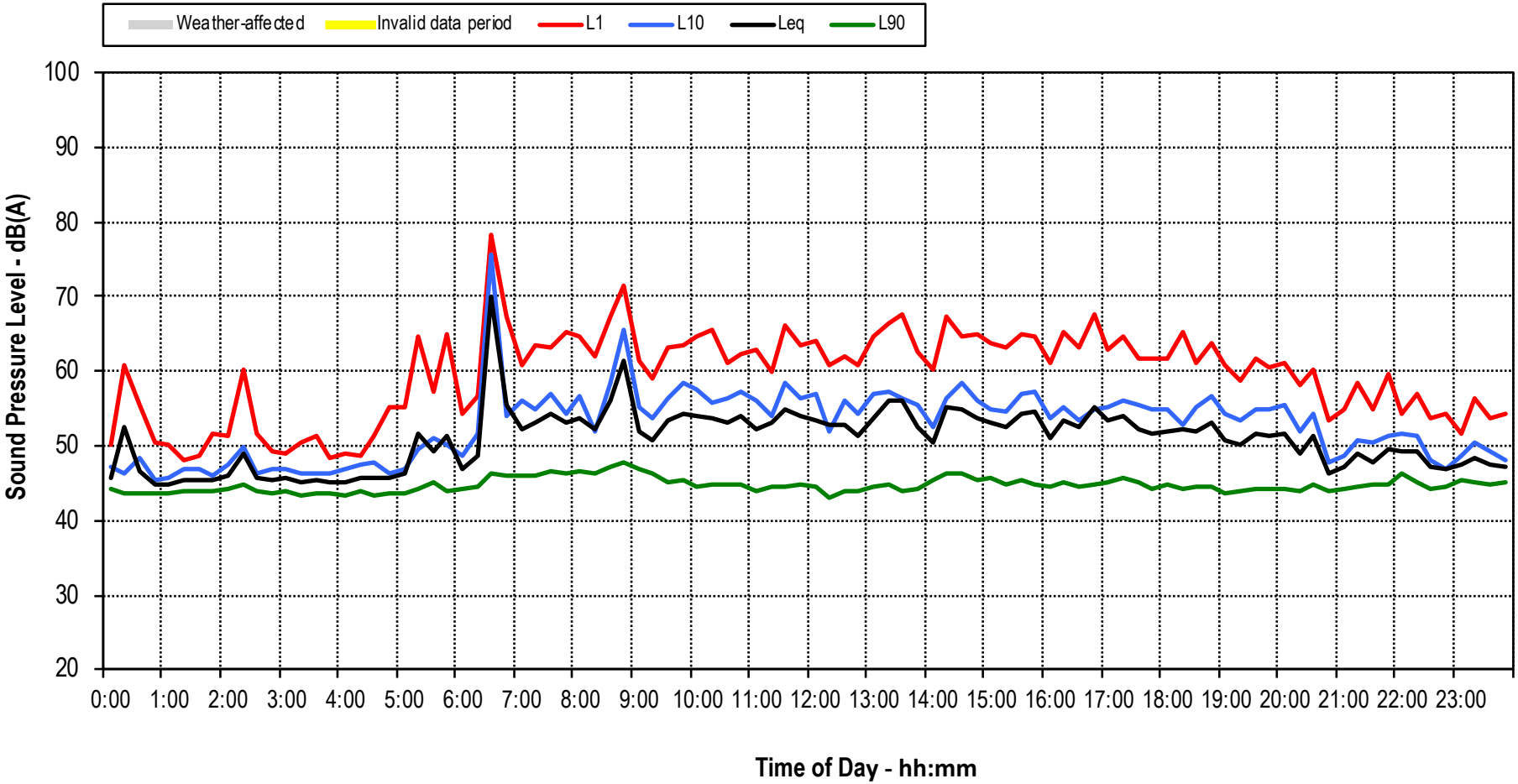
POW, 12 Blenheim St (Ambient and Background) - Friday 20 July 2018



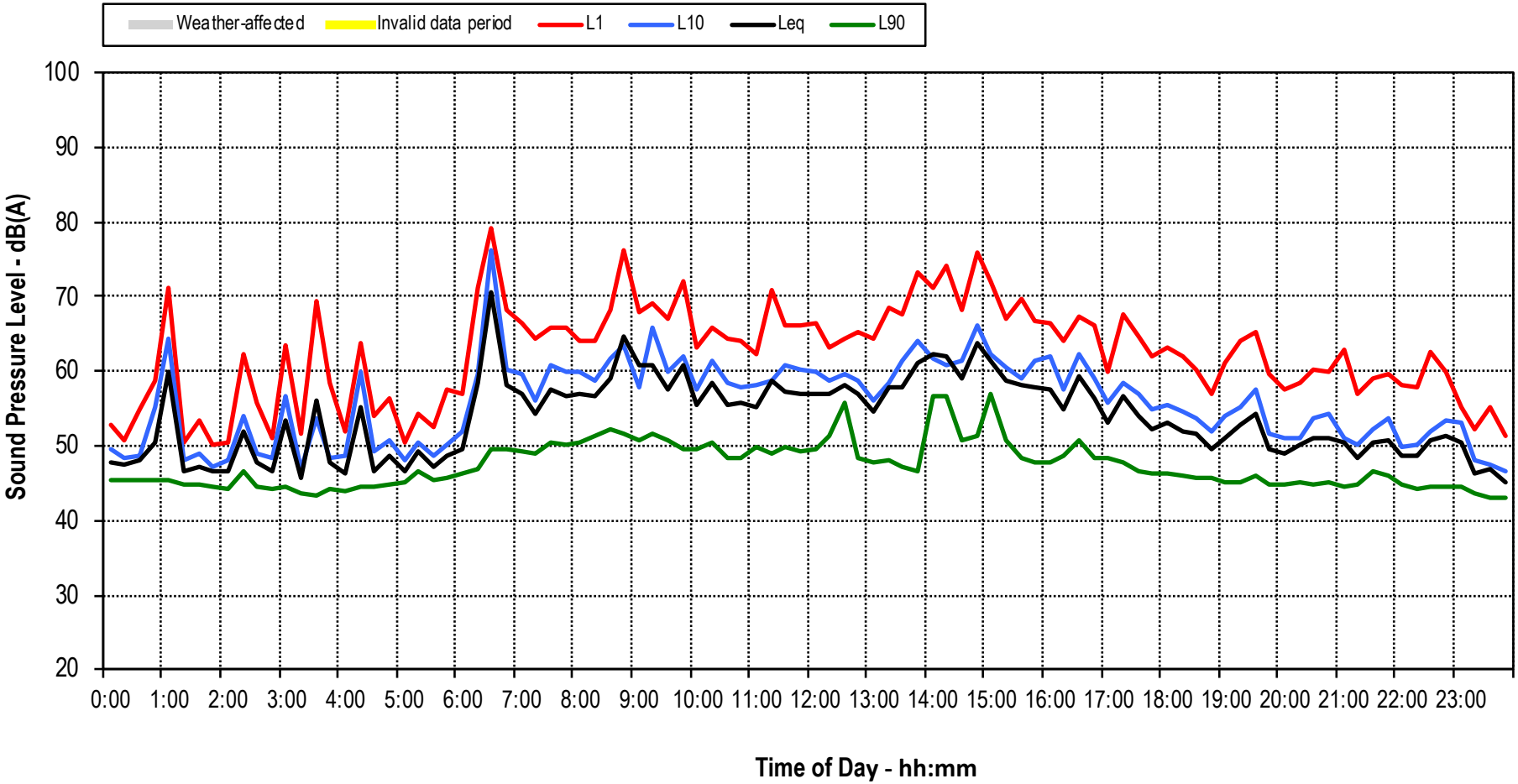
POW, 12 Blenheim St (Ambient and Background) - Saturday 21 July 2018



