Health Infrastructure

Campbelltown Hospital Redevelopment Stage 2

SSDA Acoustic Assessment Report

AC03_v6_SSDA Acoustic Assessment Report

Issue | 27 July 2018

Job number 261100

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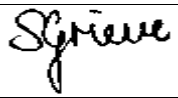
		Signature			
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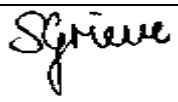
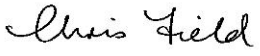
		Signature			
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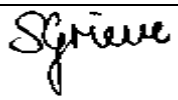
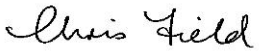
		Signature			
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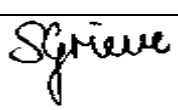
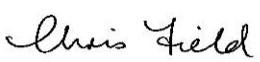
		Signature			

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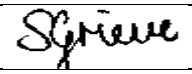
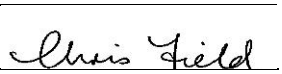
		Signature			
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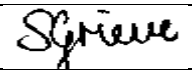
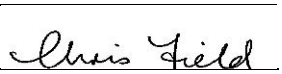
		Signature			
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1 Introduction

This report supports a State Significant Development Application (SSDA) submitted to the Minister for Planning pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

The Application (referred to as SSD 9241) seeks approval for the construction of the Campbelltown Hospital Redevelopment Stage 2 as described in Section 1.3 of this report.

1.1 Background

The Clinical Services Plan for Macarthur to 2031 identified the need for the expansion of the existing hospital services and development of the hospital campus to operate as a complete tertiary affiliated Principal Referral Hospital. This is based on significant population growth in the Campbelltown-Macarthur region, which continues to put unprecedented increases in demand for health services.

Stage 1 of the Hospital Redevelopment was approved under SSD 5003 on 21 November 2012 for the following development:

- construction of a new six level Acute Health Services building;
- construction of a new covered walkway linking the new Acute Health Services building, Campbelltown Hospital main entry, Block A, Block B and Block C;
- new patient drop off zone, six visitor parking spaces and service vehicle access from Parkside Crescent; and
- new landscaped entry driveway, internal landscaped courtyards and new communal café.

Stage 1 was completed in early 2016. Since then a development application for a seven (7) storey car park on site has been made and is currently under assessment by Campbelltown City Council.

This application is for the proposed Stage 2 works.

1.2 Site description

The Campbelltown Hospital site is located within the Campbelltown Local Government Area, approximately 51 km southwest of Sydney's Central Business District. The site is bounded by Campbelltown Private Hospital and a seniors living development to the north; Parkside Crescent and Marsden Park to the west; and arterial roads Appin Road and Therry Road to the east and south respectively.

Marsden Park is public open space with a large open water body that is situated between the Hospital site and low to medium density dwellings located west and southwest of Marsden Park.

To the south and east of the hospital site, on the opposite side of Therry and Appin Roads, is an area of established low scale residential dwellings. Thomas Reddall High School is within the residential development area to the south of the site.

The site has an approximate area of 19.33 hectares, and slopes from the south-east corner to the north-west corner. The steepest part of the site is the south-east corner bounded by Appin and Therry Roads and the existing main entry to the south-east corner of the site.

The land is owned by NSW Department of Health. The site is legally described as Lot 6 of DP 1058047. Refer to Figure 1 and Figure 2 for identification of existing hospital buildings and a site plan illustrating the scope of SSD building works.

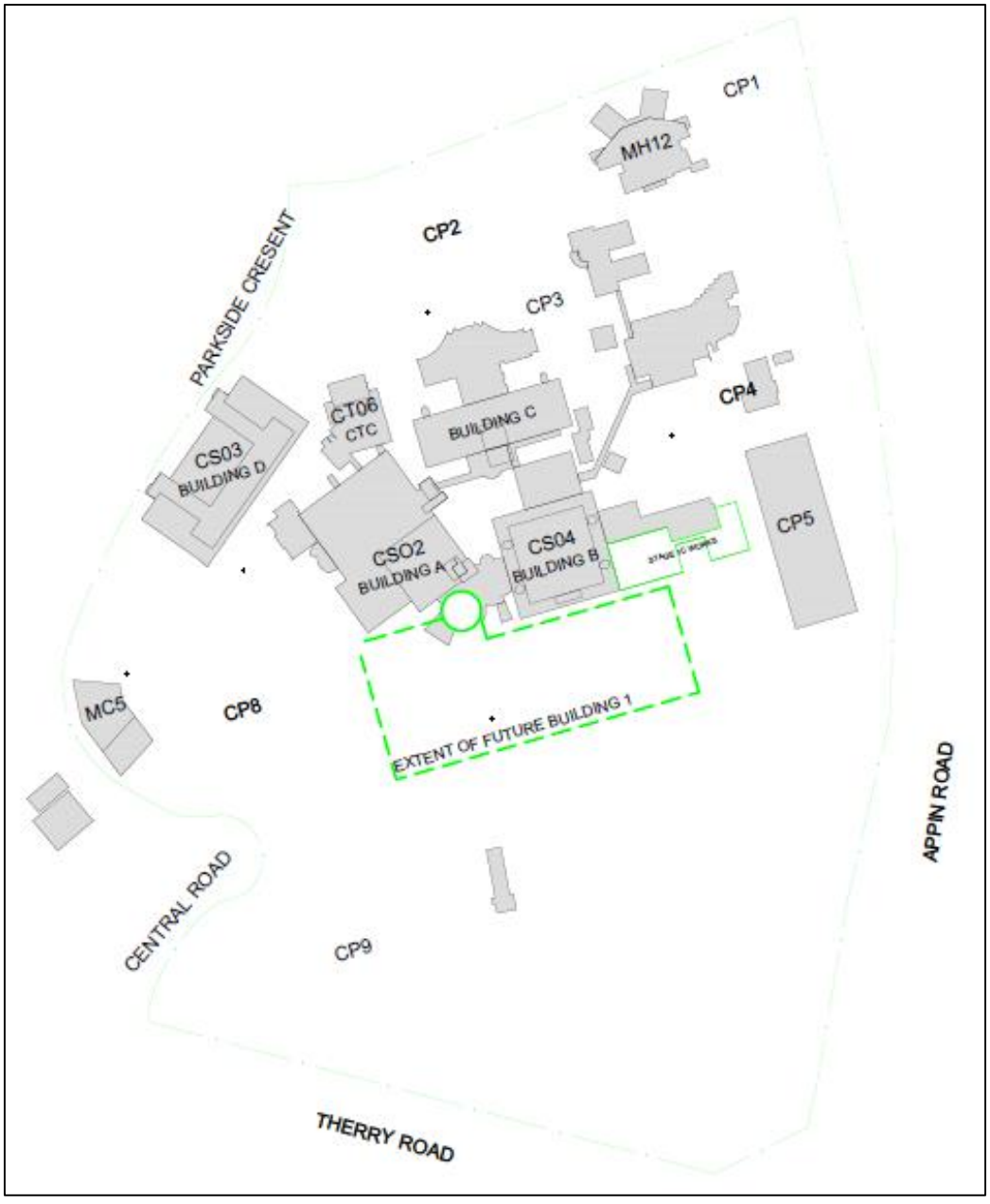


Figure 1: Identification of existing hospital buildings and approximate extent of Building 1

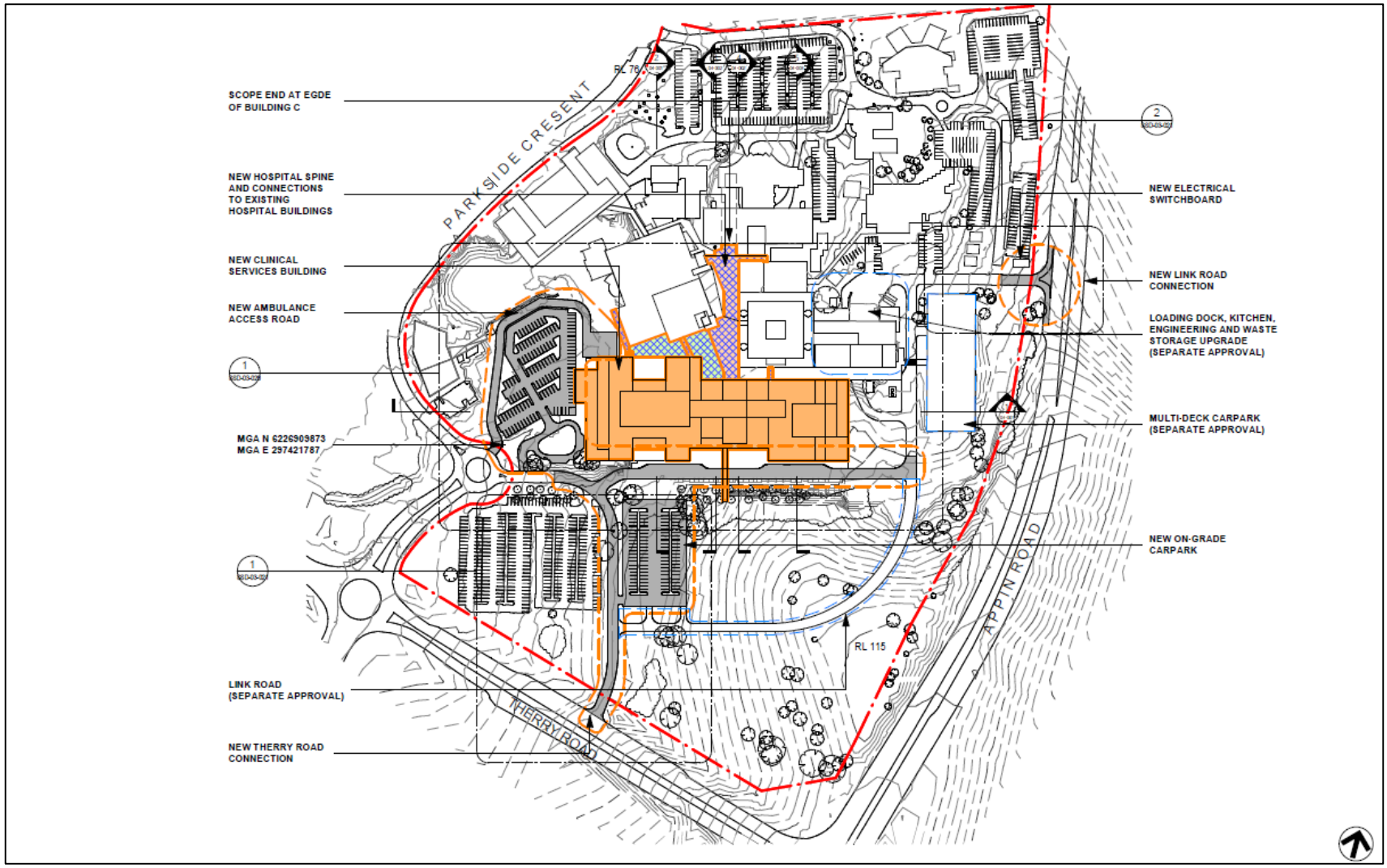


Figure 2: Plan – site plan proposed works (Billard Leece Partnership Pty Ltd, SSD-01-003, Rev J)

1.3 Proposed development description

The Development Application (DA) seeks approval for the following development:

- Demolition of existing structures;
- Partial excavation of the site (due to sloping topography);
- The construction of a new **13 storey** (two of these levels are partially below ground) Clinical Services Building containing:
    - An Emergency Department;
    - Operating Theatres;
    - Intensive Care Unit;
    - Mental Health;
    - Birthing and Speciality Care Nursery;
    - Surgical and Medical Beds;
    - Helipad facilities; and
    - An Ambulance Bay.
- Construction of a new Hospital Spine and connections to existing hospital buildings;
- Construction of augmented and new internal hospital access roads and links, including a connection to Appin Road and Therry Road;
- Construction of an at-grade car park;
- Tree removal; and
- Associated Building Services;

1.4 Acoustic assessment requirements

Arup Acoustics has been engaged to prepare a construction and operational noise and vibration assessment to address the requirements for the SSD 9241 application for the Campbelltown Hospital Redevelopment Stage 2.

Key Issue 10 of the SEARs for application SSD 9241 sets out the following requirements with regards to the assessment of noise and vibration:

> *Identify and provide a quantitative assessment of the main noise and vibration generating sources during construction and operation and outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.*
>
> *Relevant Policies and Guidelines:*
>
> - *Noise Policy for Industry 2017 (EPA)*
> - *Interim Construction Noise Guideline (DECC)*
> - *Assessing Vibration: A Technical Guideline 2006*

- *Development Near Rail Corridors and Busy Roads – Interim Guideline (Department of Planning 2008)*

State Environmental Planning Policy (Infrastructure) 2007 is also referenced in Key Issue 1.

The above policies and guidelines have been addressed in this report as follows:

Table 1: Identification of report section addressing relevant policy and guideline

Acoustic aspect	Policy or guideline	Report section
Operational noise from site	NSW Noise Policy for Industry (NSW Environmental Protection Authority, 2017 [1]	Section 4
Road traffic noise impacts onto site	Development Near Rail Corridors and Busy Roads - Interim Guideline [2]	Section 5
Construction noise & vibration	Interim Construction Noise Guideline [3]	Section 6
	Assessing Vibration: A Technical Guideline [2]	

1.5 Scope of assessment

The following procedure outlines the scope of assessment with respect to the above acoustic aspects and relevant policies and guidelines:

- Examine the proposed development plans to identify acoustic aspects of the construction and operation of the development.
- Identify off-site surrounding occupiers of land which are to be assessed regarding construction and operational activities.
- Conduct background noise monitoring to quantify the existing acoustic environment at relevant surrounding receiver locations to set project targets in accordance with relevant policy.
- Where appropriate, carry out a preliminary quantitative acoustic assessment of potential impacts and compare against the relevant noise and vibration targets.
- Identify where further input to the project design development is required, and identify in-principle mitigation or management methods for the control of noise and vibration where required.
- Outline the processes to be adopted for the continued design development of acoustic aspects for the project.

2 Surrounding land uses

The nearest most potentially affected off-site land uses surrounding the development have been identified in Figure 3. Figure 3 also shows the location of Campbelltown Hospital and the location of the proposed new hospital building, hereinafter referred to as Building 1.

The nearest most potentially affected receivers are identified as a combination of residential, health and recreation classifications. Table 2 summarises the location of the nearest most potentially affected receivers together with the location of the unattended noise monitoring locations.