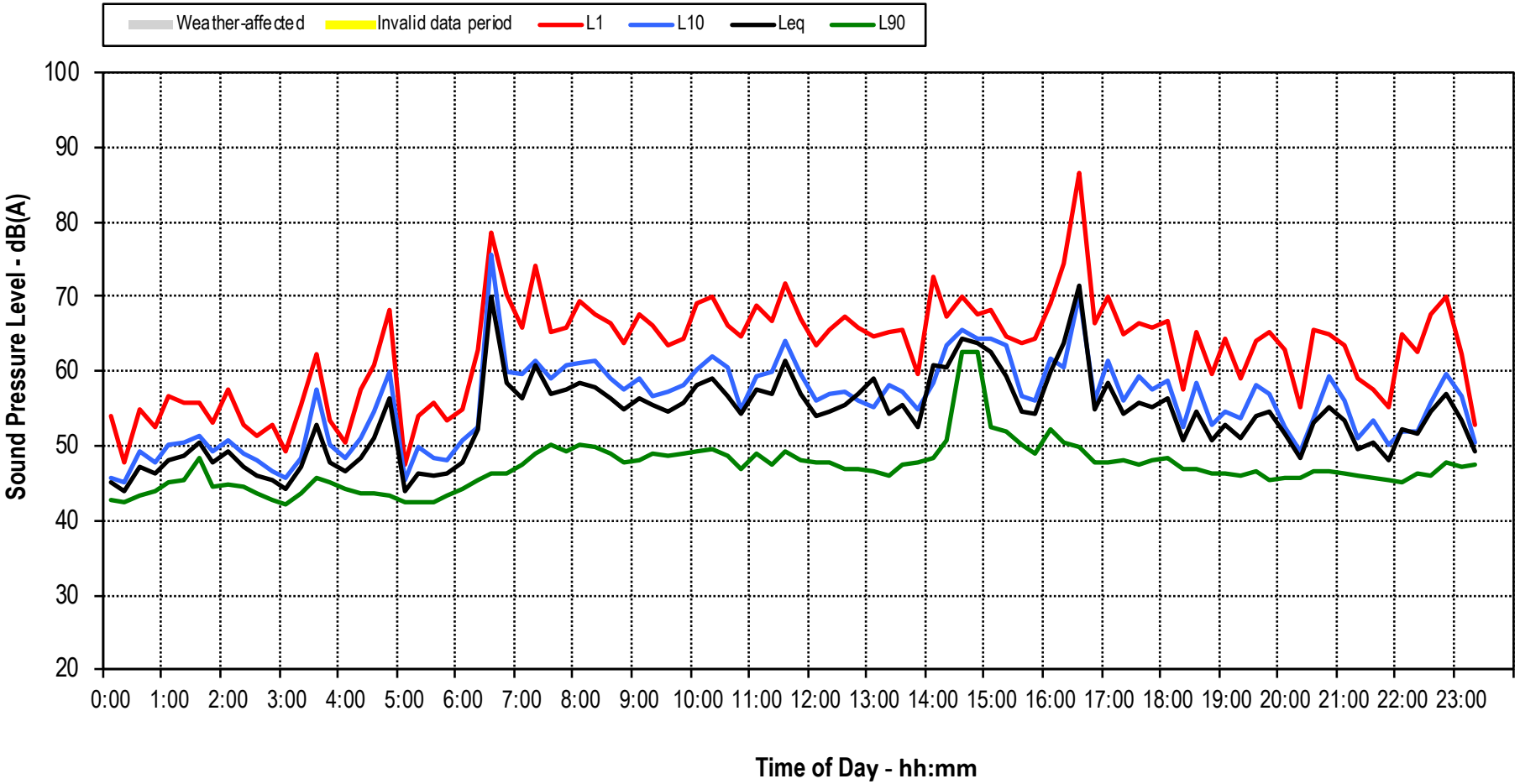
POW, 12 Blenheim St (Ambient and Background) - Sunday 22 July 2018



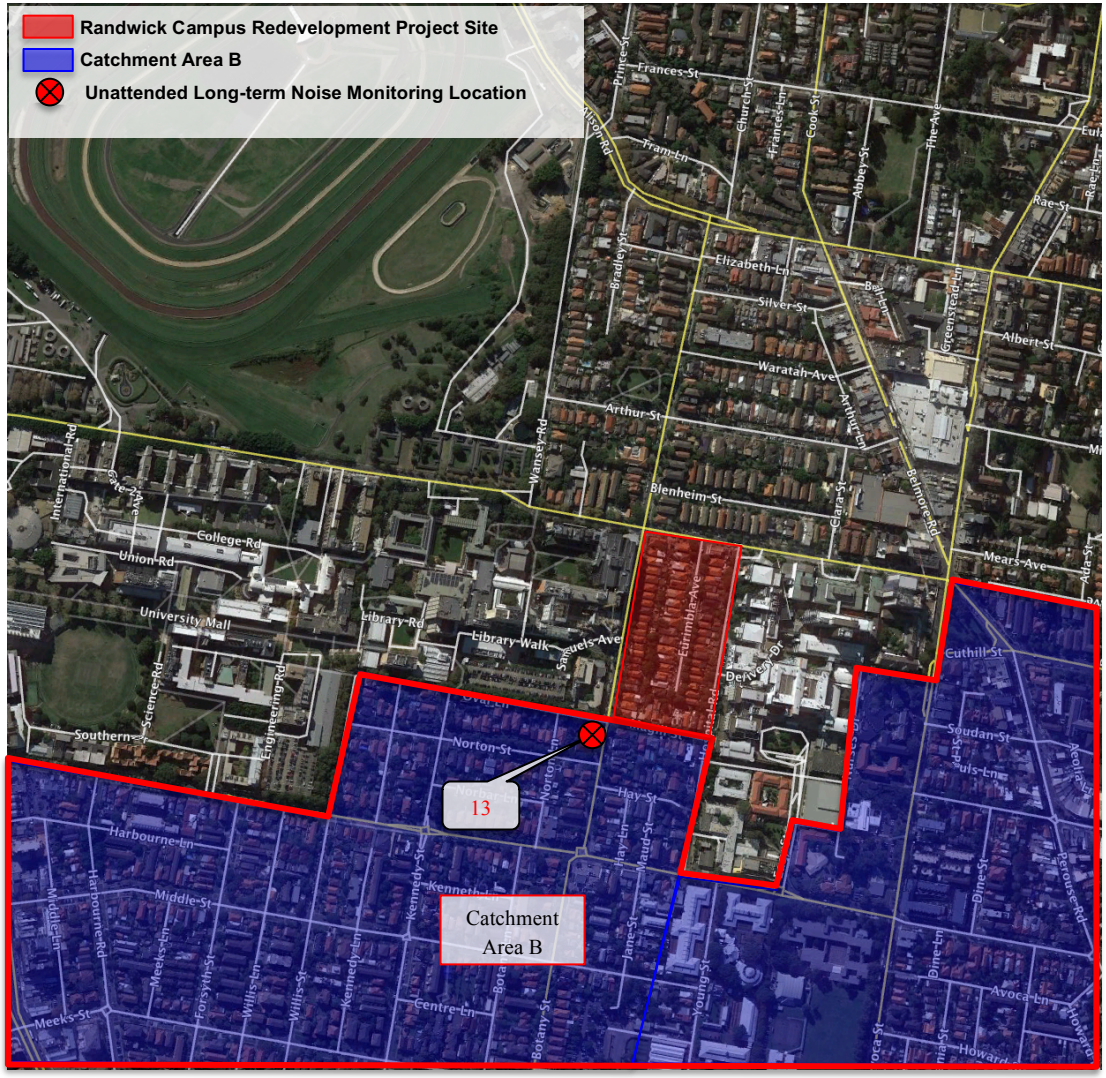
POW, 12 Blenheim St (Ambient and Background) - Monday 23 July 2018



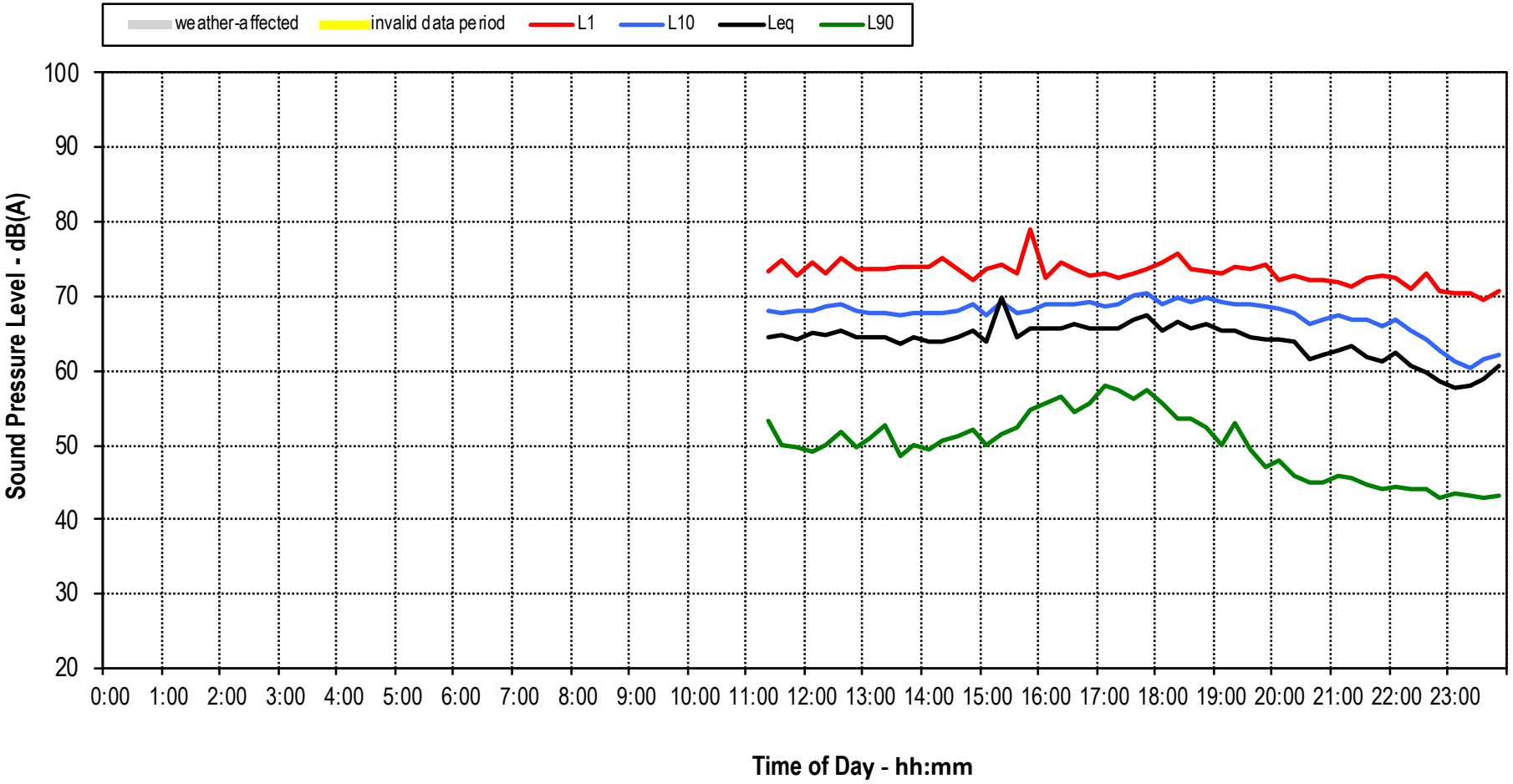
POW, 12 Blenheim St (Ambient and Background) - Tuesday 24 July 2018