Table 2: Receiver locations

ID	Address	Description
R1	1 Hyde Parade, Campbelltown	Four storey residential apartments, within seniors living development
R2	1 – 27 Appin Road, Bradbury	Single storey houses along Appin Road
R3	6 – 48 Fern Avenue, Bradbury	Single storey houses along Fern Avenue
R4	33 – 61 Georgiana Crescent, Ambarvale	Single storey houses along Georgiana Crescent, Miggs Place and Tiggs Place
	5 – 7 Miggs Place, Ambarvale	
	5 – 7 Tiggs Place Ambarvale	
R5	1 – 40 Parkside Crescent, Campbelltown	Multi-storey houses along Parkside Crescent
R6	42 Parkside Crescent, Campbelltown	Campbelltown Private Hospital
R7	Parkside Crescent, Campbelltown	Marsden Park

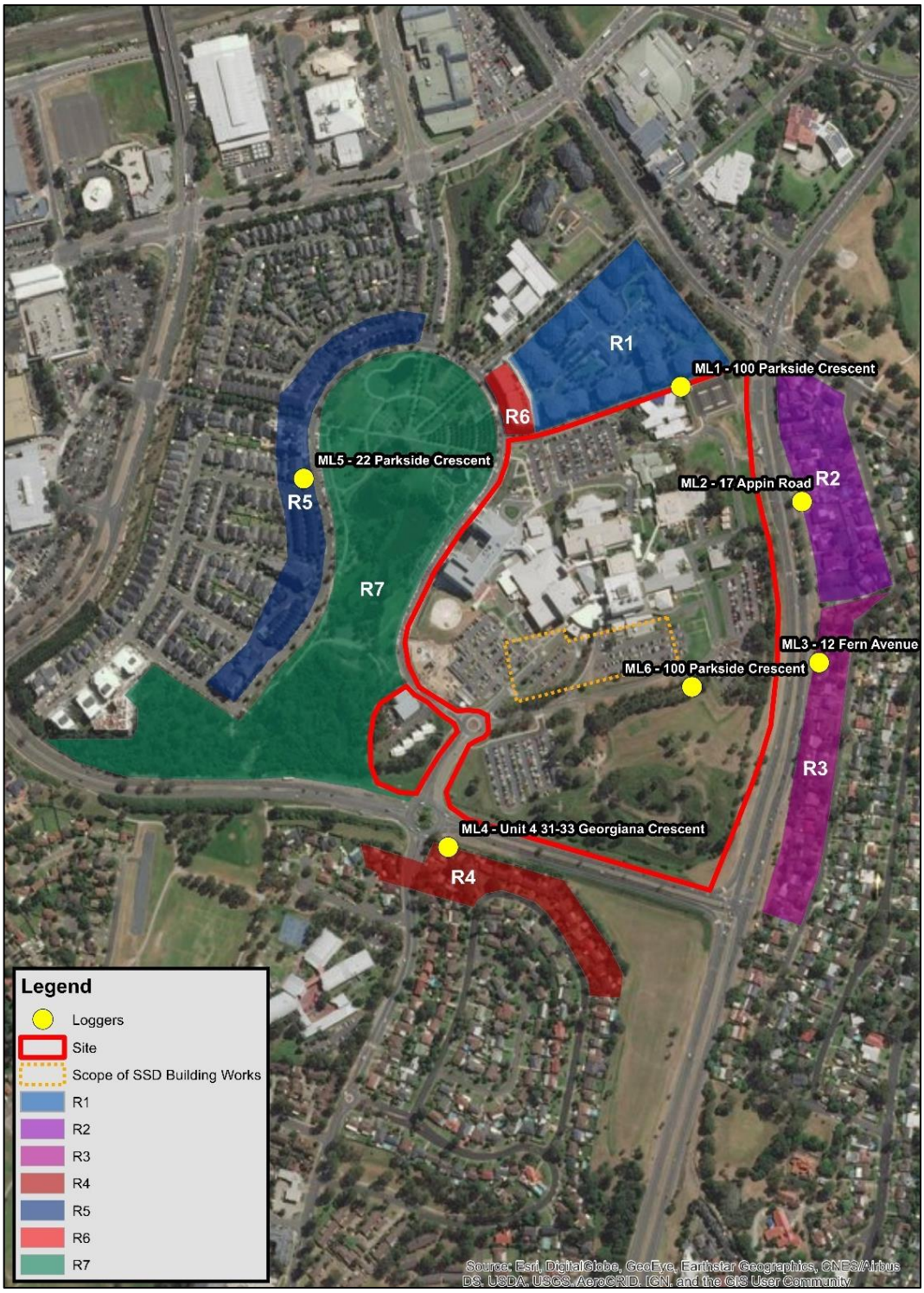


Figure 3: Site, monitoring locations and receiver locations

3 Existing noise environment

Criteria for the assessment of operational noise are usually derived from the existing noise environment of an area, excluding noise from the subject development.

Appendix A of the NSW *Noise Policy for Industry* (NPI) (EPA, 2017) [1] outlines two methods for determining the background noise level of an area, being 'Long-term' and 'Short-term' background noise methods. This assessment has used long-term noise monitoring.

3.1 Noise measurement locations

Noise measurements are ideally carried out at the nearest or most potentially affected locations surrounding a development. An alternative, representative location should be established in the case of access restrictions or if a safe and secure location cannot be identified. Furthermore, representative locations may be established in the case of multiple receivers as it is usually impractical to carry out measurements at all locations surrounding a site.

The long-term and short-term measurement locations are outlined in Table 3 and shown in Figure 3.

Table 3: Noise monitoring locations

ID	Address
ML1[1]	100 Parkside Crescent, Campbelltown Within the hospital boundary in proximity to north-east corner of Birunji building (youth mental health)
ML2[1]	17 Appin Road, Bradbury
ML3	12 Fern Avenue, Bradbury
ML4	Unit 4/31-33 Georgiana Crescent, Campbelltown
ML5	22 Parkside Crescent, Campbelltown
ML6[2]	100 Parkside Crescent, Campbelltown Within the hospital boundary in proximity to existing staff car park (CP5)

Note:

1 – Noise monitoring location referenced from recent Arup REF Acoustic Assessment of Campbelltown Hospital Carpark.

2 – Noise monitoring location selected for the measurement of road traffic noise. Noise data collected at this location will not be used to derive criteria for the assessment of operational noise.

3.2 Long-term noise measurement results

Long-term noise monitoring was carried out from Monday, 9 April 2018 to Monday, 16 April 2018. Additionally, long-term noise monitoring results have been referenced from a recent Arup REF Acoustic Assessment of Campbelltown Hospital Carpark. This noise monitoring programme was carried out from Tuesday, 28 November 2017 to Sunday, 10 December 2017. The long-term noise

monitoring methodology and noise level-vs-time graphs of the data are included in Appendix B.

Table 4 presents the overall single Rating Background Levels (RBL) and representative ambient L_{Aeq} noise levels for each assessment period, determined in accordance with the NPI.

Table 4: Long-term noise monitoring results, dB(A)

Location	Time period	Rating background noise levels, dBL_{A90}	Ambient dBL_{Aeq} noise levels
ML1	Day	45	56
	Evening	47	57
	Night	43	53
ML2	Day	54	69
	Evening	51	67
	Night	44	64
ML3	Day	45	55
	Evening	43	53
	Night	35	51
ML4	Day	51	61
	Evening	47	57
	Night	42	55
ML5	Day	46	57
	Evening	44	57
	Night	40	55

Note:

Day: 07:00-18:00 Monday to Saturday and 08:00-18:00 Sundays & Public Holidays

Evening: 18:00-22:00 Monday to Sunday & Public Holidays

Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays

As required by the INP, the external ambient noise levels presented are free-field noise levels. [i.e. no façade reflection]

3.3 Short-term noise measurement results

Short-term noise measurements were undertaken over a range of dates to provide greater detail of the surrounding noise environment. Equipment used for the short-term noise measurements have been summarised in Table 5. The instrument was calibrated prior and after measurement sequences with no significant drift observed.

All instrumentation complies with AS IEC 61672.1 2004 “Electroacoustics – Sound Level Meters” and carry current NATA certification.

Table 5: Short-term noise measurement equipment list

Equipment	Model	Serial Number	Calibration Due
Brüel & Kjær Hand-held analyzer	Type 2250	2449851	16/08/19

Equipment	Model	Serial Number	Calibration Due
Brüel & Kjær Sound calibrator	Type 4231	2445716	08/01/19

A summary of the short-term noise measurement results is presented in Table 6.

Table 6: Short-term noise monitoring results - $L_{Aeq(15min)}$

ID	Date and time[2]	dBL_{A90}	$dBL_{Aeq(15\ min)}$	dBL_{Amax}	Description of noise environment
ML1[1]	11/12/2017 12:58 pm	46	54	73	Road traffic noise from Appin Road; Insects; Heavy truck; Car engine starting; Distant helicopter; Birds;
ML2[1]	11/12/2017 12:22 pm	52	67	83	Road traffic noise from Appin Road; Heavy trucks; Motorcycle;
ML3	09/04/2018 04:55 pm	51	56	68	Road traffic; Wind; Birds
ML4	09/04/2018 03:30 pm	53	57	72	Road traffic noise; Birds; Wind through vegetation;
ML5	09/04/2018 5:43 pm	50	58	76	Road traffic noise; Birds;
ML6	18/04/2018 11:40 am	50	55	71	Road traffic noise from Appin Road; Roof top cooling towers audible; Motorcycle accelerating; Water pressure washer; Truck accelerating; Ambulance siren;

Note:

1 – Noise monitoring location referenced from recent Arup REF Acoustic Assessment of Campbelltown Hospital Carpark (19 April 2018).

2 – Start time.

4 Operational noise emissions

4.1 Overview

The primary operational noise sources with the potential to impact upon surrounding noise sensitive uses has been identified as building services (i.e. mechanical, electrical and hydraulic plant and equipment) and vehicular movements on site.

4.2 Environmental noise criteria

4.2.1 Preamble

It is noted that applications to modify an existing development, such as the case with Campbelltown Hospital Redevelopment Stage 2, typically require all existing sources of noise to be assessed in aggregate with additional sources of noise being introduced to the site. However, Building 1 has been assessed in isolation on the basis that standard[1] operational noise from existing components of Campbelltown Hospital do not contribute at off-site receivers (R2, R3 and R4) located nearest to the proposed Building 1; with consideration to the below factors:

- The expanse of the Campbelltown Hospital site (approx. 19.33 hectares) provides advantageous separation distance between existing hospital buildings and the abovementioned off-site receivers;
- Upon completion, Building 1 will provide substantial shielding to the abovementioned off-site receivers from existing hospital buildings;
- The existing noise environment at the abovementioned off-site receivers is characterised predominantly by road traffic noise from Appin and Therry Road; and
- Observations during the environmental noise monitoring programme at the abovementioned off-site receivers confirm no noise contribution from existing components of Campbelltown Hospital.

In addition to the above:

- Operational noise criteria established throughout the following sub-sections contains a moderate allowance for noise contribution from other sources of industry which may or may not be attributable to noise from Campbelltown Hospital (refer sub-section 4.2.2.2); and
- Operational noise emissions associated with building services are expected to be sufficiently controlled to achieve on-site external noise design targets.

[1] Standard operations do not include emergency vehicles (i.e. helicopter and/or ambulance events) or testing of emergency back-up systems.

4.2.2 NSW Noise Policy for Industry

Per the SEARs, operational noise emissions from the project are to be assessed in accordance with the Noise Policy for Industry (NPI), which is primarily concerned with controlling intrusive noise impacts in the short-term for residences, and maintaining long-term noise level amenity for residences and other land uses.

The NPI sets out the procedure to determine the project noise trigger levels relevant to an industrial development. The project noise trigger level is a level that, if exceeded would indicate a potential noise impact on the community and so 'trigger' a management response.

4.2.2.1 Intrusive noise trigger level

The intrusiveness noise trigger level is applicable to residential premises only and is summarised as follows:

- $L_{Aeq,15minute} \leq$ Rating Background Level (RBL) plus 5 dB

  (where $L_{Aeq,15minute}$ represent the equivalent continuous noise level of the source)

4.2.2.2 Recommended and project amenity noise level

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 should remain below the recommended amenity noise levels specified in Table 2.2 of the NPI where feasible and reasonable. An extract from the policy is given below in Table 7.

Table 7: NPI Recommended Amenity Noise Levels (RANLs)

Receiver	**Noise amenity area**	**Time of Day**	**Recommended amenity noise levels (RANLs) L_{Aeq}, dB(A)**
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45

Receiver	Noise amenity area	Time of Day	Recommended amenity noise levels (RANLs) L_{Aeq}, dB(A)
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks	See column 4	See column 4	5 dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day
School classroom - internal	All	Noisiest 1-hour period when in use	35 (see notes for table)
Hospital ward Internal External	 All All	 Noisiest 1-hour Noisiest 1-hour	 35 50
Place of worship – internal	All	When in use	40
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50
Active recreation area (e.g. school playground, gold course)	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	70
Industrial interface (applicable only to residential noise amenity areas)	All	All	Add 5 dB(A) to recommended noise amenity area

Notes: The recommended amenity noise levels (RANLs) refer only to noise from industrial sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

1. The NPI defines day, evening and night time periods as:
    - Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
    - Evening: the period from 6 pm to 10 pm.
    - Night: the remaining period.

(These periods may be varied where appropriate. In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable L_{Aeq} noise level may be increased to 40 dB $L_{Aeq(1hr)}$

The recommended amenity noise levels (RANLs) represent the objective for **total** industrial noise at a receiver location, whereas the **project amenity noise level (PANL)** represents the objective for noise from a **single** industrial development at a receiver location.

To ensure that any new industrial source of noise is within the RANLs for an area, the PANL applies for each new source of industrial noise as follows:

- *Project Amenity Noise Level (PANL) = Recommended Amenity Noise Level (RANL) minus 5 dB(A)*

The NPI also provides the following exceptions to the above method for deriving the project amenity noise level:

1. *In areas with high traffic noise levels.*
2. *In proposed developments in major industrial clusters.*
3. *Where the resultant project amenity noise level is 10 dB or more lower than the existing industrial noise level. In this case the project amenity noise levels 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.*
4. *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 amenity noise level is assigned as the project amenity noise level for the development.*

The area surrounding the site can be categorised as Urban under the NPI. According to Section 3, ambient noise levels at the sensitive receivers are controlled by traffic. The NPI sets the PANLs to $L_{Aeq(period(traffic))}$ minus 15 dB(A) in the case that the level of transport $L_{Aeq(period(traffic))}$ exceeds the RANL by 10 dB or more.

Table 8 summarises the RANLs and the PANLs applicable for the project.

Table 8: NPI RANLs and PANLs

ID	Indicative Noise Amenity Area	Time of day[1]	Recommended Amenity Noise Level (RANL) $L_{Aeq(period)}$	Existing Traffic $L_{Aeq(period)}$ [2]	Project Amenity Noise Level (PANL) $L_{Aeq(period)}$
ML1	Urban	Day	60	56	55
		Evening	50	57	45
		Night	45	53	40
ML2	Urban	Day	60	69	55
		Evening	50	67	52[2]
		Night	45	64	49[2]
ML3	Urban	Day	60	55	55
		Evening	50	53	45
		Night	45	51	40
ML4	Urban	Day	60	61	55
		Evening	50	57	45

ID	Indicative Noise Amenity Area	Time of day[1]	Recommended Amenity Noise Level (RANL) $L_{Aeq(period)}$	Existing Traffic $L_{Aeq(period)}$ [2]	Project Amenity Noise Level (PANL) $L_{Aeq(period)}$
		Night	45	55	40
ML5	Urban	Day	60	57	55
		Evening	50	57	45
		Night	45	55	40

Notes:

1. The NPI defines day, evening and night time periods as:
   - Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
   - Evening: the period from 6 pm to 10 pm.
   - Night: the remaining period.
2. Traffic noise is the dominant source of noise at the receiver location:
   a. the existing traffic noise is 10 dB(A) or more above the ANL for the area; and
   b. it is unlikely that traffic noise will reduce over time

4.2.2.3 Sleep disturbance

The NSW NPI recommends the following screening criteria for the assessment of potential sleep disturbance, for the period between 10 pm and 7 am:

- $L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or;
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater

4.2.2.4 NPI Project specific noise levels

Based on the background and ambient noise monitoring, Table 9 summarises the derived project specific noise levels based on the NPI.

Table 9: NPI Project specific noise levels

Receiver	Time Period	Project Specific Noise Levels		
		Intrusive Noise Trigger Levels $L_{Aeq,15min}$	Project Amenity Noise Level (PANL) $L_{Aeq,period}$	Sleep Disturbance $L_{Amax(night)}$
R1 (ML1)	Day	50	55	N/A[2]
	Evening	52	45	N/A[2]
	Night	48	40	58
R2 (ML2)	Day	59	55	N/A[2]
	Evening	56	52	N/A[2]
	Night	49	49	59
R3 (ML3)	Day	50	55	N/A[2]
	Evening	48	45	N/A[2]

Receiver	Time Period	Project Specific Noise Levels		
		Intrusive Noise Trigger Levels $L_{Aeq,15min}$	**Project Amenity Noise Level (PANL)** $L_{Aeq,period}$	**Sleep Disturbance** $L_{Amax(night)}$
	Night	40	40	52
R4 (ML4)	Day	56	55	N/A[2]
	Evening	52	45	N/A[2]
	Night	47	40	57
R5 (ML5)	Day	51	55	N/A[2]
	Evening	49	45	N/A[2]
	Night	45	40	55
R6	All	N/A	Noisiest 1-hour: Internal 35 External 50	N/A[2]
				N/A[2]
				58
R7	All	N/A	When in use: 50	N/A[2]
				N/A[2]
				N/A[2]

Notes:

1. The NPI defines day, evening and night time periods as:
   - Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
   - Evening: the period from 6 pm to 10 pm.
   - Night: the remaining period.
2. N/A Not Applicable

4.3 Operational noise review

A summary of the primary noise generating building services equipment in connection with Building 1, existing hospital buildings (Buildings A, B, D, CTC) and the proposed Hospital Street is provided in Appendix C.

It is noted that only new building services equipment has been identified for existing hospital buildings.

4.3.1 Building services

The primary operational noise associated with the development relates to building services equipment as outlined in Section 4.1. However, building services equipment has not been selected at this early stage of design to allow acoustic assessment or design. During ongoing design of the development, building services equipment will be selected and provided with noise and vibration attenuation measures as required to meet the Project goals. Where low noise equipment selection alone is insufficient, standard noise control methods can be adopted such as attenuators, acoustic louvres, acoustic screening around plant

areas, acoustic enclosures and use of sound absorptive treatments to screens and plant rooms.

Further detailed acoustic design will be required following confirmation of the building services equipment selections. The minimum separation distance to off-site receiver locations, orientated to the east of Building 1, is approximately 160 metres. This distance is advantageous and provides a fundamental safeguard to those receiver locations. Preliminary guidance concerning primary sources of building services noise has been provided below.

- The large proportion of building services plant and equipment are proposed to be housed internally within plant rooms situated on Level 3 and Level 9, or located in smaller plant rooms on tower levels 4 to 9. While discharge and intake will need to be ducted to external locations, sufficient scope is provided for any necessary acoustic treatment along these paths. Due to the proximity of existing hospital buildings on-site (i.e. Building A and B), noise control of building services equipment is expected to be determined by the need to minimise impacts upon adjacent hospital buildings.
- For items of plant located externally on the roof-top of Building 1 (i.e. cooling towers, various fans and pumps), noise control measures such as acoustic attenuators and/or acoustic screens may be necessary to safeguard off-site receivers orientated to the east of Building 1.
- Acoustic assessment of building services equipment should be undertaken during the detailed design phase of the development to ensure that the cumulative noise of all equipment does not exceed the applicable noise criteria.
- Building services noise emission can be controlled by appropriate system design and implementation of common engineering methods, which may include:
    - Procurement of ‘quiet’ plant
    - Commercially available acoustic attenuators for air discharge and air intakes of plant
    - Acoustically lined and lagged ductwork
    - Acoustic barriers between plant and sensitive neighbouring premises
    - Partial or complete acoustic enclosures over plant

4.3.2 Vehicular movements on site

The strategy regarding future on-site car parking, internal road layout and the location/quantity of access roads associated with the development have not yet been resolved. However, it is generally understood that on-site car parking and traffic matters, in connection with the application, are likely to involve:

- Relocation of existing parking spaces (i.e. CP5, 5A, CP6 and CP7) to make way for future development;
- Potential additional access road on Therry Road;

- Potential relocation of and/or signalling of the existing Appin Road access road; and
- Reconfiguration of internal roads.

It is noted however that the DA for the multi-deck carpark [4] and REF [5] for reconfigured at-grade parking included acoustic assessments of the increased traffic resulting from the subject proposed development and thus is not considered to be required within this report.

4.3.2.1 Loading dock

It is understood the development application does not incorporate provision of an additional loading dock facility. Rather the existing loading dock, located at grade beneath the north-eastern corner of Building B, will be retained and undergo minor reconfiguration work.

The loading dock is separated from the nearest off-site receiver locations by approximately 150 m. Additionally, the existing ground profile primarily obstructs line-of-sight between the loading dock and the nearest off-site residential receivers to the east. This current arrangement, with consideration to the minor reconfiguration works, is expected to be suitable.

5 Impacts upon development

5.1 Road traffic noise

The SEARs refers to the *NSW State Environmental Planning Policy (Infrastructure) 2007* (known as 'ISEPP') [6] and the supplementary guideline, Department of Planning's publication *Development near Rail Corridors and Busy Roads – Interim Guideline* [7] for guidance concerning the assessment of road traffic noise.

The ISEPP came into force in NSW on 1 January 2008 to facilitate the effective delivery of infrastructure across the State. Relevant to the acoustic assessment are the following clauses:

> *102 Impact of road noise or vibration on non-road development*
>
> *(1) This clause applies to development for any of the following purposes that is on land in or adjacent to the road corridor for a freeway, a tollway or a transitway or any other road with an annual average daily traffic volume of more than 40,000 vehicles (based on the traffic volume data published on the website of the RTA) and that the consent authority considers is likely to be adversely affected by road noise or vibration:*
>
> *a) a building for residential use,*
>
> *b) a place of public worship,*
>
> *c) a hospital,*
>
> *d) an educational establishment or child care centre.*

5.1.1 Department of Planning publication 'Development near rail corridors and busy roads – Interim guideline'

The NSW Department of Planning *Development in Rail Corridors and Busy Roads – Interim Guideline* (December 2008) [7] supplements the ISEPP [6]. While the ISEPP [6] applies only to roads with an AADT greater than 40,000 vehicles, the guideline is also recommended for other road traffic noise affected sites.

At the time of writing AADT data was not available for Appin Road, therefore a preliminary acoustic assessment has been carried out to inform future design of the building façade.

5.1.2 Clarification of ISEPP noise limits

The Guideline clarifies the time period of measurement and assessment. Section 3.4 '*What Noise and Vibration Concepts are Relevant*' and Table 3.1 of Section 3.6.1 confirms that noise assessment is based over the following time periods:

- Daytime 7:00am - 10:00pm $L_{Aeq(15hr)}$

- Night-time 10:00pm - 7:00am $L_{Aeq(9hr)}$

The noise criteria nominated in the ISEPP apply to internal noise levels with windows and doors closed. Where the noise assessment is based on measurements/predictions at external locations, equivalent external noise criteria have been established. The equivalent external noise criterion is used to determine which areas of the development may require acoustic treatment in order to meet the internal noise requirements of the ISEPP. The equivalent external goals have been determined on the following basis:

- The ISEPP states: "*If internal noise levels with windows or doors open exceed the criteria by more than 10dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia*." The internal criteria with windows open is therefore 10dB(A) above the criteria explicitly outlined in the ISEPP.
- The generally accepted noise reduction through an open window from a free-field external position is 10dB(A). Windows/doors are assumed to be open no more than 5% of room floor area, in accordance with the Building Code of Australia (BCA) ventilation requirements.

Table 10 presents the ISEPP internal noise criteria for non-residential buildings.

Table 10: Road traffic intrusion noise criteria

Non-residential building	Area designation	Internal noise level[1]
Hospitals	Wards	35
	Other noise sensitive areas	45

Note:
1 – airborne noise is calculated as L_{eq} (9h) (night) and L_{eq} (15h) (day).

5.1.3 Existing road traffic noise levels

Existing road traffic noise levels were measured on-site at the approximate location of the nearest building façade as identified in Figure 3. Table 11 presents a summary of the measured road traffic noise levels.

Table 11: Measured road traffic noise levels

ID	Day	Night
ML6	55	51

Note:
L_{eq} (9h) (night) and L_{eq} (15h) (day).

5.1.4 Road traffic noise intrusion

At this stage, detailed road traffic noise intrusion calculations have not been carried out subject to insufficient architectural detail. Notwithstanding, the above road traffic noise levels are moderate and internal criteria can be readily achieved with a sealed façade. The acoustic specification of the façade will be determined during the detailed design phase.

Notwithstanding, it is noted that road traffic noise is unlikely to be the determinate factor driving façade glazing requirements. Noise impacts associated with emergency helicopter events and the proposed roof top Helicopter Landing Site (HLS) are likely to control façade glazing requirements.

6 Construction

This assessment should be used to inform the proposed work practices and management measures contained in the preliminary Construction Management Plan (CMP). The preliminary CMP will be further developed as the construction methodologies and processes are confirmed during the design development process.

6.1 Construction stages and activities

Table 12 gives a high-level outline of the general stages of work and an outline of the activities that will be carried out as part of the construction works associated with the SSD application. Only those stages of work presented in bold text are considered throughout the construction noise assessment.

Table 12: General stages of work

Description	Indicative plant items
Stage 2A – Enabling and Early Works	
- Provide displacement car parking CP6 and CP7 - Close down Car park 6 and redirect to Car park 2 - Close down Car park 7 - **Construct new internal road and relocate Appin Road intersection including in-ground services infrastructure diversion** - **Services diversion under new CSB Building 1** - **Bulk excavation works and construction of internal bypass road** - **Reconfigure internal road, main entry drop-off and on-grade car park CP7** - Reconfigure existing Cooper's Cottage as main contract works site office	- Backhoe - Bull dozer - Compactor - Concrete saw - Crane (franna crane 20t) - Excavator tracked (hydraulic) – 35t - Front end loader - Generator (diesel) - Grader - Hammer pneumatic - Roller (vibratory) - Scraper - Truck (dump – 15t) - Truck (water cart)
Stage 2B – Main Works Preparation	
- **Construct new temporary main hospital entrance at level L00 during construction works** - **Part demolish and reconfigure existing FOH areas between Buildings A & 1 including old Pharmacy and Day Surgery entry** - Set-up/configure existing Building D & C entries for day/ambulatory and public car parking during construction works - Utilise CP3 as temporary Day Surgery entry through Building C	- Cherry picker - Concrete saw - Crane (franna crane 20t) - Excavator tracked (hydraulic) – 35t - Front end loader - Generator (diesel) - Hand tools

Description	Indicative plant items
Stage 2C – Main Works	
- **Construct new main hospital building**	- Cherry picker - Compressor (silenced) - Concrete pump - Concrete truck - Crane (franna crane 20t) - Crane (tower) - Generator (diesel) - Hammer (pneumatic) - Piling (bored) - Vehicle (light commercial) - Welder

6.2 Indicative programme and schedule

The indicative construction schedule associated with the SSD application is outlined in Table 13.

Table 13: Indicative construction schedule

Element	Commence	Duration
Stage 2A – Enabling and Early Works	October 2018	11 months
Stage 2B – Main Works Preparation	December 2018	9 months
Stage 2C – Main Works	August 2019	35 months

6.3 Construction hours

The proposed construction hours for the development are summarised in Table 14. It is noted that the proposed construction hours extend beyond the recommended standard construction hours prescribed in the *Interim Construction Noise Guideline* (ICNG).

A 30-minute extension in the morning on week days (i.e. Monday to Friday) is sought for the specific undertaking of preparatory actions to minimise clashing with early hospital shift staff. Noise intensive equipment and/or processes will not be carried out during this time.

Extended construction hours on Saturday are targeted for the undertaking of typical construction activities.

Table 14: Proposed construction hours

Day	Standard construction hours	Proposed construction hours
Monday to Friday	7 am to 6 pm	6:30 am to 6 pm
Saturday	8 am to 1 pm	7 am to 3 pm
Sunday and public holiday	No work	No work

6.4 Construction noise criteria

The ICNG provides recommended noise levels for airborne construction noise at sensitive land uses. The guideline provides construction noise management levels above which all feasible and reasonable work practices should be applied to minimise the construction noise impact. The ICNG works on the principle of a 'screening' criterion – if predicted or measured construction noise exceeds the ICNG levels then the construction activity must implement all 'feasible and reasonable' work practices to reduce noise levels.

The ICNG provides two methods for assessing construction noise, varying typically based on the project duration, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement of background noise levels for determination of noise management levels and prediction of construction noise levels. A qualitative assessment is recommended for small projects with a duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification.

The size of the Campbelltown Hospital Redevelopment Stage 2 and indicative construction schedule warrant a quantitative assessment including prediction of construction noise levels. A preliminary screening quantitative assessment has been carried out, however it is expected that a more detailed quantitative assessment be undertaken prior to commencement of works, to confirm mitigation and management processes.

6.4.1 Management levels

The ICNG sets out management levels for noise at noise sensitive receivers, and how they are to be applied. These noise management levels (NMLs) for residential receivers and other sensitive receivers are reproduced in Table 15 and in Table 16 respectively.

It is noted that the 30-minute morning extension (Monday to Friday) is proposed to be assessed against management levels applicable to recommended standard hours. Extended hours on Saturday (7 am to 8am and 1 pm to 3pm) are proposed to be assessed against management levels applicable to outside standard hours.

Table 15: Construction noise management levels (NMLs) at residential receivers

Time of day	NML 1 $L_{Aeq\ (15\ min)}$	How to apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10dB	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: times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5dB	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 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

1 - Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Table 16: Construction noise management levels (NMLs) at other noise sensitive land uses

Land use	Where objective applies	Management level $L_{Aeq(15\ min)}$[1]
Classrooms at schools and other educational institutions	Internal noise level	45 dB(A)
Hospital wards and operating theatres	Internal noise level	45 dB(A)
Places of worship	Internal noise level	45 dB(A)

Land use	Where objective applies	Management level $L_{Aeq(15\ min)}$[1]
Active recreation areas	External noise level	65 dB(A)
Passive recreation areas	External noise level	60 dB(A)
Community centres	Depends on the intended use of the centre.	Refer to the 'maximum' internal levels in AS2107 for specific uses.
Commercial premises	External noise level	70 dB(A)
Industrial premises	External noise level	75 dB(A)

1 - Noise management levels apply when receiver areas are in use only.

For work within standard construction hours, if after implementing all 'feasible and reasonable' noise levels the site still exceeds the noise affected level, the ICNG does not require any further action – since there is no further scope for noise mitigation.

For out-of-hours work, the ICNG uses a noise level 5 dB above the noise-affected level as a threshold where the proponent should negotiate with the community. While there is no 'highly-noise affected level' outlined in the ICNG for out-of-hours work, this report adopts the terminology where the construction noise level is 5 dB above the noise affected level.

6.4.2 Project construction noise targets

Based on the measured background noise levels presented in Table 4 and the criteria methodology presented above, Table 17 outlines the construction noise management levels applicable to demolition, excavation and construction.