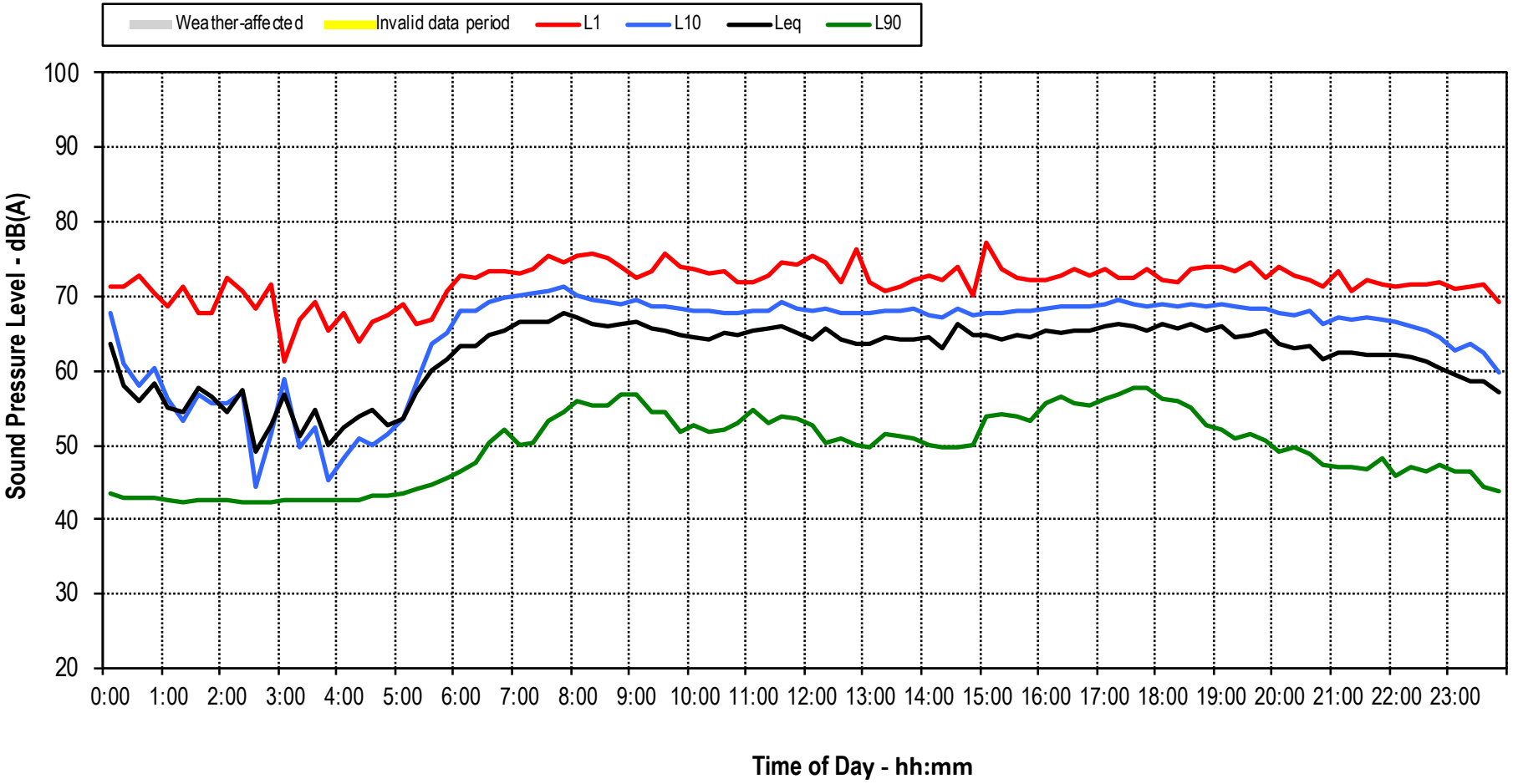
Location 13


Randwick Campus Redevelopment Project Site
Catchment Area B
Unattended Long-term Noise Monitoring Location
13
Catchment Area B
Frances-St
Prince-St
Church-St
Cook-St
Abbey-St
The-Ave
Rae-St
Tram-Ln
Elizabeth-Ln
Silver-St
Albert-St
Waratah-Ave
Arthur-St
Blenheim-St
Mears-Ave
Wansey-Rd
Bradley-St
Belmore-Rd
Clara-St
College-Rd
Union-Rd
University-Mall
Library-Rd
Library-Walk
Samuels-Ave
Eurimbla-Ave
Euthill-St
Norton-St
Hay-St
Harbourne-Ln
Middle-St
Kennedy-St
Jane-St
Maud-St
Dine-St
Avoca-Ln
Howard
Meeks-St
Centre-Ln
Botany-St
Young-St
Perouse-Rd
Southern
Science-Rd
Engineering-Rd
International-Rd

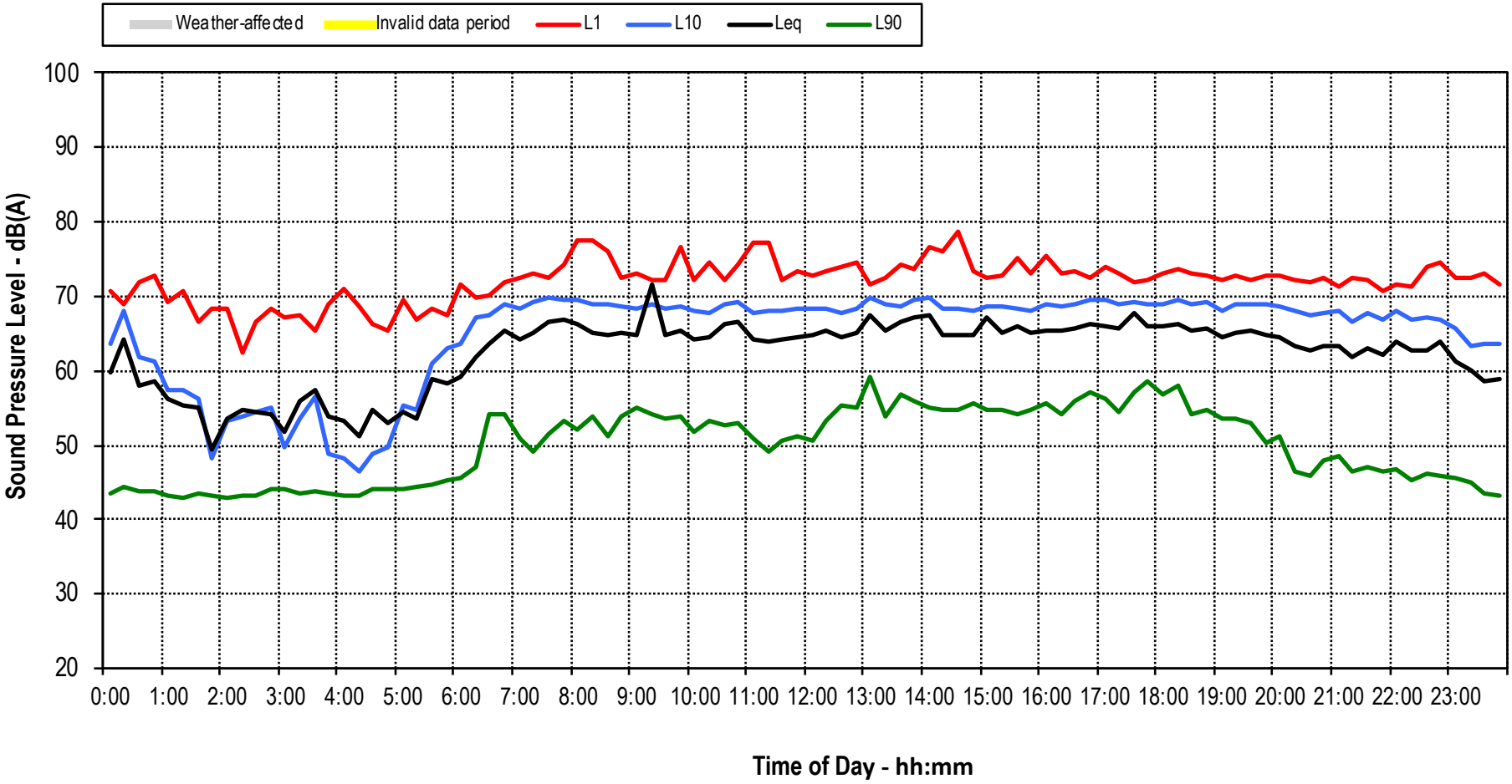
POW, 40 Botany St (Ambient and Background) - Wednesday 18 July 2018