Table 17: Construction noise management levels (NMLs)

Receiver	Noise management level, $L_{Aeq(15\ min)}$ dB(A)			
	Standard hours[1]		Outside standard hours[2]	
	Noise affected	Highly noise affected	Noise affected	Highly noise affected
R1	55	75	48	53
R2	64	75	49	54
R3	55	75	40	45
R4	61	75	47	52
R5	56	75	45	50
R6	45[3]	-	45[3]	-
R7	60	-	60	-

Note:

1 – Monday to Friday 7 am to 6pm; Saturday 8am to 1pm; Sunday and Public Holidays no work

2 – Noise management level based on evening period (i.e. 6 pm to 10 pm) background noise level

3 – Internal noise level

6.5 Construction vibration criteria

6.5.1 Disturbance to building occupants

Concerns regarding impacts on human occupants to buildings would generally be assessed in accordance with the 'intermittent' vibration criteria outlined in the DEC Guideline [2]. However, due to the low vibration intensity works proposed, focus for management purposes is on structural damage, as outlined below.

6.5.2 Structural damage

6.5.2.1 Definition

Potential structural or cosmetic damage to buildings as a result of vibration is typically assessed in accordance with British Standard 7385 Part 2 [8] and/or German Standard DIN4150-3 [9]. British Standard 7385 Part 1: 1990, defines different levels of structural damage as:

- *Cosmetic - The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in mortar joints of brick/concrete block construction.*
- *Minor - The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*
- *Major - Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

Table 1 of British Standard 7385 Part 2 (1993) sets limits for the protection against cosmetic damage, however the following guidance on minor and major damage is provided in Section 7.4.2 of the Standard:

> *7.4.2 Guide values for transient vibration relating to cosmetic damage*
>
> *Limits for transient vibration, above which cosmetic damage could occur are given numerically in Table 1 and graphically in Figure 1. In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to line 2 are reduced. Below a frequency of 4 Hz, where a high displacement is associated with a relatively low peak component particle velocity value a maximum displacement of 0.6 mm (zero to peak) should be used.*
>
> *Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 1, and major damage to a building structure may occur at values greater than four times the tabulated values.*

Within DIN4150-3, damage is defined as "*any permanent effect of vibration that reduces the serviceability of a structure or one of its components"* (p.2). The Standard also outlines:

"that for structures as in lines 2 and 3 of Table 1, the serviceability is considered to have been reduced if

- *cracks form in plastered surfaces of walls;*
- *existing cracks in the building are enlarged;*
- *partitions become detached from loadbearing walls or floors.*

These effects are deemed 'minor damage." (DIN4150.3, 1990, p.3)

While the DIN Standard defines the above damage as 'minor', the description aligns with BS7385 cosmetic damage, rather than referring to structural failures.

6.5.2.2 British standard BS7835-2

BS7385-2 is based on peak particle velocity and specifies damage criteria for frequencies within the range 4–250 Hz, and a maximum displacement value below 4 Hz is recommended. Table 18 sets out the BS7385 criteria for cosmetic, minor and major damage.

Table 18: BS7385-2 structural damage criteria

Group	Type of structure	Damage level	Peak component particle velocity, mm/s[1]		
			4 Hz to 15 Hz	15 Hz to 40 Hz	40 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	50		
		Minor[2]	100		
		Major[2]	200		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50
		Minor[2]	30 to 40	40 to 100	100
		Major[2]	60 to 80	80 to 200	200

Note:

1 - Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.

2 - Minor and major damage criteria established based on British Standard 7385 Part 2 (1993) Section 7.4.2

All levels relate to transient vibrations in low-rise buildings. Continuous vibration can give rise to dynamic magnifications that may require levels to be reduced by up to 50%.

6.5.2.3 German standard DIN 4150

German Standard DIN 4150 - Part 3 '*Structural vibration in buildings - Effects on Structure'* [9] are generally recognised to be conservative and is often referred to for the purpose of assessing structurally sensitive buildings. For the subject site, surrounding buildings are not deemed structurally sensitive and therefore the British Standard is considered appropriate for vibration management.

6.5.3 Vibration sensitive equipment or receivers

Some high technology manufacturing facilities, hospitals and laboratories use equipment and processes that are highly sensitive to vibration, such as high magnification microscopy (including optical and electron microscopes) and high resolution imaging equipment (e.g. MRI). Buildings housing sensitive computer or telecommunications equipment may also require assessment against stricter criteria than those nominated for building damage.

While the acceptable vibration levels for such equipment are recommended to be obtained from the instrument manufacturers, generic criteria such as the ASHRAE Vibration Criteria for Vibration Sensitive Equipment (VC-curves) can be adopted for planning purposes.

Regarding existing hospital buildings/facilities on site at Campbelltown Hospital, an investigation of all vibration sensitive equipment should take place during development of the detailed Construction Noise and Vibration Management Plan.

6.5.4 Buried services

It is not expected that the proposed works will impact upon buried services, however the following is nonetheless provided for guidance. DIN 4150-2:1999 sets out guideline values for vibration effects on buried pipework (see Table 19).

Table 19: Guideline values for short-term vibration impacts on buried pipework

	Pipe material	**Guideline values for vibration velocity measured on the pipe, mm/s**
1	Steel (including welded pipes)	100
2	Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
3	Masonry, plastic	50

Note:

For gas and water supply pipes within 2m of buildings, the levels given in DIN4150-3 [9] should be applied. Consideration must also be given to pipe junctions with the building structure as potential significant changes in mechanical loads on the pipe must be considered.

In addition, specific limits for vibration affecting high-pressure gas pipelines is provided in the UK National Grid's *Specification for Safe Working in the Vicinity of National Grid High Pressure Gas Pipelines and Associated Installations – Requirements for Third Parties* (report T/SP/SSW/22, UK National Grid, Rev 10/06, October 2006). This specification states that no piling is allowed within 15 m of a pipeline without an assessment of the vibration levels at the pipeline. The PPV at the pipeline is limited to a maximum level of 75 mm/s, and where PPV is predicted to exceed 50 mm/s the ground vibration is required to be monitored.

Other services that maybe encountered include electrical cables and telecommunication services such as fibre optic cables. While these may sustain vibration velocity levels from between 50 mm/s and 100 mm/s, the connected services such as transformers and switchgear, may not. Where encountered, site

specific vibration assessment in consultation with the utility provider should be carried out.

6.6 Construction noise and vibration assessment

6.6.1 Construction works – noise impact

As detail of the construction noise equipment / plant to be used during the construction stages of the project is not known at the time of this assessment, a generic approach has been adopted and noise sources normally found on construction sites similar to the Campbelltown Hospital redevelopment have been considered.

The anticipated airborne noise levels for the likely construction noise sources are listed in Table 22. Equipment sound power levels (L_w) have been sourced from AS2436 – 2010 Guide to noise and vibration control on construction, demolition and maintenance sites. It should be noted that during the different construction stages, it is unlikely that all machinery would be operating at the same time (like the modelling assumes), but taking a 'worse-case' scenario approach helps to identify where noise impacts could be a concern and assists in the design of mitigation measures.

Table 20: Assumed construction equipment and sound power levels

Equipment	Sound power level (per unit), dB(A)
Stage 2A – Enabling and Early Works	
Backhoe	117
Bull dozer	111
Compactor	106
Concrete saw	113
Crane (franna crane 20t)	105
Excavator tracked (hydraulic) – 35t	111
Front end loader	110
Generator (diesel)	102
Grader	115
Hammer pneumatic	112
Roller (vibratory)	108
Scraper	110
Truck (dump – 15t)	109
Truck (water cart)	109
Stage 2B – Main Works Preparation	
Cherry picker	95
Concrete saw	113
Crane (franna crane 20t)	105
Excavator tracked (hydraulic) – 35t	111

Equipment	Sound power level (per unit), dB(A)
Front end loader	110
Generator (diesel)	102
Hand tools	112
Stage 2C – Main Works	
Cherry picker	95
Compressor (silenced)	103
Concrete pump	106
Concrete truck	108
Crane (franna crane 20t)	105
Crane (tower)	105
Generator (diesel)	102
Hammer (pneumatic)	112
Piling (bored)	112
Vehicle (light commercial)	106
Welder	101

6.6.2 Assessment

Predicted construction noise levels considering standard construction hours and outside standard construction hours are tabulated in Table 21. Noise levels have been compared to the receiver's relevant Noise Management Level and exceedances have been highlighted. It should be noted that in general construction works are temporary in nature therefore any potential noise impact on the community and the surrounding environment will not be permanent. However, where possible the impacts due to construction noise should be minimised.

Where the predicted $L_{Aeq(15min)}$ noise level is greater than the noise management levels all feasible and reasonable work practices should be applied, however it is unlikely mitigation measures would reduce the received noise levels below the noise management levels in all cases.

The magnitude of construction noise impacts is dependent upon a number of aspects including the intensity and location of activities, the type of equipment used and background noise levels during the construction period. Based on these factors, the predicted construction noise levels are generally conservative and do not represent a constant noise emission that would be experienced by the community on a daily basis throughout the project construction period. The predicted noise levels would only be experienced for limited periods of time when works are occurring and should not be experienced for full daytime, evening or night time periods. It is also emphasised that all the equipment listed in Table 20 is very unlikely to operate continuously for 15 minutes and concurrently. A conservative adjustment for duration has been applied in the predicted construction noise levels. The adjustment assumes each item of equipment operates for 75% of the 15-minute assessment period.

Table 21: Predicted noise levels at nearest affected off-site receiver locations

Location	Noise management level, $L_{Aeq(15\ min)}$ dB(A)		Predicted sound level, $L_{Aeq(15\ min)}$ dB(A)		
	Noise affected	Highly noise affected	Scenario 1 (Stage 2A)	Scenario 2 (Stage 2B)	Scenario 3 (Stage 2C)
Standard hours					
R1	55	75	66	37	50
R2	64	75	75	53	56
R3	55	75	70	58	59
R4	61	75	68	62	58
R5	56	75	67	59	55
R6	45[1]	-	50[2]	30[2]	25[2]
R7	60	-	49	41	37
Outside standard hours					
R1	48	53	66	37	50
R2	49	54	75	53	56
R3	40	45	70	58	59
R4	47	52	68	62	58
R5	45	50	67	59	55
R6	45[1]	-	50[2]	30[2]	25[2]
R7	60	-	49	41	37

Note:

1 – internal noise level

2 – predicted sound pressure level includes -10 dB adjustment accounting for external-to-internal noise reduction (assuming window partially open)

Predicted sound pressure level ≤ noise affected level

Noise affected level < predicted sound pressure level ≤ highly noise affected

Highly noise affected < predicted sound pressure level

6.6.3 Construction works – vibration impact

The nearest off-site vibration sensitive receiver locations are presented in Table 22.

Table 22: Nearest off-site vibration receivers

ID	Address	Description
R2	1 – 27 Appin Road, Bradbury	Single storey houses along Appin Road
R3	6 – 48 Fern Avenue, Bradbury	Single storey houses along Fern Avenue
R4	33 – 61 Georgiana Crescent, Ambarvale	Single storey houses along Georgiana Crescent, Miggs Place and Tiggs Place
	5 – 7 Miggs Place, Ambarvale	
	5 – 7 Tiggs Place Ambarvale	

ID	Address	Description
R7	Parkside Crescent, Campbelltown	Marsden Park

6.6.4 Vibration sources

Vibration generated from demolition, excavation and construction works will vary depending on the level and type of activity carried out at each site during each activity.

Table 23 below identifies the dominant vibration generating plant and equipment. Potential vibration generated to receivers is dependent on separation distances, the intervening soil and rock strata, dominant frequencies of vibration and the receiver structure. Typical levels of ground vibration from these sources are shown in Table 23.

Table 23: Construction plant vibration levels

Equipment	Indicative size	PPV vibration (mm/s) at distance from plant					
		5m	10m	15m	20m	30m	40m
Excavator & breaker	Heavy	10.5	2.5	-	-	-	-
Excavator (travelling)	Heavy	8.0	3.4	1.6	-	-	-
Piling – rotary bored cast in-situ	-	11.4	6.4	-	5.6	-	-
Roller – vibratory (pad foot)	12t	15.1	10.3	3.2	-	-	-
Truck & trailer	≤ 45t net	14.5	10.3	3.4	-	-	-

6.6.5 Indicative minimum working distances for vibration intensive equipment

As a guide, indicative minimum working distances for typical items of vibration intensive plant and equipment are provided in Table 24. Minimum working distances are quoted for:

- Cosmetic damage, based on the British Standard 7385; and
- Human comfort, based on the DECCs ‘Assessing Vibration; a technical guideline’.

Table 24: Recommended minimum working distances for vibration intensive equipment

Plant Item	Rating/ Description	Minimum Working Distance, m	
		Cosmetic Damage (BS 7385)	Human Response (DECC Guideline)
Vibratory Roller[2]	<50 kN (Typically 1-2 tonnes)	5	15 - 20
	<100 kN (Typically 2-4 tonnes)	6	20
	<200 kN (Typically 4-6 tonnes)	12	40
	<300 kN (Typically 7-13 tonnes)	15	100
	>300 kN (Typically 13-18 tonnes)	20	100
	>300 kN (Typically >18 tonnes)	25	100
Compactor[1]	852G	10	20
Dozer[1]	(D810) with ripper	2 (nominal)	10
Excavator[1]	<=30 Tonne (travelling/ digging)	10	15
Grader[1]	<= 20 tonne	2 (nominal)	10
Small Hydraulic Hammer[2]	300kg (5-12 tonne excavator)	2	7
Medium Hydraulic Hammer[2]	900kg (12-18 tonne excavator)	7	23
Large Hydraulic Hammer[2]	1600kg (18-34 tonne excavator)	22	73
Pile Boring[2]	≤ 800 mm	2 (nominal)	N/A
Jackhammer[2]	Hand held	1 m (nominal)	Avoid contact with structure
Truck Movements[1]	-	-	10m

Notes:

More stringent conditions may apply to heritage or other sensitive structures

The minimum working distances are indicative and will vary depending on the specific equipment and geotechnical conditions.

They apply to cosmetic damage of buildings and have been derived from measured vibration data from a range of projects available in our database under varying geotechnical conditions. Vibration monitoring should be undertaken to confirm the safe working distances at specific sites where considered necessary.

Regarding the proposed development and separation distance to off-site receiver locations, vibration is not expected to impact upon surrounding development.

N.B. While not specifically within the scope of the SEARs, attention is drawn to the potential for certain demolition, excavation and construction activities to result in vibration impacts upon existing hospital buildings; in particular Building A and Building B. During development of the detailed Construction Noise and Vibration Management Plan an investigation of vibration impact upon existing hospital buildings should take place.

6.7 Construction noise and vibration mitigation

Noise mitigation measures for each major construction activity are discussed in the following sections. These mitigation measures are considered to represent 'feasible and reasonable' mitigation measures suitable for implementation during construction of the project.

6.7.1 Construction noise and vibration management plan

For all construction works, the contractor would be expected to prepare a detailed Construction Noise and Vibration Management Plan (CNVMP). This plan should include but not be limited to the following:

- Roles and responsibilities
- Noise and vibration sensitive receiver locations
- Areas of potential impact
- Mitigation strategy
- Monitoring methodology
- Community engagement strategy.

General guidance on the control of construction noise and vibration impacts relevant to this study are discussed in the following sections.

6.7.2 General

In general, practices to reduce construction noise impacts will be required, and may include;

- Adherence to the standard approved working hours as outlined in the Project Approval.
- Manage noise from construction work that might be undertaken outside the recommended standard hours
- The location of stationary plant (concrete pumps, air-compressors, generators, etc.) as far away as possible from sensitive receivers
- Using site sheds and other temporary structures or screens/hoarding to limit noise exposure where possible.
- Sealing of openings in the building (temporary or permanent) prior to commencement of internal works to limit noise emission.
- The appropriate choice of low-noise construction equipment and/or methods
- Modifications to construction equipment or the construction methodology or programme. This may entail programming activities to occur concurrently where a noisy activity will mask a less noisy activity, or, at different times where more than one noisy activity will significantly increase the noise. The programming should also consider the location of the activities due to occur concurrently.

- Carry out consultation with the community during construction including, but not limited to; advance notification of planned activities and expected disruption/effects, construction noise complaints handling procedures.

6.7.3 Universal work practices

The following noise mitigation work practices are recommended to be adopted at all times on site:

- Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise.
- Site managers to periodically check the site and nearby residences for noise problems so that solutions can be quickly applied.
- Avoid the use of radios or stereos outdoors.
- Avoid the overuse of public address systems.
- Avoid shouting, and minimise talking loudly and slamming vehicle doors.
- Turn off all plant and equipment when not in use.

6.7.4 Vibration – minimum working distances

Recommended minimum working distances for vibration intensive plant, which are based on international standards and guidance and reproduced in Table 25 for reference. With regards to the proposed development works, vibration is not expected to impact upon surrounding development.

Table 25: Recommended minimum working distances for vibration intensive plant

Plant Item	**Rating / Description**	**Minimum working distance**	
		Cosmetic damage (BS 7385)	**Human response (OH&E Vibration Guideline)**
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7 m	23 m
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

7 Conclusion

Arup has completed an acoustic and vibration assessment for the proposed Campbelltown Hospital Redevelopment Stage 2 to address the SEARs for SSD 9241, which relate to operational and construction related environmental noise and vibration emissions.

Regarding operations, the assessment concludes that the proposed development is capable of satisfying the standard NSW EPA noise policy requirements. Notwithstanding, further detailed acoustic assessment is warranted during the design development, particularly concerning building services noise control.

Regarding construction, the proposed works are predicted to result in exceedance of the relevant noise management levels at most off-site assessment locations and accordingly mitigation and management procedures will need to be considered for the works. However, the predicted exceedances are only expected during periods of intense activity subject to the type of equipment used.

A detailed Construction Noise and Vibration Assessment for the project will be required, in which specific attention should be given to controlling noise impacts upon the considered off-site receiver locations. It is expected that the detailed Construction Noise and Vibration Management Plan would be prepared by the contractor prior to the commencement of works.

References

[1] NSW Environment Protection Authority, "NSW Noise Policy for Industry," NSW Environment Protection Authority, Sydney, 2017.

[2] Department of Environment and Conservation (NSW), "Assessing Vibration: A technical guideline," Department of Environment and Conservation (NSW), Sydney, 2006.

[3] Department of Environment and Climate Change NSW, "Interim Construction Noise Guideline," Department of Environment and Climate Change NSW, Sydney, 2009.

[4] "Campbelltown Hospital Carpark DA Acoustic Assessment_AC02_V2," Arup, Sydney, December 2017.

[5] "Campbelltown Hospital Carpark REF Acoustic Assessment_AC03_V2," Arup, Sydney, April 2019.

[6] NSW Government, "State Environmental Planning Policy (Infrastructure) 2007," 2007.

[7] NSW Department of Planning, "Development Near Rail Corridors and Busy Roads - Interim Guideline," NSW Department of Planning, Sydney, 2008.

[8] Bristish Standard Institution, "BS 7385-2: 1993 Evaluation and measurement for vibration in buildings - Pt 2: Guide to damage levels from groundborne vibration," Bristish Standard Institution, London, 1993.

[9] Deutsches Institut fur Normung, "DIN 4150-3 (1999) Structural vibration - Effects of vibration on structures," Deutsches Institut fur Normung, Berlin, 1999.

Appendix A

Glossary

Ambient Noise Level

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

Background Noise Level

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

Assessment Background Level (ABL)

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

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

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

Decibel

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

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

dB(A)

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

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

Some typical dB(A) levels are shown below.

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

L_1

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

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

L_{10}

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

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

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

L_{90}

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

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

L_{eq}

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

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

L_{max}

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

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

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

Frequency

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

Peak Particle Velocity (PPV)

Peak Particle Velocity (PPV) is the highest velocity of a particle (such as part of a building structure) as it vibrates. Most sound level meters measure *root mean squared* (RMS) values; it is common to approximate the PPV based on an RMS measurement.

PPV is commonly used as a vibration criteria, and is often interpreted as a PPV based on the L_{max} or $L_{max,spec}$ index.

Sound Power and Sound Pressure

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

Vibration

Waves in a solid material are called “vibration”, as opposed to similar waves in air, which are called “sound” or “noise”. If vibration levels are high enough, they can be felt; usually vibration levels must be much higher to cause structural damage.

A vibrating structure (eg a wall) can cause airborne noise to be radiated, even if the vibration itself is too low to be felt. Structureborne vibration limits are sometimes set to control the noise level in a space.

Vibration levels can be described using measurements of displacement, velocity and acceleration. Velocity and acceleration are commonly used for structureborne noise and human comfort. Vibration is described using either metric units (such as mm, mm/s and mm/s²) or else using a decibel scale.

Appendix B

Unattended Monitoring Results

B1 Noise monitoring equipment

Unattended monitoring was carried out using the following equipment:

Measurement location	Equipment/model	Serial No.	SLM Type
ML1	ARL Ngara	878107	Type 1
ML2	ARL Ngara	878000	Type 1
ML3	ARL Ngara	878107	Type 1
ML4	ARL Ngara	8780D1	Type 1
ML5	ARL Ngara	878060	Type 1
ML6	ARL Ngara	878000	Type 1

Notes:

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

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

B2 Extraneous/weather affected data

Measurement samples affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the procedures outlined in Fact Sheet A of the NSW Noise Policy for Industry (NPI).

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

B3 Logger graphs

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

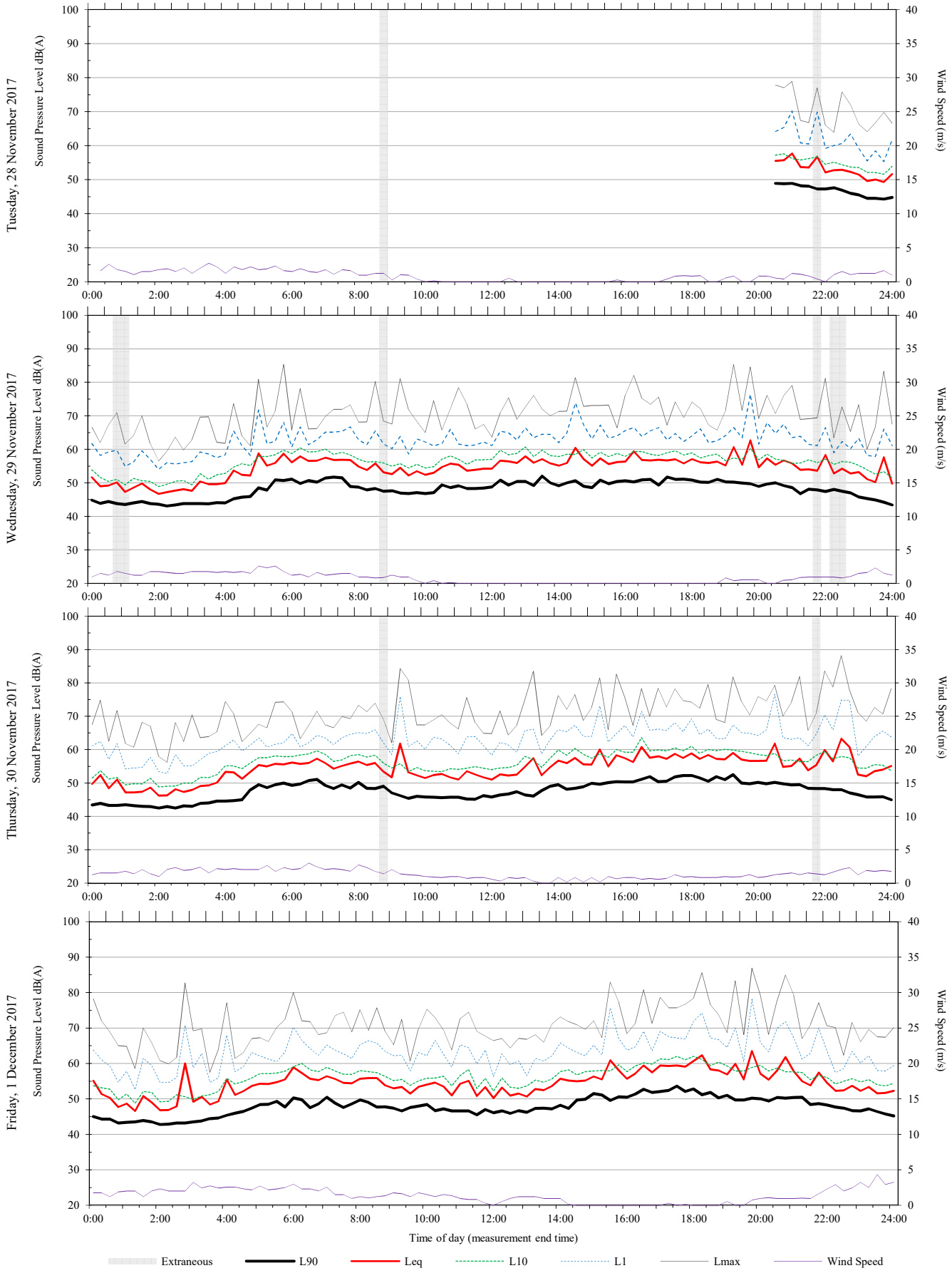
Wind speeds are also show where relevant, and periods of excluded data are shaded grey.

ML1 – 100 Parkside Crescent, Campbelltown (Campbelltown Hospital near Birunji building)

Date	**L_{A90} Background noise levels, dB(A)[4]**			**L_{Aeq} Ambient noise levels, dB(A)**		
	Day[1]	**Eve[2]**	**Night[3]**	**Day[1]**	**Eve[2]**	**Night[3]**
Tuesday-28-November-2017	-	-	44	-	-	53
Wednesday-29-November-2017	47	47	43	56	57	53
Thursday-30-November-2017	46	48	43	56	58	55
Friday-01-December-2017	47	48	-	56	59	-
Saturday-02-December-2017	-	48	44	-	56	53
Sunday-03-December-2017	45	-	-	53	-	-
Monday-04-December-2017	50	47	44	57	55	53
Tuesday-05-December-2017	48	46	-	56	57	-
Wednesday-06-December-2017	45	47	43	55	55	55
Thursday-07-December-2017	45	46	44	53	57	53
Friday-08-December-2017	45	49	43	57	57	53
Saturday-09-December-2017	45	47	43	55	56	53
Sunday-10-December-2017	45	47	42	55	55	53
Representative Weekday[5]	**46**	**47**	**43**	**56**	**57**	**54**
Representative Weekend[5]	**45**	**47**	**43**	**55**	**56**	**53**
Representative Week[5]	**45**	**47**	**43**	**56**	**57**	**53**

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Eve is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Unattended monitoring: 100 Parkside Cres (Campbelltown Hospital near Birunji building) (Free Field) ARUP



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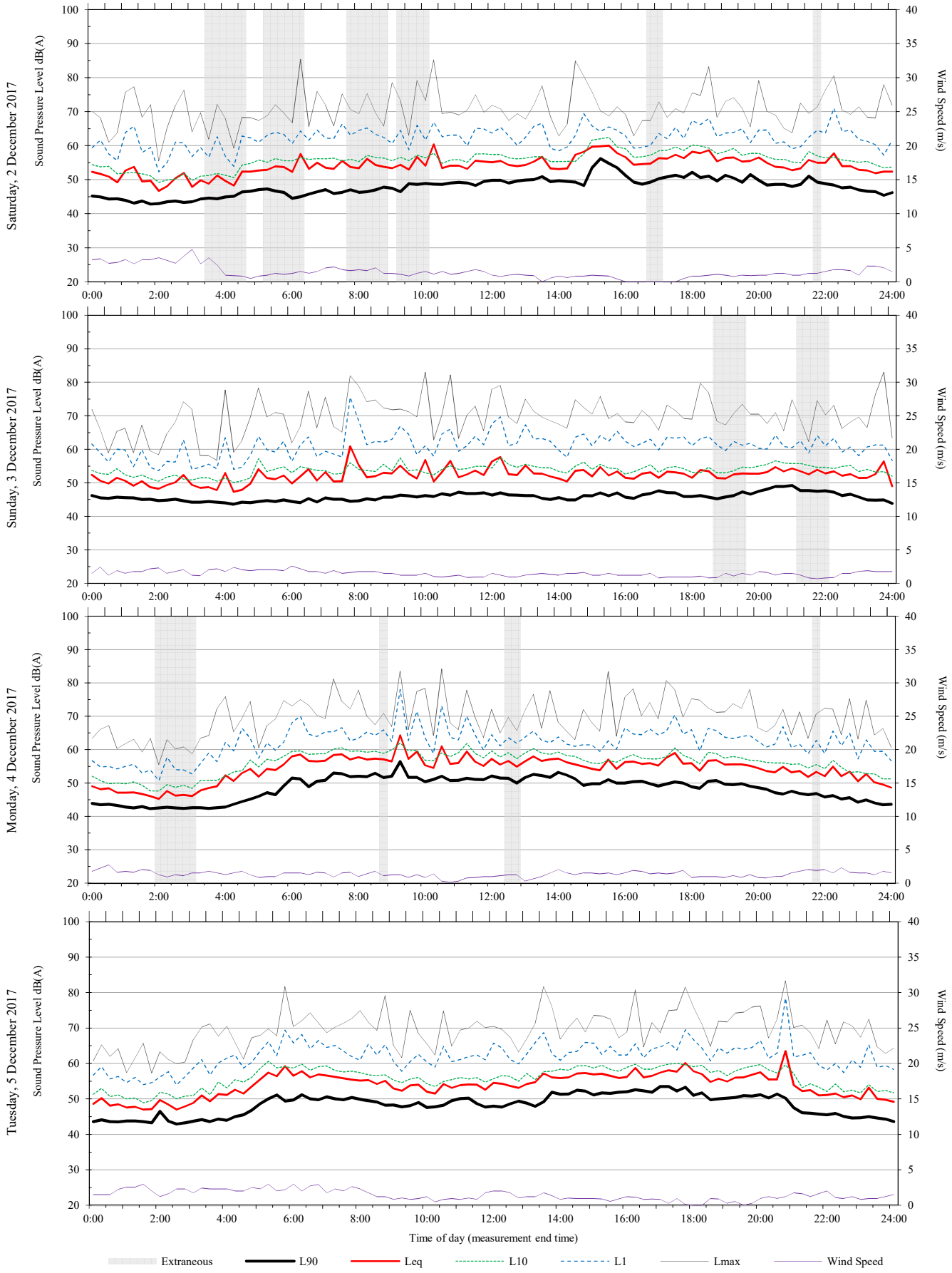