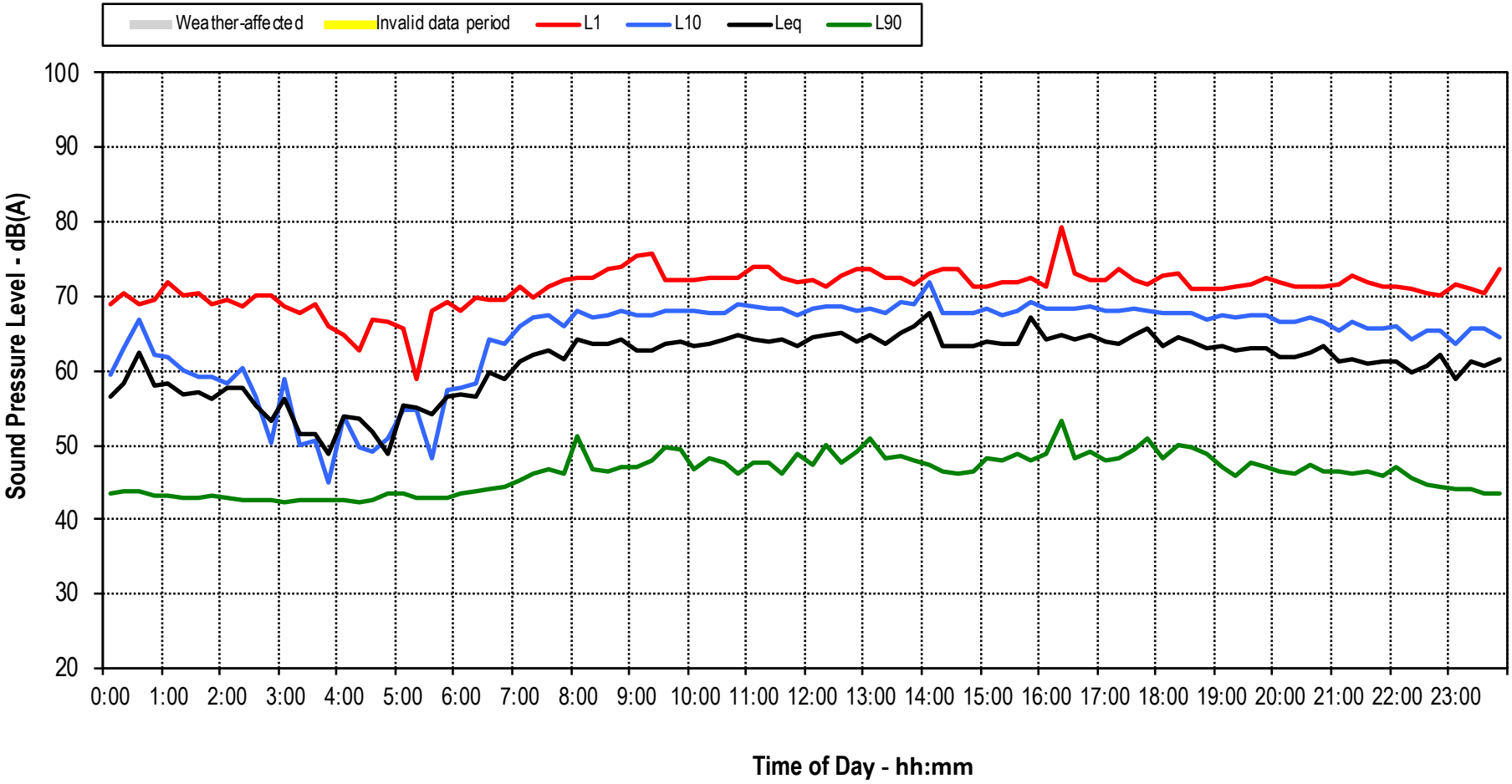
POW, 40 Botany St (Ambient and Background) - Thursday 19 July 2018



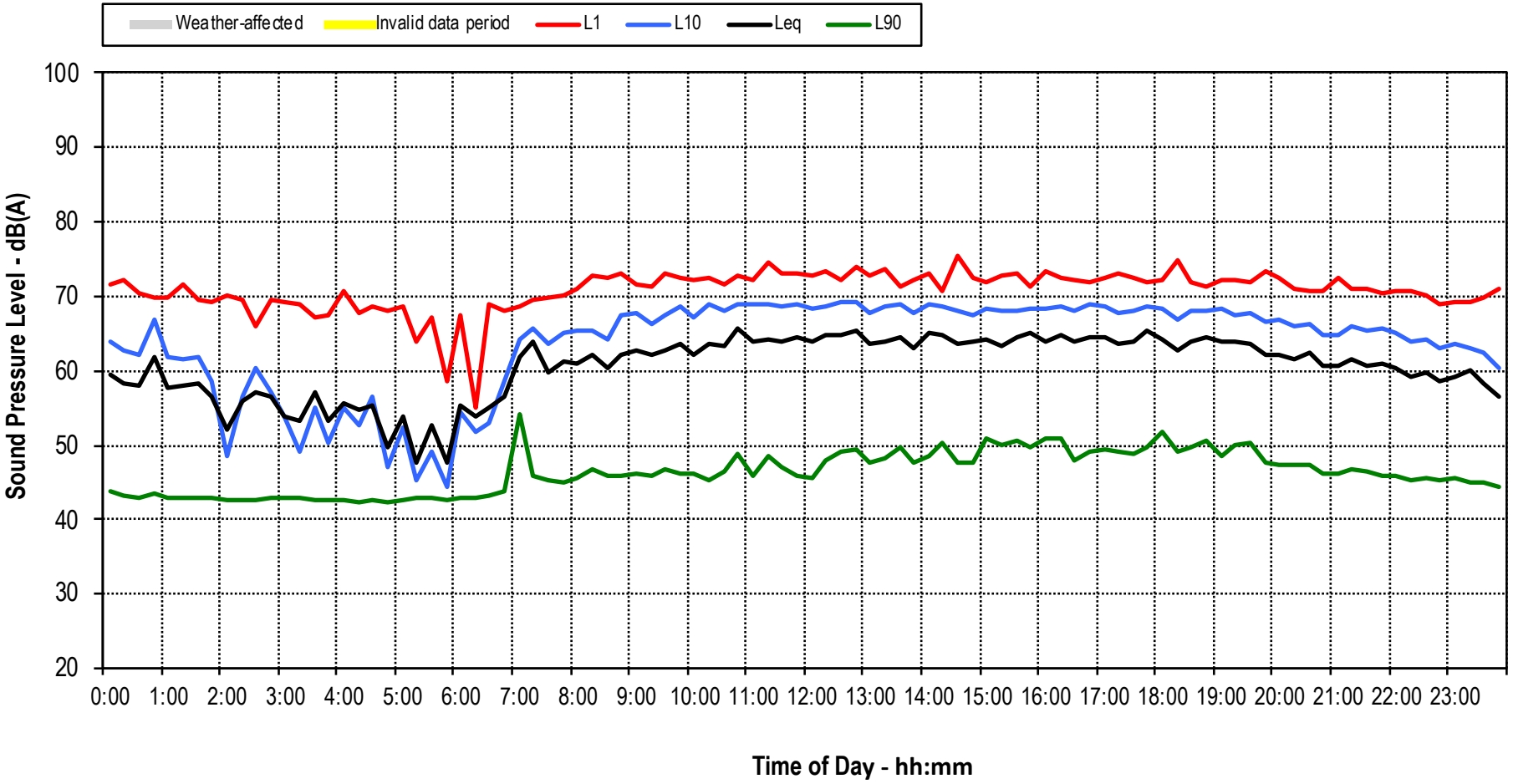
POW, 40 Botany St (Ambient and Background) - Friday 20 July 2018



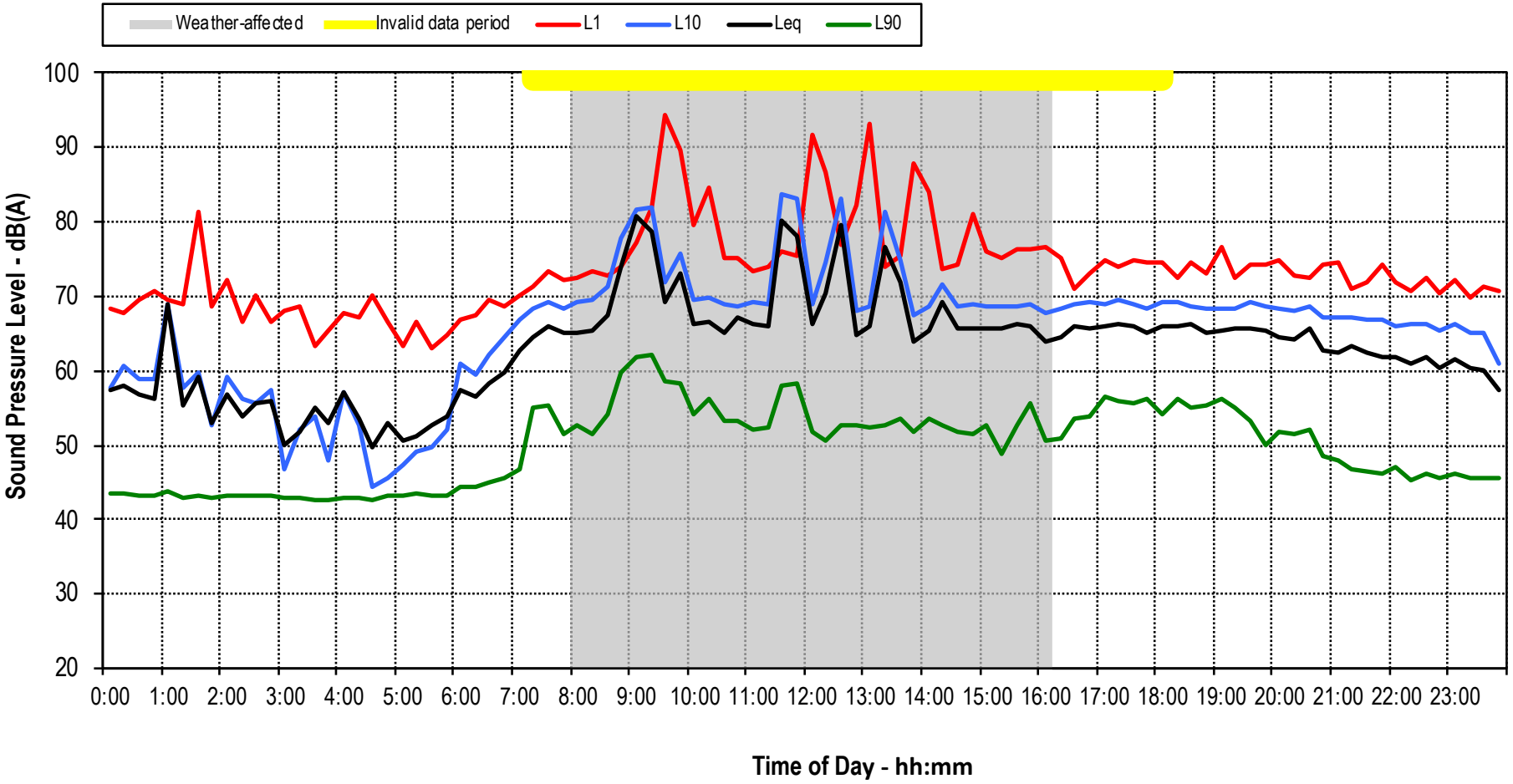
POW, 40 Botany St (Ambient and Background) - Saturday 21 July 2018