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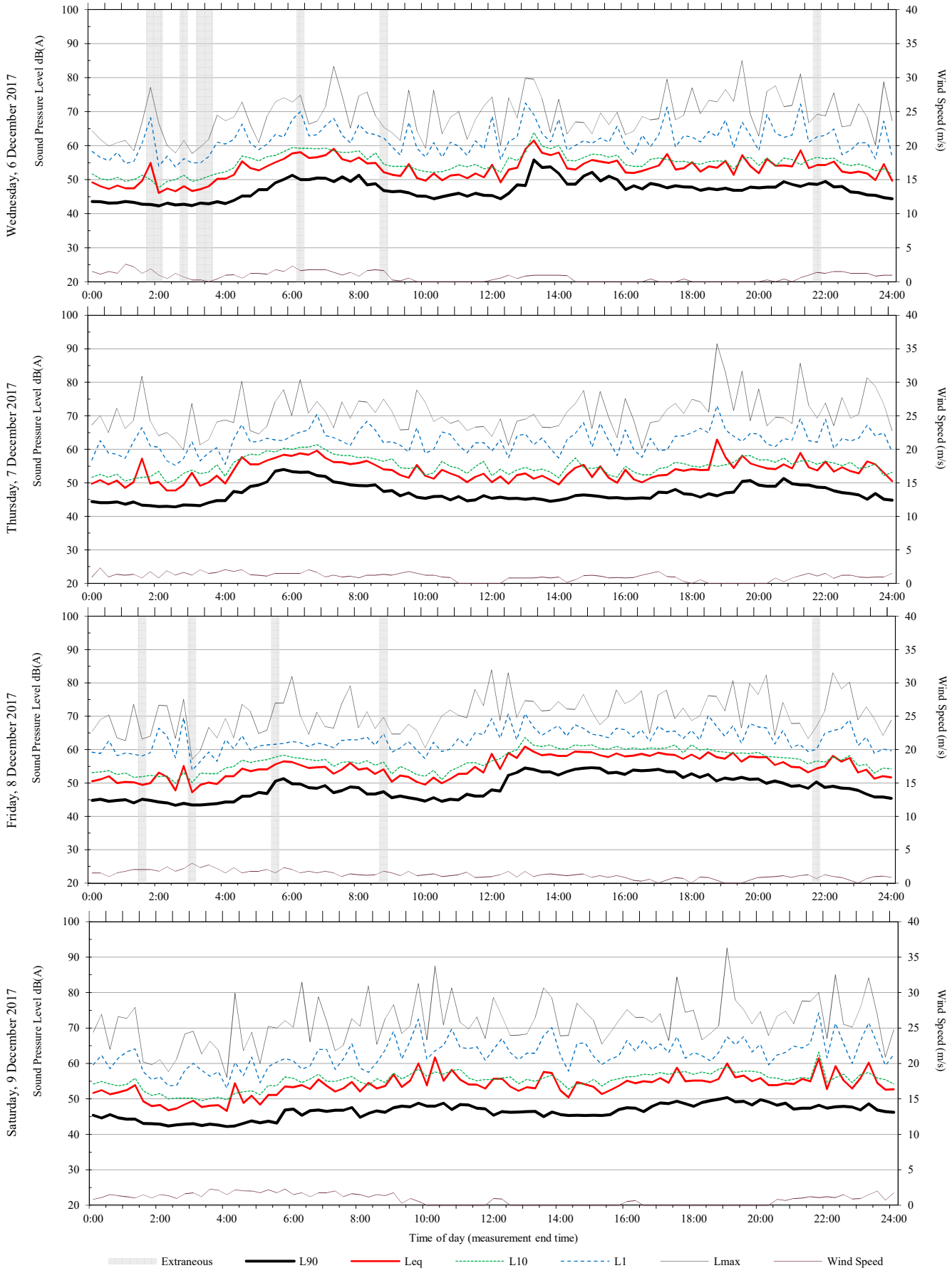

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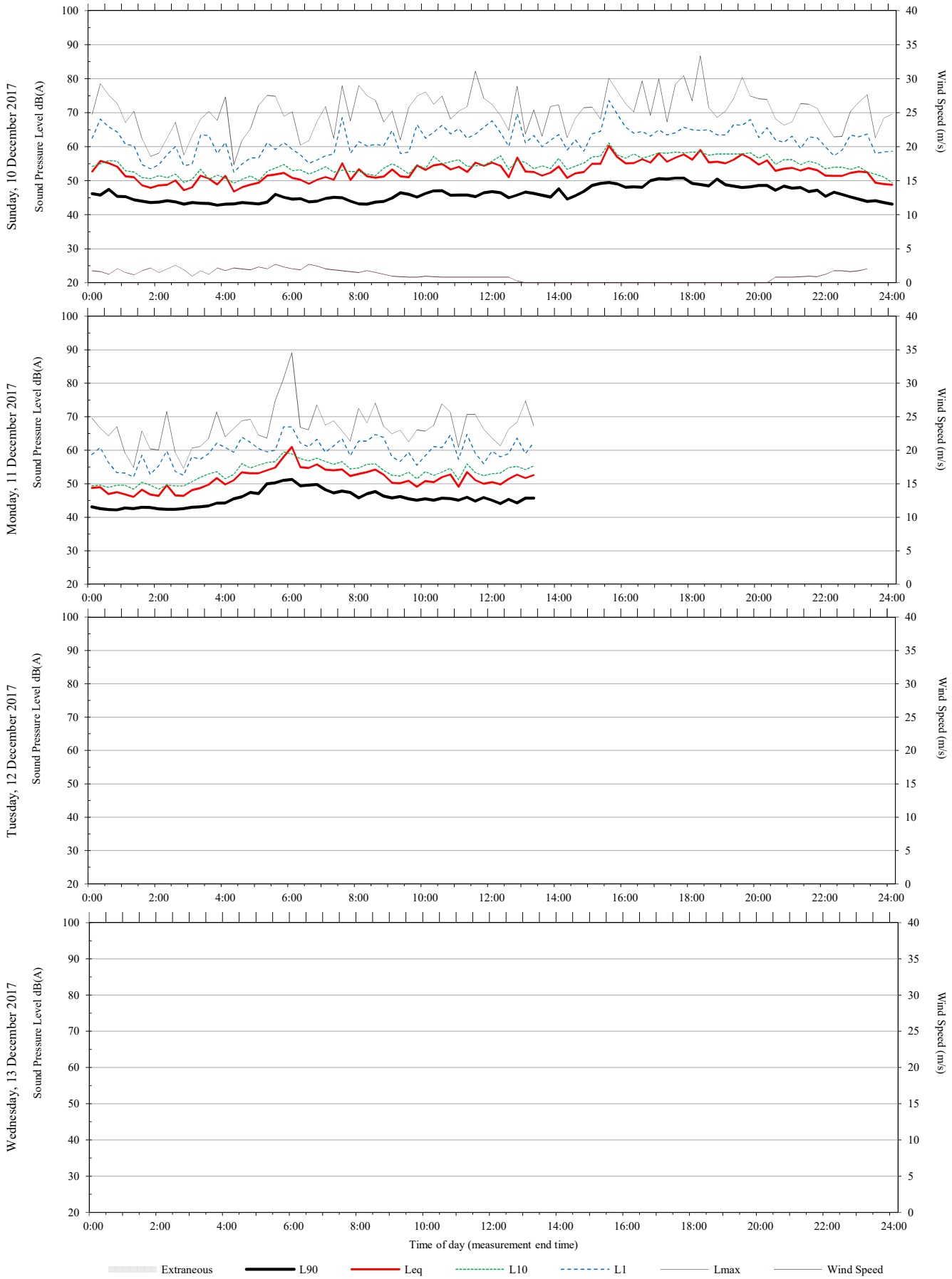


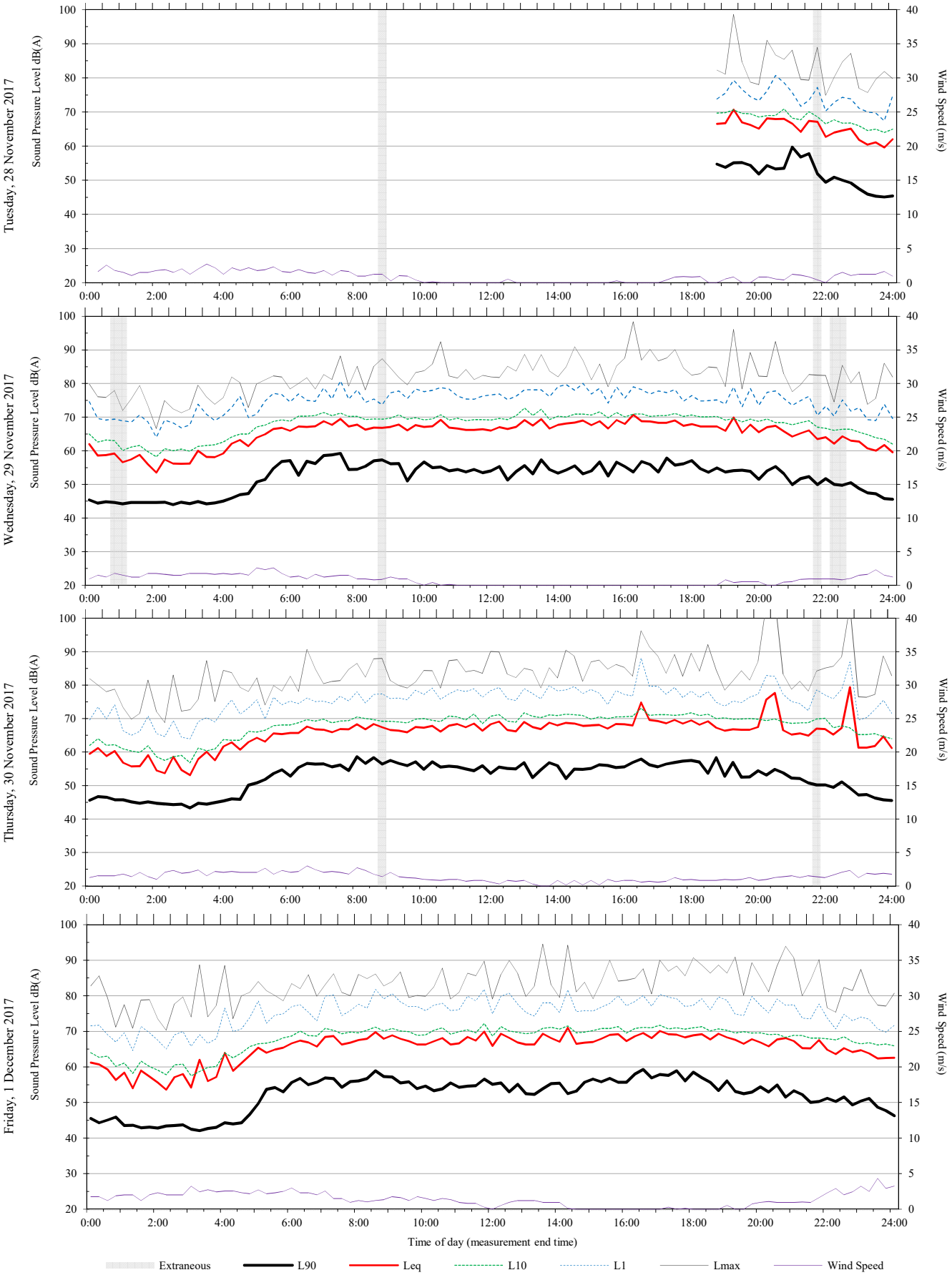
ML2 – 17 Appin Road, Bradbury

Date	**L_{A90} Background noise levels, dB(A)[4]**			**L_{Aeq} Ambient noise levels, dB(A)**		
	Day[1]	**Eve[2]**	**Night[3]**	**Day[1]**	**Eve[2]**	**Night[3]**
Tuesday-28-November-2017	-	-	44	-	-	63
Wednesday-29-November-2017	53	52	44	68	67	62
Thursday-30-November-2017	55	51	43	68	70	66
Friday-01-December-2017	53	50	-	68	67	-
Saturday-02-December-2017	-	56	45	-	68	64
Sunday-03-December-2017	54	-	-	69	-	-
Monday-04-December-2017	56	51	44	70	67	64
Tuesday-05-December-2017	55	51	-	69	67	-
Wednesday-06-December-2017	54	54	46	69	67	63
Thursday-07-December-2017	55	51	45	69	67	63
Friday-08-December-2017	55	53	43	69	67	62
Saturday-09-December-2017	52	49	44	67	66	64
Sunday-10-December-2017	52	49	42	68	66	63
Representative Weekday[5]	**55**	**51**	**44**	**69**	**68**	**64**
Representative Weekend[5]	**52**	**49**	**44**	**68**	**67**	**63**
Representative Week[5]	**54**	**51**	**44**	**69**	**67**	**64**

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Eve is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Unattended monitoring: 17 Appin Road (Free Field)

ARUP



Unattended monitoring: 17 Appin Road (Free Field)

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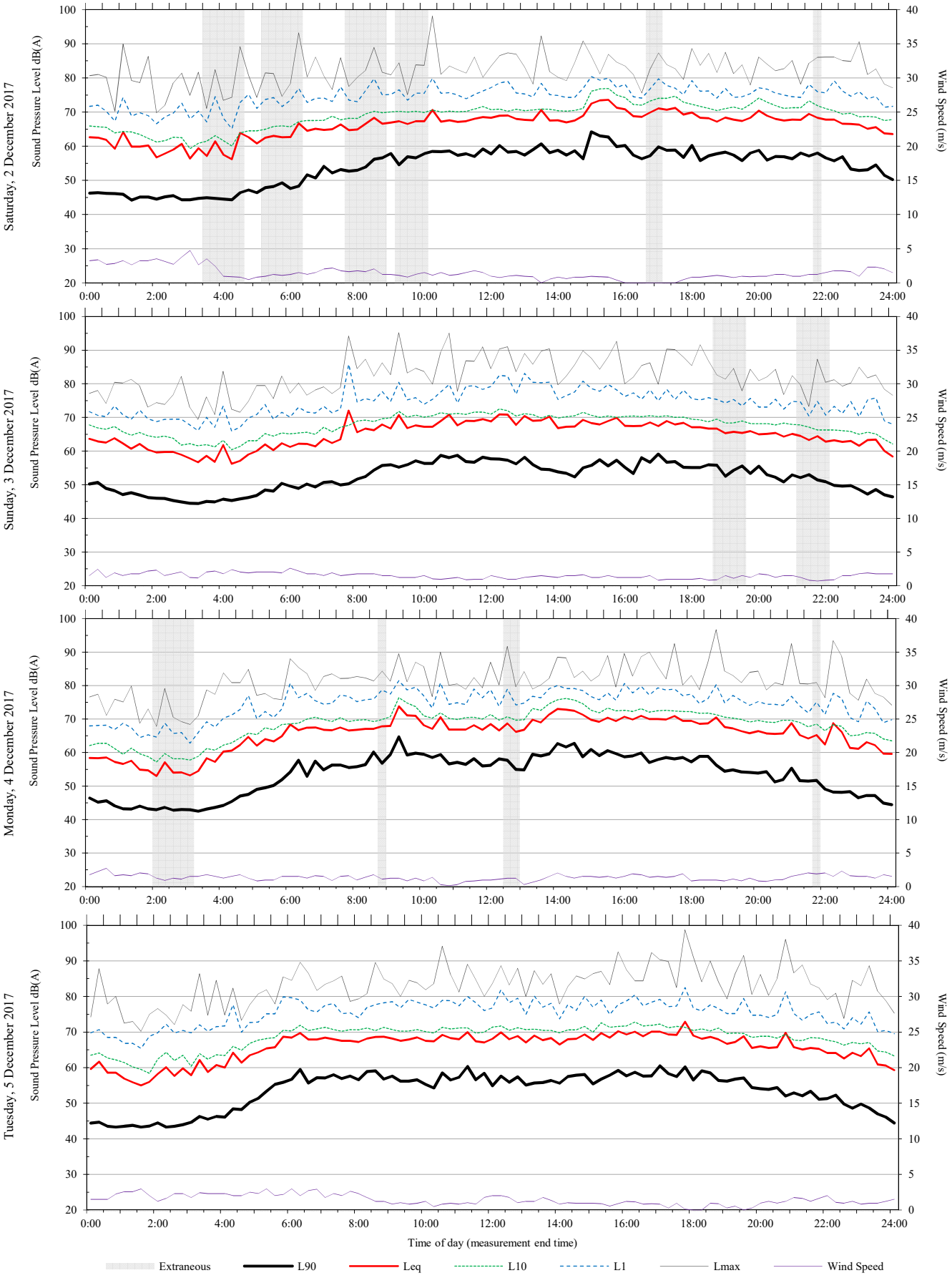

Unattended monitoring: 17 Appin Road (Free Field)

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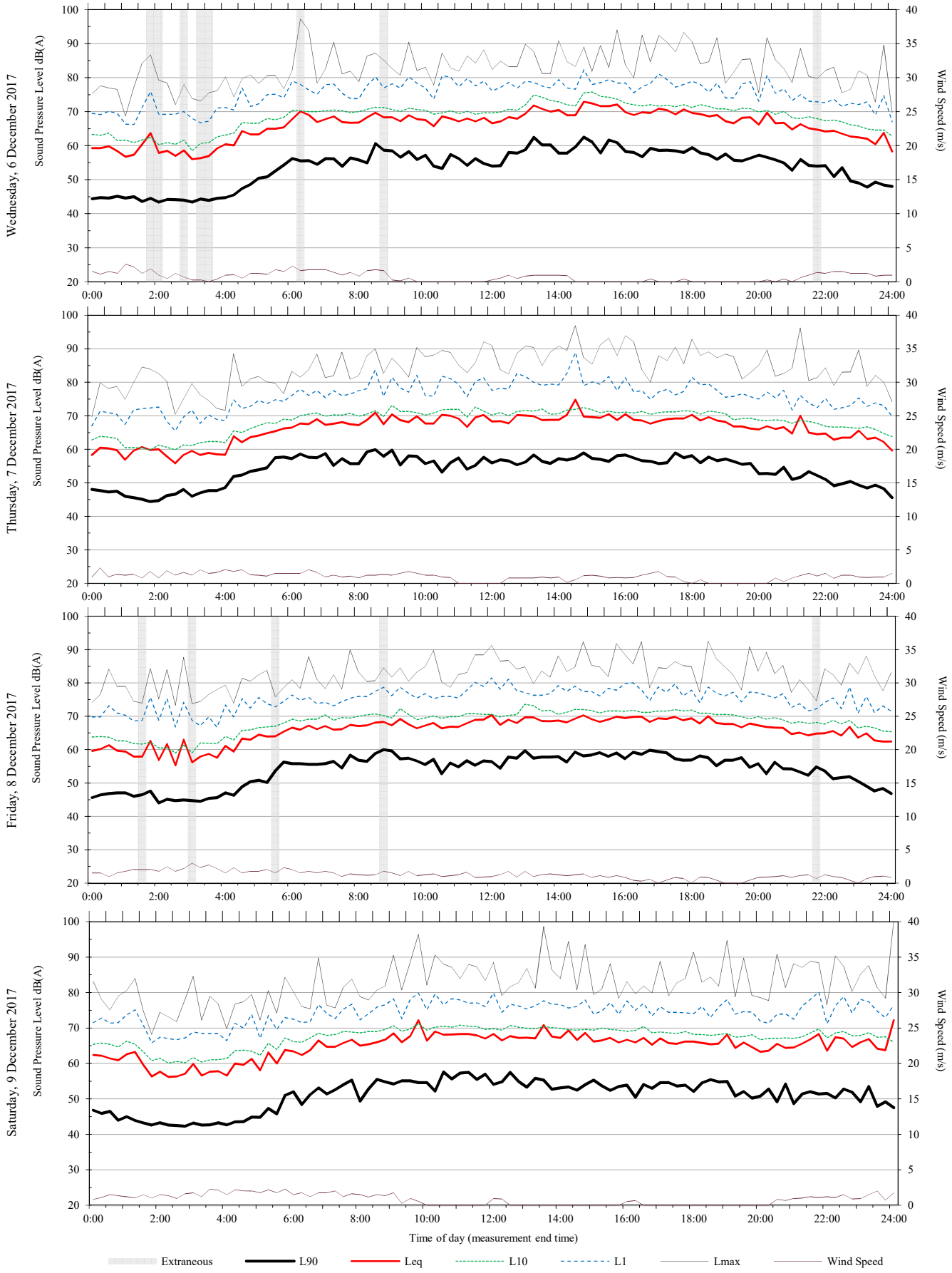

Unattended monitoring: 17 Appin Road (Free Field)

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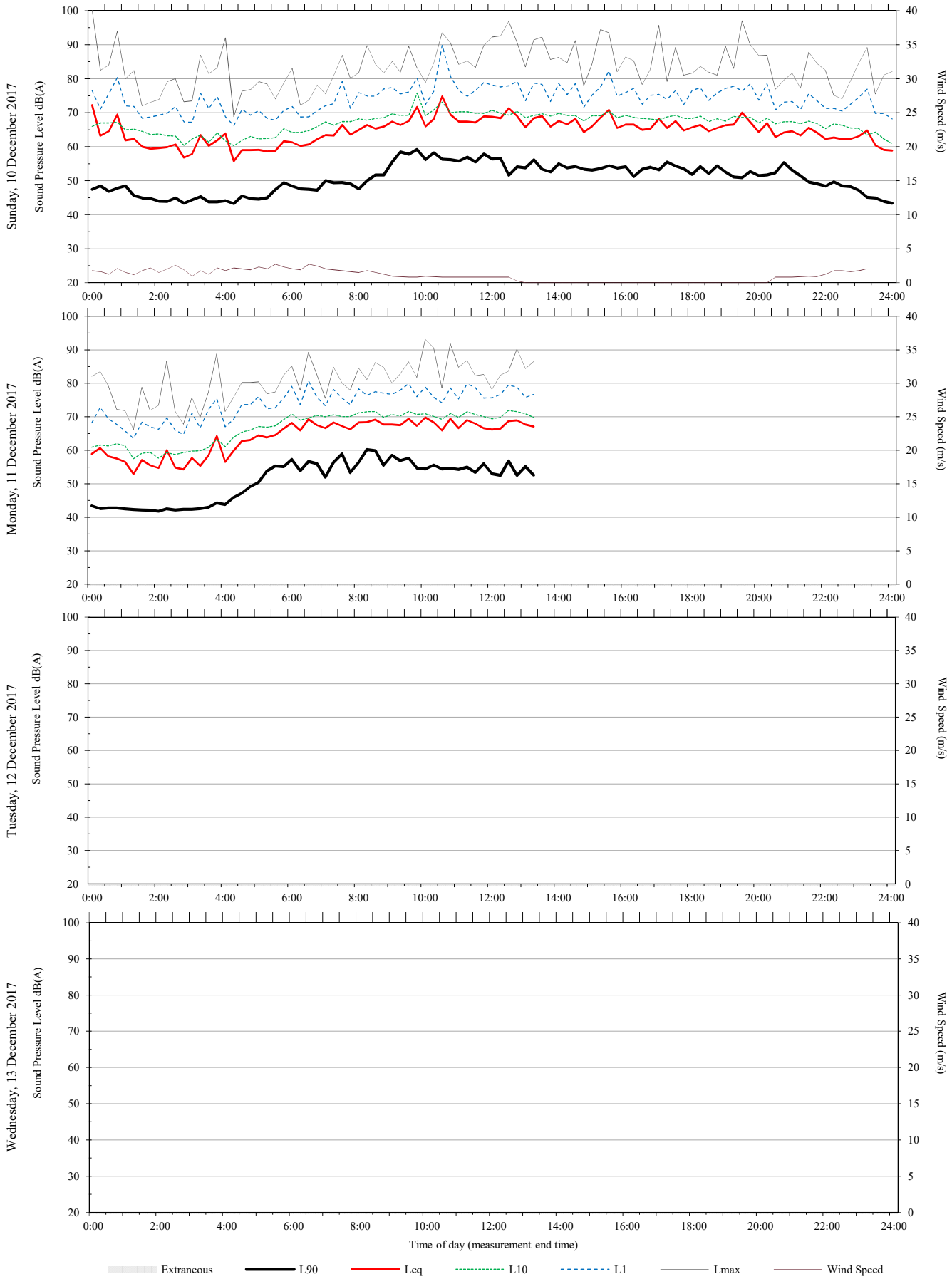


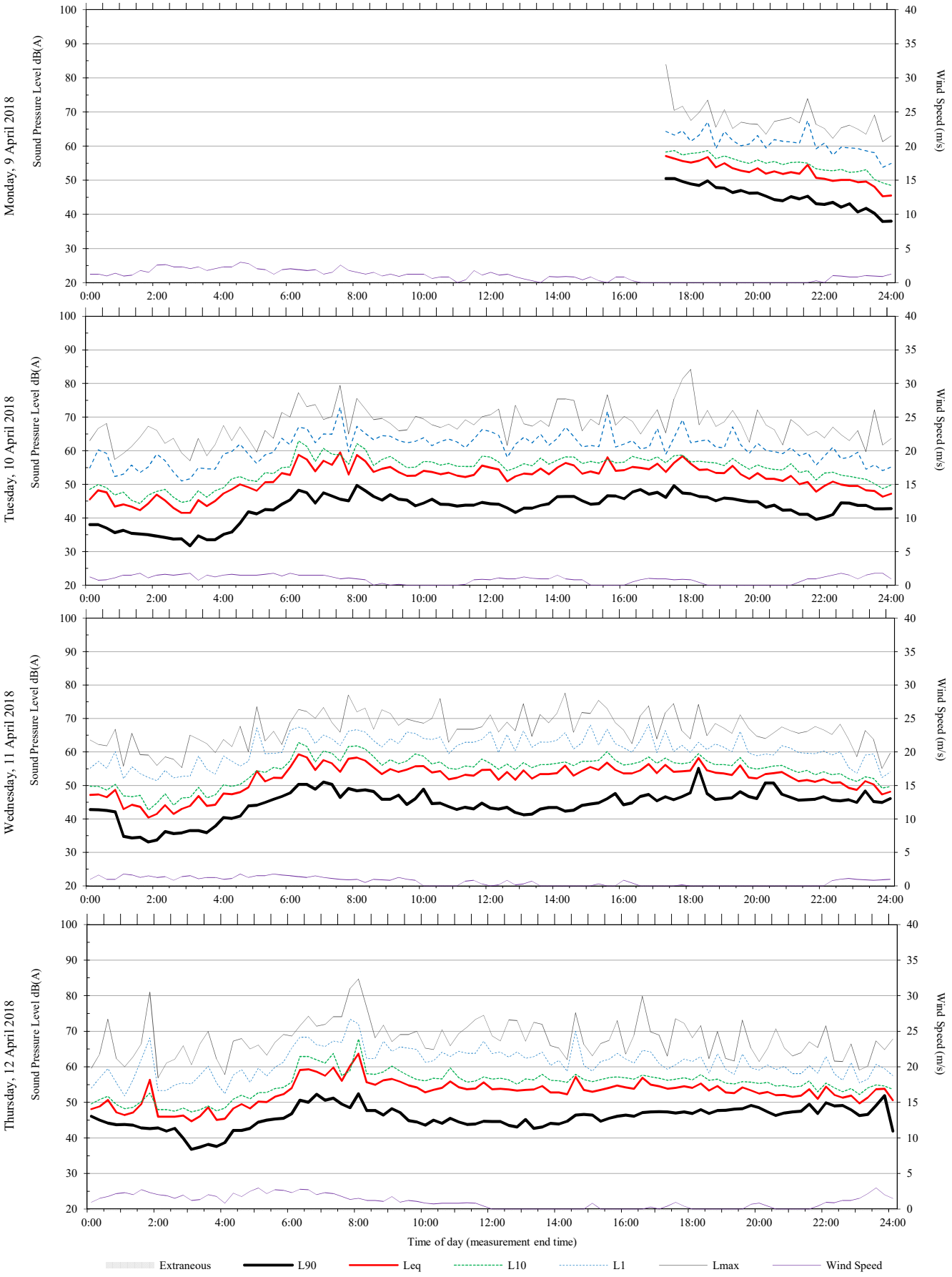
ML3 – 12 Fern Avenue, Bradbury

Date	**L_{A90} Background noise levels, dB(A)[4]**			**L_{Aeq} Ambient noise levels, dB(A)**		
	Day[1]	**Eve[2]**	**Night[3]**	**Day[1]**	**Eve[2]**	**Night[3]**
Monday-09-April-2018	-	43	34	-	54	51
Tuesday-10-April-2018	44	40	35	55	53	51
Wednesday-11-April-2018	43	46	38	55	54	52
Thursday-12-April-2018	44	47	41	56	53	52
Friday-13-April-2018	44	45	39	54	52	49
Saturday-14-April-2018	46	44	35	56	54	52
Sunday-15-April-2018	47	41	34	56	51	50
Monday-16-April-2018	46	43	32	56	52	51
Tuesday-17-April-2018	45	41	31	55	52	51
Representative Weekday[5]	**44**	**43**	**35**	**55**	**53**	**51**
Representative Weekend[5]	**46**	**42**	**34**	**56**	**52**	**51**
Representative Week[5]	**45**	**43**	**35**	**55**	**53**	**51**

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Eve is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