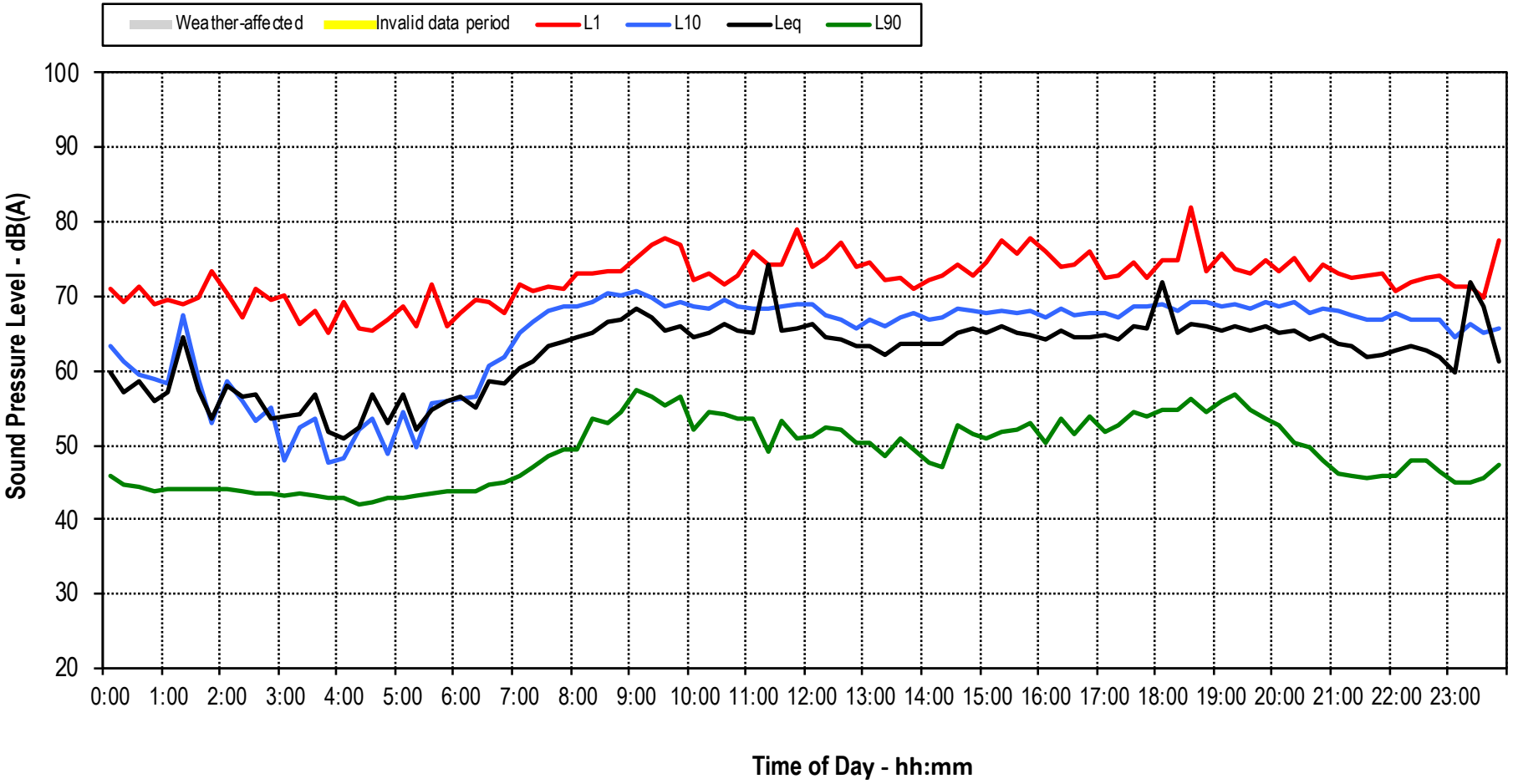
POW, 40 Botany St (Ambient and Background) - Sunday 22 July 2018



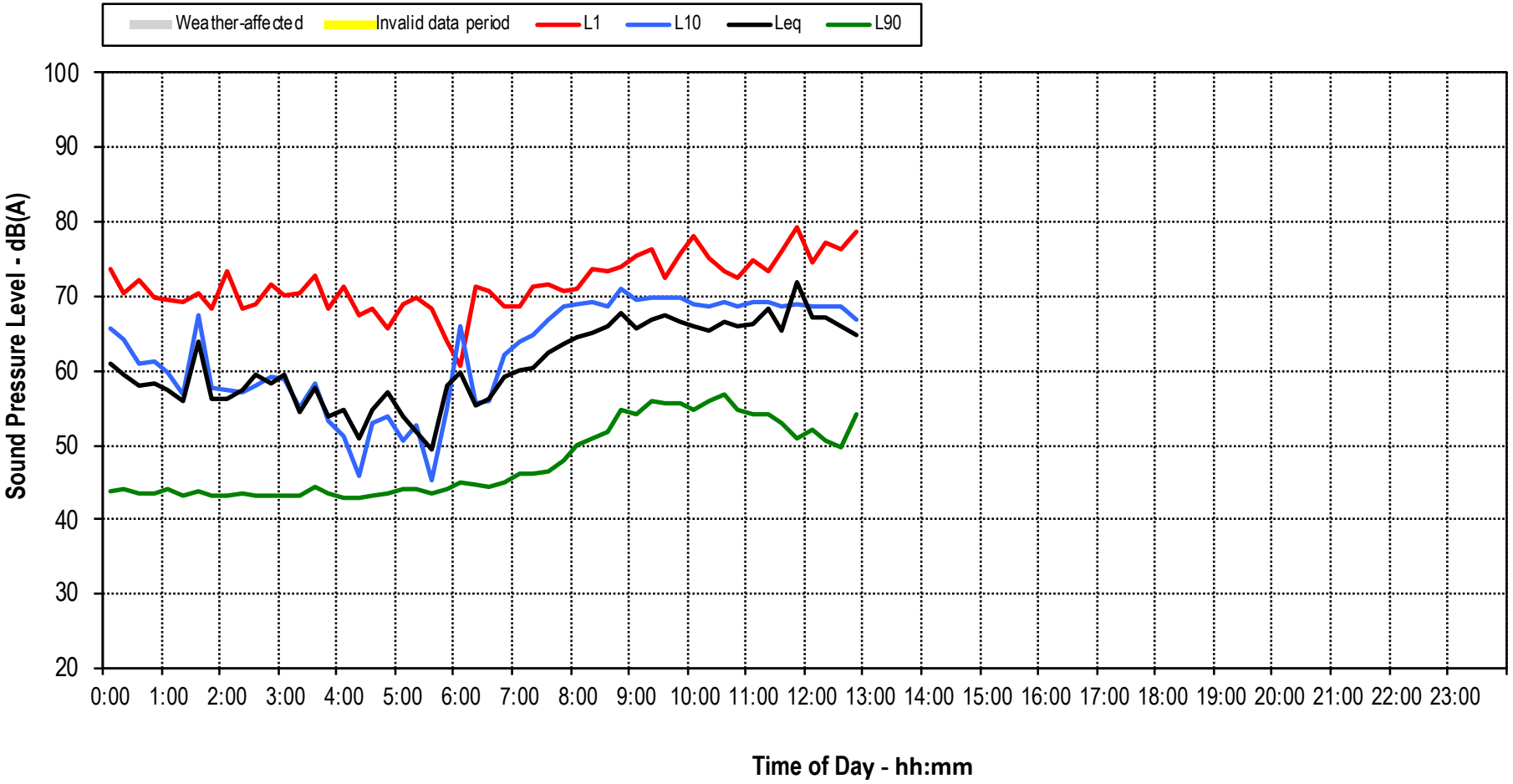
POW, 40 Botany St (Ambient and Background) - Monday 23 July 2018



POW, 40 Botany St (Ambient and Background) - Tuesday 24 July 2018



POW, 40 Botany St (Ambient and Background) - Wednesday 25 July 2018



Appendix B – Establishing NSW NPI Criteria

The main source of noise break-out from the ASB to the environment will be activities noise from the premises and noise from the mechanical plant at the rooftop.

The environmental noise impact of the site has been assessed in accordance with the NSW EPA Noise Policy for Industry 2017 (NSW NPI).

The NSW NPI sets two separate noise criteria to meet environmental noise objectives: one to account for intrusive noise and the other to protect the amenity of particular land uses. Both are used to derive the Project Noise Trigger Level (PNTL).

Assessing intrusiveness

The intrusiveness criterion essentially means that the equivalent continuous noise level of the source is not to be more than 5 dB above the measured existing background noise level.

Assessing amenity

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria only relate to industrial-type noise, including plant. The existing noise level from industry (or plant) is measured – if it approaches the criterion value, then the noise levels from new plant need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion.

The cumulative effect of noise from all industrial or plant sources is considered in assessing impact.

Project noise trigger level

For the new plant in ASB premises, the more stringent of the intrusive and the amenity criteria sets the PNTL.

The derivation of the PNTL is provided below.

B.1 Existing Background and Ambient Noise Levels

The Rating Background Level (RBL) has been determined from $L_{A90,15min}$ measured during the long-term noise survey in accordance with the methodology prescribed in NSW NPI. Data affected by adverse weather conditions was removed for the analysis procedure. These data are shadowed at Appendix B graphs.

Three time periods are considered (consistent with the operating times and the time of day classifications in the NSW NPI):

- Day - 7am to 6pm
- Evening - 6pm to 10pm
- Night - 10pm to 7am

The estimated RBL's and ambient noise levels are shown below in Table B1.

Location	L_{90} RBL Background Noise Levels, dB(A)			L_{eq} Ambient Noise Levels, dB(A)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
Logger Location 1 101 Botany Street (Catchment B)	43	45	41	54	53	51
Logger Location 2 1-3 Eurimbla Ave (Catchment A)	46	45	43	57	52	50
Logger Location 3 79 Botany Street (Catchment D)	47	41	39	60	58	55
Logger Location 11 7 Magill Street (Catchment B)	46	44	43	55	51	51
Logger Location 12 12 Blenheim Street (Catchment A)	47	45	43	59	53	55
Logger Location 13 40 Botany Street (Catchment B)	49	46	43	65	64	59

Table B1 : Long-term background and ambient noise levels based on NSW NPI around the site

B.2 Determination of project intrusiveness noise level

The intrusiveness noise level is defined as:

$$L_{Aeq,15minute} = \text{RBL plus 5 dB(A)} \quad \text{(Equation 1)}$$

In some rural situations, the RBL may be the same for the day, evening and night. In these cases, it is recognised that excursions of noise above the project intrusiveness noise level during the day would not usually have the same impact as they would during the evening or night. This is due to the more sensitive nature of activities likely to be disturbed at night (for example, sleep and relaxation). Considering this, minimum assumed RBLs apply in this policy. These result in minimum intrusiveness noise levels as follows:

Time of Day	Minimum assumed rating background noise level (dB[A])	Minimum project intrusiveness noise levels ($L_{Aeq,15min}$ dB[A])
Day	43	45
Evening	46	45
Night	47	41

Table B2 : Minimum assumed RBLs and Project Intrusiveness Noise Levels

The intrusiveness noise level has been determined from the RBL's presented in table B1 for each period.

Catchment A

- Day Intrusiveness criterion of 47 + 5 = **52 dB(A)**
- Evening Intrusiveness criterion of 45 + 5 = **50 dB(A)**
- Night Intrusiveness criterion of 43 + 5 = **48 dB(A)**

Catchment B

- Day Intrusiveness criterion of 46 + 5 = **51 dB(A)**
- Evening Intrusiveness criterion of 44 + 5 = **49 dB(A)**
- Night Intrusiveness criterion of 43 + 5 = **48 dB(A)**

The Intrusiveness noise levels are only applied to residential receivers.

B.3 Determination of project amenity noise levels

To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined is to remain below the recommended Amenity Noise Levels (ANL) specified in Table 2.2 of the NSW NPI where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance.

The recommended ANL represents the objective for total industrial noise at a receiver location, whereas the project ANL represents the objective for noise from a single industrial development at a receiver location.

To ensure that industrial noise levels (existing plus new) remain within the recommended ANL for an area, a project ANL applies for each new source of industrial noise from an industrial development as follows:

Project ANL = Recommended ANL minus 5 dB(A) (Equation 2)

The nearest residential receivers to the project are considered to be – as per NSW NPI Table 2.3 – in a Noise Amenity Area characterised by the NSW NPI as urban.

The recommended ANLs relevant to this project are specified in Table B3.

Receiver[30]	*Time of Day*	L_{Aeq}, *dB(A)*
		Recommended ANL
Residential (Urban)	Day	60
	Evening	50
	Night	45
School Classroom - Internal	Noisiest 1-hour period when in use	35
Hospital Ward - External	Noisiest 1-hour	50
Place of Worship - Internal	When in use	40
Passive Recreation Area	When in use	50
Commercial	When in use	65

Table B3 : Recommended L_{Aeq} noise levels from industrial noise sources at residential and non-residential receivers

[30] The NSW NPI states, "Where internal noise levels are specified, they refer to the noise level at the centre of the habitable room that is most exposed to the noise and are to apply with the windows opened sufficiently to provide adequate ventilation, except where means of ventilation complying with the Building Code of Australia are provided. In cases where gaining internal access for monitoring is difficult, then external noise levels 10 dB(A) above internal levels apply".

The following exceptions to the above method to derive the project ANL apply:

- **Exception A – In areas with high traffic noise levels**

  The level of transport noise, road traffic noise in particular, may be high enough to make noise from an industrial source effectively inaudible, even though the LAeq noise level from that industrial noise source may exceed the project amenity noise level. In such cases the project amenity noise level may be derived from the $L_{Aeq,\ period(traffic)}$ minus 15 dB(A).

  This high traffic project amenity noise level may be applied only if all the following apply:

  - traffic noise is identified as the dominant noise source at the site,
  - the existing traffic noise level (determined using the procedure outlined in Section A2, Fact Sheet A of NSW NPI, measuring traffic instead of industrial noise) is 10 dB or more above the recommended ANL for the area, and
  - it is highly unlikely traffic noise levels will decrease in the future,

  for each assessment period where these traffic noise provisions apply, the High Traffic Project ANL is to be used for industrial development, derived from the $L_{Aeq,period(traffic)}$ as:

  High Traffic Project ANL = $L_{Aeq,period(traffic)}$ minus 15 dB(A) (Equation 3)

- **Exception B – In proposed developments in major industrial clusters**

  The recommended amenity noise level from Table B3 represents the total industrial noise level from all sources (new and proposed) that is sought to be achieved using feasible and reasonable controls.

  The approach of deriving the project amenity noise level resulting from a new development on the basis of the recommended amenity noise level minus 5 dB is based on a receiver not being impacted by more than three to four individual industrial noise sources.

Where an existing cluster of industry, for example, an industrial estate or port area, is undergoing redevelopment and/or expansion and the development constitutes a single premises addition or expansion, with no other redevelopment planned in the foreseeable future, the project amenity noise level approach procedure in Section B.3 can be applied.

However, where a greenfield or redevelopment of an existing cluster of industry consisting of multiple new noise-generating premises is proposed, the approach for determining the project amenity noise level in Section B.3 is not applicable and the approach below is to be applied.

For the new multiple premises or redevelopment of existing clusters of industry, for each individual premise,

$$\text{Individual Project ANL} = 10\text{Log}_{10}(10^{(L - 5\ dB/10)}/N)\ dB(A) \quad \text{(Equation 4)}$$

where L is the relevant recommended ANL from Table B3 and N is the number of proposed additional premises.

Where a greenfield development is proposed and it can be demonstrated that existing L_{Aeq} industrial noise levels are more than 5 dB lower than the relevant recommended ANL, the above equation can be modified to reflect "L" in lieu of "L – 5 dB".

- **Exception C**

  Where the resultant project ANL is 10 dB or more lower than the existing industrial noise level. In this case the project ANL can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.

- **Exception D**

  Where cumulative industrial noise is not a necessary consideration because no other industries are present in the area, or likely to be introduced into the area in the future. In such cases the relevant ANL is assigned as the project ANL for the development.

Where the project ANL applies and it can be met, no additional consideration of cumulative industrial noise is required. However, in circumstances where this level cannot be feasibly and reasonably met, an assessment of existing industrial noise, and the combined resulting noise level from existing and the proposed industries, is required so the impact of the residual noise levels can be determined in accordance with Section 4.2 of the NSW NPI.

For this project, Exception A applies to the UNSW Classroom receiver during the day time periods. Exception C applies to the Catchment A and Catchment B residential receivers during the night time periods plus the Passive Recreation Area receivers during the day time period. Furthermore, Exception B applies to all other receivers. These considerations are detailed below:

Exception A – it was observed that the day time ambient noise levels for the UNSW classroom receiver were dominated by traffic noise from nearby roads and distant traffic in general. Therefore the ANL in areas of high traffic noise are to be adapted for this receiver. In such cases the Project ANL may be derived from the following equation:

$$\text{Project ANL} = L_{Aeq,period(traffic)} \text{ minus } 15 \text{ dB(A)}$$

Exception B – as the proposed development consists of multiple (potentially three) new premises to be developed in the foreseeable future, the following equation is to be applied:

$$\text{Individual Project ANL} = 10\text{Log}_{10}(10^{(L - 5\ dB/10)}/N)\ dB(A)$$

Exception C – as the recommended ANL for Catchment A and Catchment B Residential receivers during night time plus Passive Recreation Area receivers during the day time, according to Table B2, are more than 10 dB lower than the existing industrial noise level presented in Table B1, existing industrial noise level minus 10 dB is adapted as the project ANL.

For all other receivers, none of the exceptions apply, therefore Equation 2 is used for determining the project ANL.

The project ANL for each receiver type has been determined considering the above information, for each period as presented in Table B3.

Receiver - External	*Time of Day*	*Existing L_{Aeq}*	*Recommended ANL*	*Adjustment*	*Project ANL*
Residential (Catchment A)	Day	59	60	Equation 4	55
	Evening	53	50	Equation 4	45
	Night	55	45	Existing L_{Aeq} (Industry) minus 10	45
Residential (Catchment B)	Day	55	60	Equation 4	55
	Evening	51	50	Equation 4	45
	Night	51	45	Existing L_{Aeq} (Industry) minus 10	41
Commercial Premises (Catchment A)	When in use	59	65	Equation 4	60
Commercial Premises (Catchment B)	When in use	55	65	Equation 4	60
Randwick Hospitals Campus (Catchment C)	Noisiest 1 Hour Period	55	50	Equation 4	45
UNSW Clasroom (Catchment D)	Noisiest 1-hour period when in use	60	45	Existing L_{Aeq} (Traffic) minus 15	45
Place of Worship (Catchment B)	When in use	55	50	Equation 4	45
Passive Recreation Area (Catchment A)	When in use	59	50	Equation 4	45

Table B3 : Determination of Project Amenity Noise Levels for residential and commercial receivers

B.4 Project noise trigger level

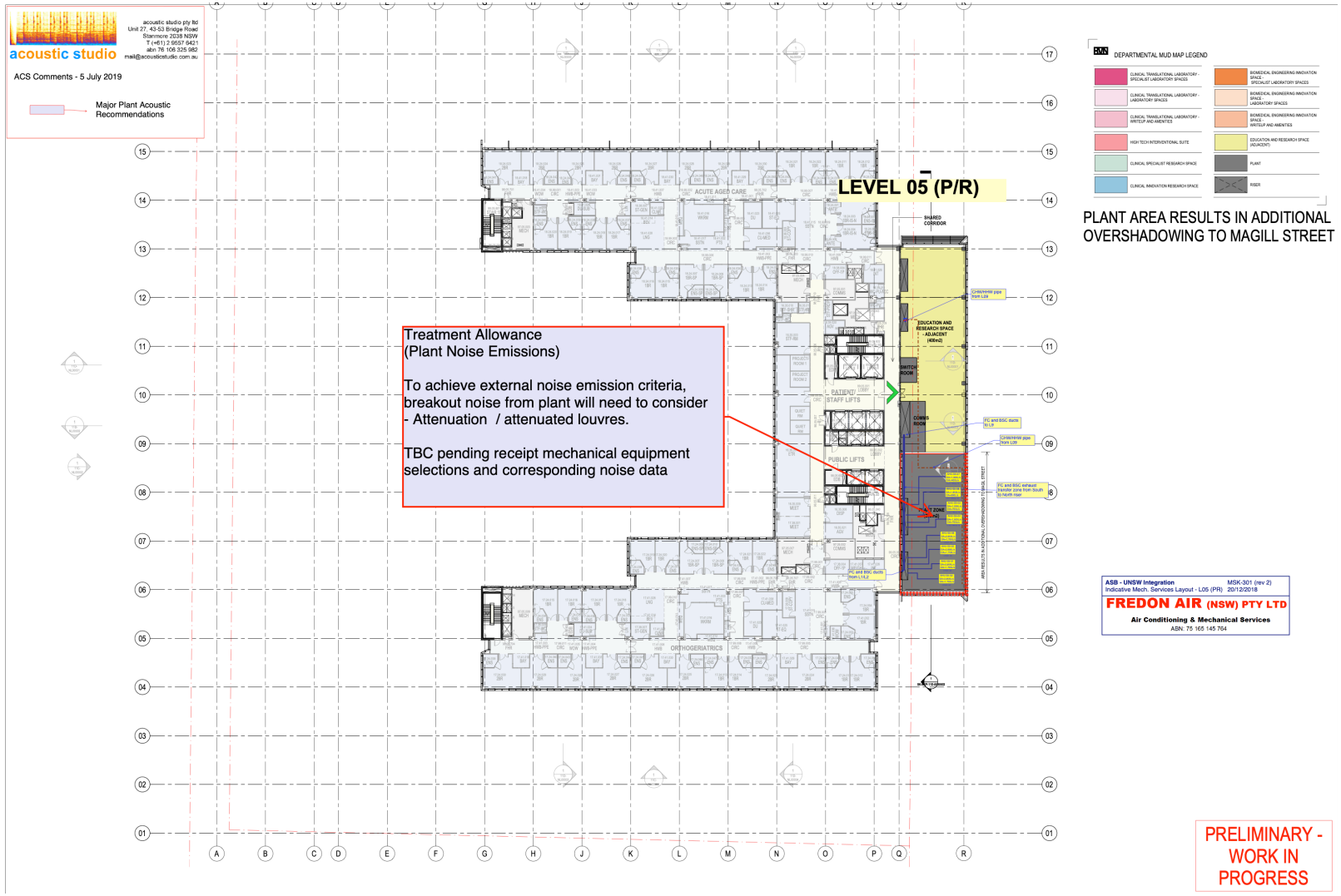
The PNTL is defined as the lower of the project intrusiveness and amenity noise levels. On this basis, the PNTL are shown in Table B4 below (PNTLs shown shaded).

Receiver - External	*Period*	*Project Intrusiveness Noise Level*	*Project Amenity Noise Level*
Residential (Catchment A)	Day	52	55
	Evening	50	45
	Night	48	45
Residential (Catchment B)	Day	51	55
	Evening	49	45
	Night	48	41
Commercial Premises (Catchment A)	When in use	-	60
Commercial Premises (Catchment B)	When in use	-	60
Randwick Hospitals Campus (Catchment C)	Noisiest 1 Hour Period	-	45
UNSW Clasroom (Catchment D)	Noisiest 1-hour period when in use	-	45
Place of Worship (Catchment B)	When in use	-	45
Passive Recreation Area (Catchment A)	When in use	-	45

Table B4 : Determination of Project Noise Trigger Levels for the site

Appendix C – Major Building Services Noise and Vibration Control Recommendations

Level 05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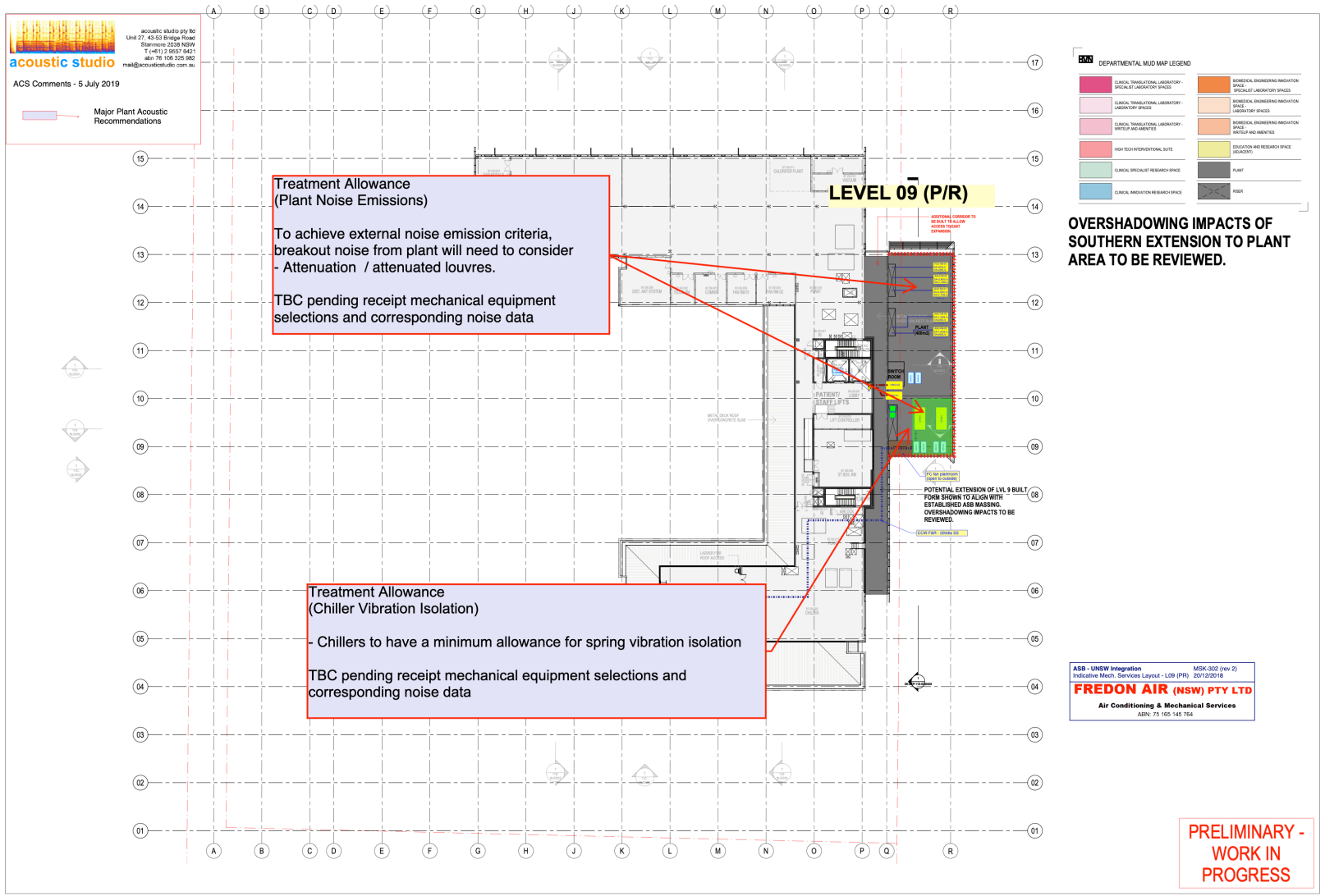
ACS Comments - 5 July 2019
Major Plant Acoustic Recommendations
LEVEL 05 (P/R)
Treatment Allowance
(Plant Noise Emissions)
To achieve external noise emission criteria, breakout noise from plant will need to consider
- Attenuation / attenuated louvres.
TBC pending receipt mechanical equipment selections and corresponding noise data
DEPARTMENTAL MUD MAP LEGEND
PLANT AREA RESULTS IN ADDITIONAL OVERSHADOWING TO MAGILL STREET
ASB - UNSW Integration
Indicative Mech. Services Layout - L05 (PR)
MSK-301 (rev 2)
20/12/2018
FREDON AIR (NSW) PTY LTD
Air Conditioning & Mechanical Services
ABN: 75 165 145 764
PRELIMINARY - WORK IN PROGRESS

Level 09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ACS Comments - 5 July 2019
Major Plant Acoustic Recommendations
Treatment Allowance
(Plant Noise Emissions)
To achieve external noise emission criteria, breakout noise from plant will need to consider
- Attenuation / attenuated louvres.
TBC pending receipt mechanical equipment selections and corresponding noise data
Treatment Allowance
(Chiller Vibration Isolation)
- Chillers to have a minimum allowance for spring vibration isolation
TBC pending receipt mechanical equipment selections and corresponding noise data
LEVEL 09 (P/R)
DEPARTMENTAL MUD MAP LEGEND
OVERSHADOWING IMPACTS OF SOUTHERN EXTENSION TO PLANT AREA TO BE REVIEWED.
POTENTIAL EXTENSION OF LVL 9 BUILT FORM SHOWN TO ALIGN WITH ESTABLISHED ASB MASSING. OVERSHADOWING IMPACTS TO BE REVIEWED.
ASB - UNSW Integration
Indicative Mech. Services Layout - L09 (PR)
MSK-302 (rev 2)
20/12/2018
FREDON AIR (NSW) PTY LTD
Air Conditioning & Mechanical Services
ABN: 75 165 145 764
PRELIMINARY - WORK IN PROGRESS

Appendix D – UNSW Sensitive Receivers Surrounding ASB and Construction Vibration Criteria

Number	Building	Floor	Room no	Description of critical equipment	Vib Criteria (specify tolerance or applicable VC Curve)	Other (specify)	Installation manual or other spec document	*Other comments*
1	Lowy C25	B	B03	-				
2	Lowy C25	B	B17	9.4T Preclinical MRI	600µg within the relevant frequency range of 5 to 30Hz		Bruker BioSpec Avance II Site Planning Information	
3	Lowy C25	B	B06	Home-built Stabilised TIRF (MCL RM21 base)	Vibration Class - D, 6 um/s for 8-80 Hz RMS			Highly sensitive to vibration, currently housed in the basement as building ambient vibration is too much for the machine
4	Lowy C25	B	B10	Surgical microscope	Uncertain			
5	Lowy C25	B	B18	Animal Holding & Breeding	Loud noise, and unknown frequencies or vibrations			
6	Lowy C25	LG	LG18	Bruker Bioscope Catalyst AFM	Vibration Class C, 12.5um/s for 8-80 Hz RMS	on a vibration and acoustic isolation table	Bioscope Catalyst Brochure	
7	Lowy C25	LG	LG22	Zeiss 780 confocal	5um pp at 5Hz, 10um pp at 10Hz and 10uM pp at 20Hz with system vibration isolation table	On a vibration isolation table	LSM 710_780 ZEN installation requirements	
8	Lowy C25	LG	LG22	Leica Sp5 STED multiphoton	Vibration Class C :5-12.5 Hz, 30 um/sec rms and >30Hz: 12.5 um/sec rms Max floor amplitudes	On a vibration isolation table	Leica TCS STED CW technical documentation	
9	Lowy C25	LG	LG22	Leica SP5 WLL STED	Vibration Class C :5-12.5 Hz, 30 um/sec rms and >30Hz: 12.5 um/sec rms Max floor amplitudes	On a vibration isolation table	Leica TCS STED CW technical documentation	
10	Lowy C25	LG	LG22	Picoquant microtime	Vibration Class C, 12.5um/s for 8-80 Hz RMS	On a vibration isolation table		
11	Lowy C25	LG	LG23	Olympus fv1200	5um pp at 5Hz, 10um pp at 10Hz and 10uM pp at 20Hz with system vibration isolation table	On a vibration isolation table		
12	Lowy C25	LG	LG23	Nikon TiE Live cell imaging System	5um pp at 5Hz, 10um pp at 10Hz and 10uM pp at 20Hz with system vibration isolation table	On a vibration isolation table	NikonA1 Series Environmental and Placemnt Specifications	
13	Lowy C25	LG	LG24	Till photoics TIRF	Vibration Class C, 12.5um/s for 8-80 Hz RMS	On a vibration isolation table		
14	Lowy C25	3	328	PRIMO	Vibration Class C, 12.5um/s for 8-80 Hz RMS	On a vibration isolation table		
15	Lowy C25	3	328	Olympus FV1000	5um pp at 5Hz, 10um pp at 10Hz and 10uM pp at 20Hz with system vibration isolation table	On a vibration isolation table		
16	Lowy C25	3	328A	Lattice Light Sheet	Vibration Class C, 12.5um/s for 8-80 Hz RMS	On a vibration isolation table		
17	Lowy C25	3	329	Home-built FCS system 1	Vibration Class C, 12.5um/s for 8-80 Hz RMS	On a vibration isolation table		
18	Lowy C25	3	329	Home-built FCS system 2	Vibration Class C, 12.5um/s for 8-80 Hz RMS	On a vibration isolation table		
19	Lowy C25	3	330	JPK Optical Tweezers + TIRF	Vibration Class C, 12.5um/s for 8-80 Hz RMS	On a vibration isolation table		
20	Lowy C25	3	330	Home-built dual-camera TIRF (ASI RAMM base)	Vibration Class C, 12.5um/s for 8-80 Hz RMS	On a vibration isolation table		
21	Lowy C25	3	330A	soSPIM	Vibration Class C, 12.5um/s for 8-80 Hz RMS	On a vibration isolation table		
22	Lowy C25	3	331	Home-built TIRF + tweezers	Vibration Class C, 12.5um/s for 8-80 Hz RMS	On a vibration isolation table		
23	Lowy C25	3	333A	Zeiss Elyra PS1	Vibration Class C, 12.5um/s for 8-80 Hz RMS	On a vibration isolation table	Elyra installation requiremnts	
24	Wallace Wurth C27	LG	LG07A	Micro injector	Uncertain			
25	Wallace Wurth C27	LG	LG07	Animal Holding & Breeding	Loud noise, and unknown frequencies or vibrations			
26	Wallace Wurth C27	LG	LG10	Animal Holding & Breeding	Loud noise, and unknown frequencies or vibrations			
27	Wallace Wurth C27	LG	LG15	CLAMS unit	uncertain			
28	Wallace Wurth C27	LG	LG18	Animal Holding & Breeding	Loud noise, and unknown frequencies or vibrations			
29	Wallace Wurth C27	LG	LG17	Animal Holding & Breeding	Loud noise, and unknown frequencies or vibrations			
30	Wallace Wurth C27	LG	LG23	Animal Holding & Breeding	Loud noise, and unknown frequencies or vibrations			
31	Wallace Wurth C27	LG	LG25	Microsurgical microscope	uncertain			
32	Wallace Wurth C27	LG	LG26	Sensitive Behaviour equipment	uncertain			
33	Wallace Wurth C27	LG	LG27 & 27A	Sensitive Behaviour equipment	uncertain			
34	Wallace Wurth C27	LG	LG37	Nikon A1 Intravital microscope	5um pp at 5Hz, 10um pp at 10Hz and 10uM pp at 20Hz with system vibration isolation table	On a vibration isolation table	NikonA1 Series Environmental and Placemnt Specifications	
35	Wallace Wurth C27	LG	LG37	3i Spinning disk intravital	5um pp at 5Hz, 10um pp at 10Hz and 10uM pp at 20Hz with system vibration isolation table	On a vibration isolation table		
36	Wallace Wurth C27	3	354	Animal holding room	TBA			
37	Wallace Wurth C27	3	352	Zeiss 780 Confocal microscope	TBA			

Table D: UNSW Sensitive Receivers Surrounding ASB and Construction Vibration Criteria