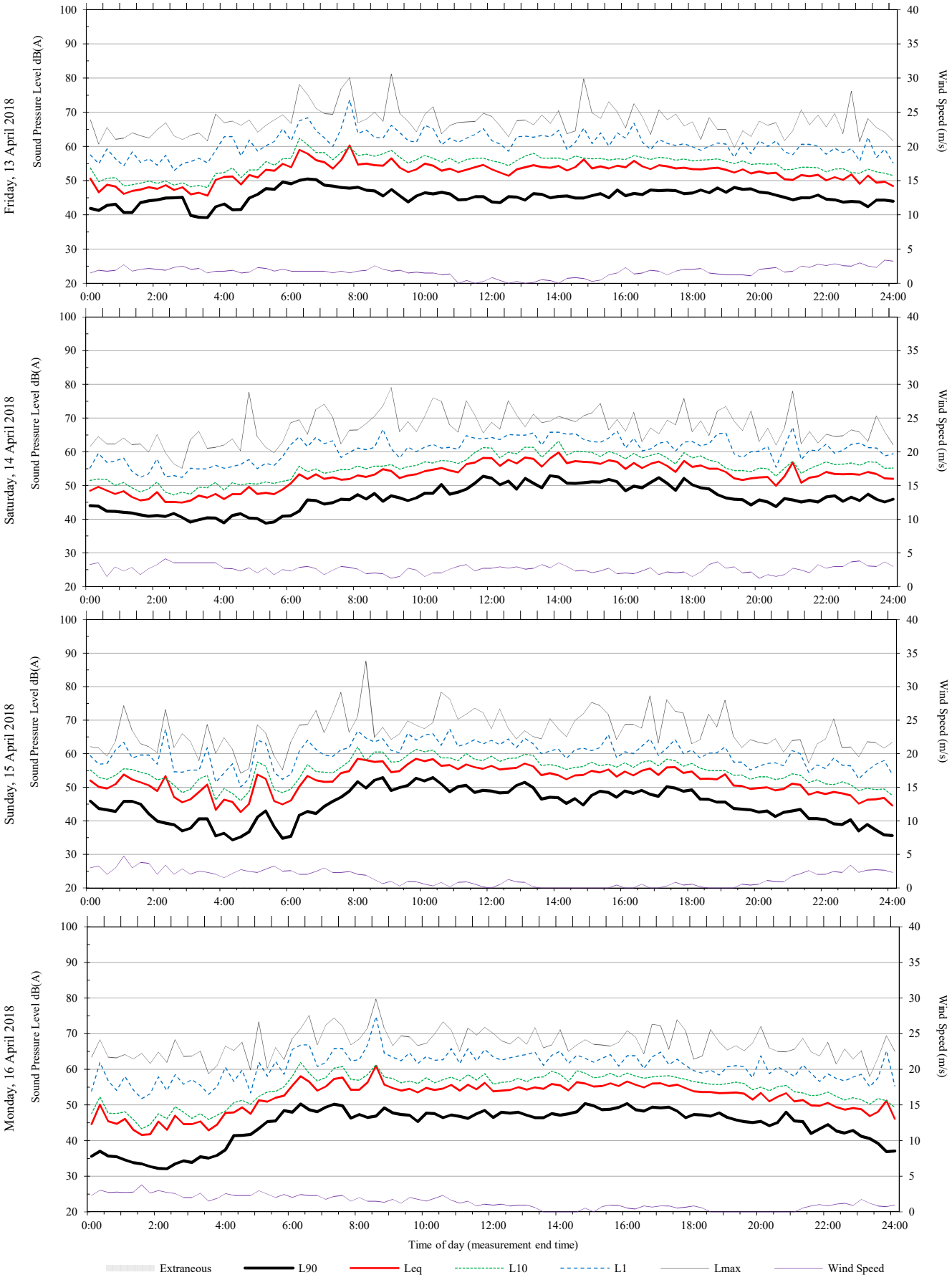
Unattended monitoring: 12 Fern Avenue (Free Field)

ARUP



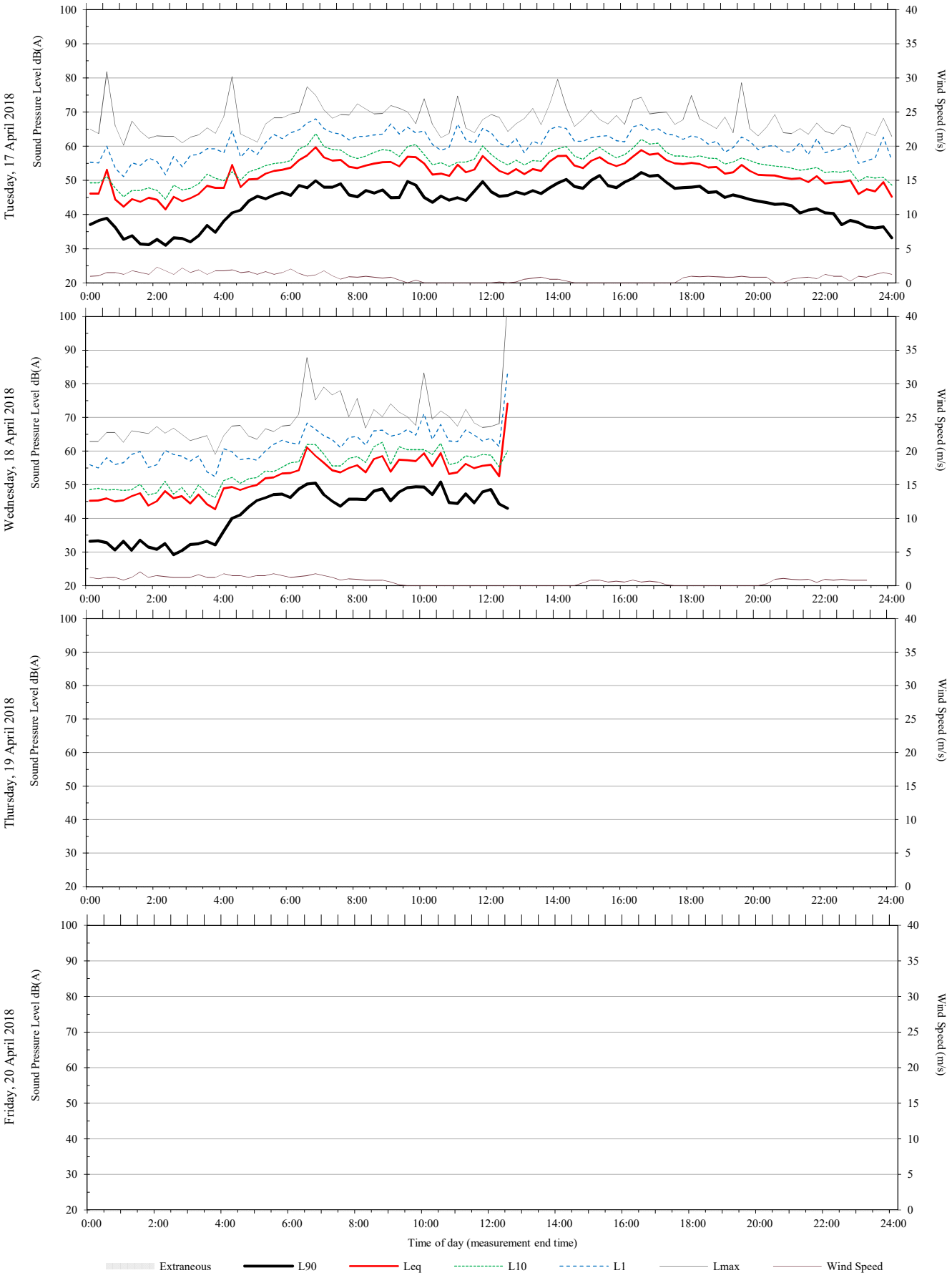
Unattended monitoring: 12 Fern Avenue (Free Field)

ARUP



Unattended monitoring: 12 Fern Avenue (Free Field)

ARUP



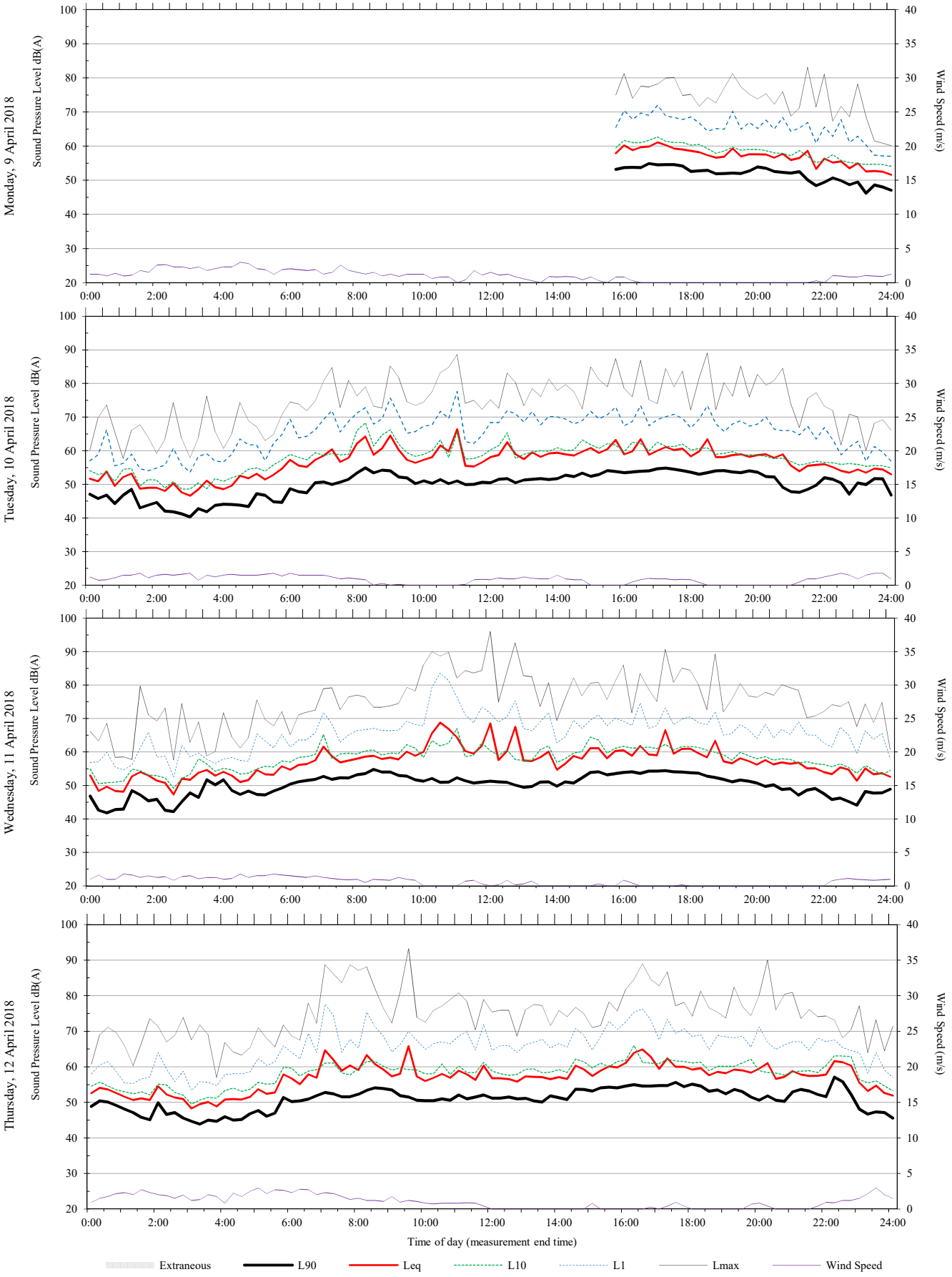
ML4 – Unit 4/31-33 Georgiana Crescent, Campbelltown

Date	**L_{A90} Background noise levels, dB(A)[4]**			**L_{Aeq} Ambient noise levels, dB(A)**		
	Day[1]	**Eve[2]**	**Night[3]**	**Day[1]**	**Eve[2]**	**Night[3]**
Monday-09-April-2018	-	49	42	-	57	53
Tuesday-10-April-2018	50	48	43	60	59	54
Wednesday-11-April-2018	51	48	45	62	58	55
Thursday-12-April-2018	51	51	44	60	59	56
Friday-13-April-2018	51	45	42	61	58	58
Saturday-14-April-2018	52	47	38	61	57	52
Sunday-15-April-2018	51	44	39	60	55	53
Monday-16-April-2018	51	45	-	61	57	-
Representative Weekday[5]	**51**	**48**	**43**	**61**	**58**	**55**
Representative Weekend[5]	**51**	**45**	**39**	**60**	**56**	**53**
Representative Week[5]	**51**	**47**	**42**	**61**	**57**	**55**

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Eve is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

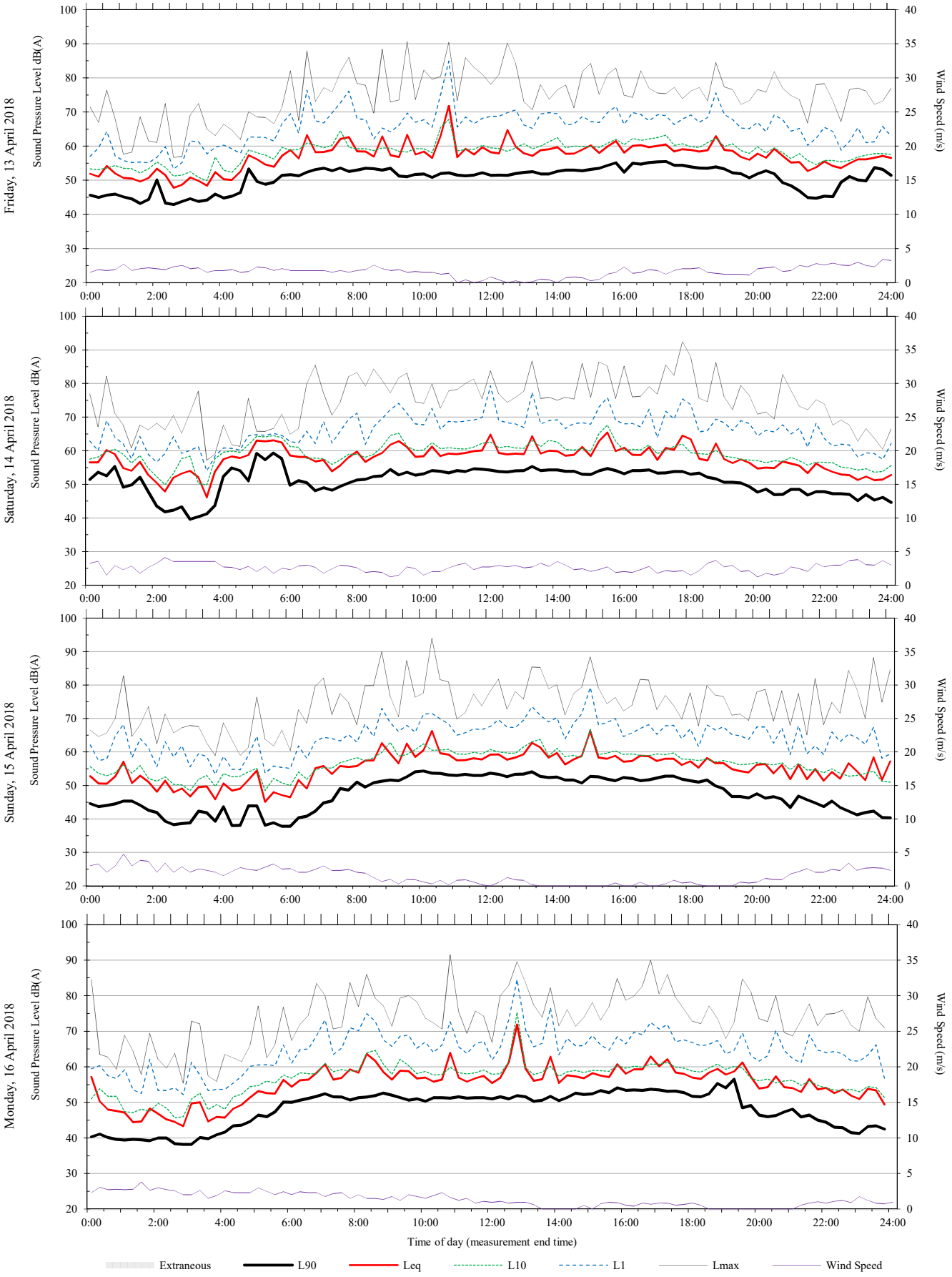
Unattended monitoring: U4 31-33 Georgiana Crescent (Free Field)

ARUP



Unattended monitoring: U4 31-33 Georgiana Crescent (Free Field)

ARUP



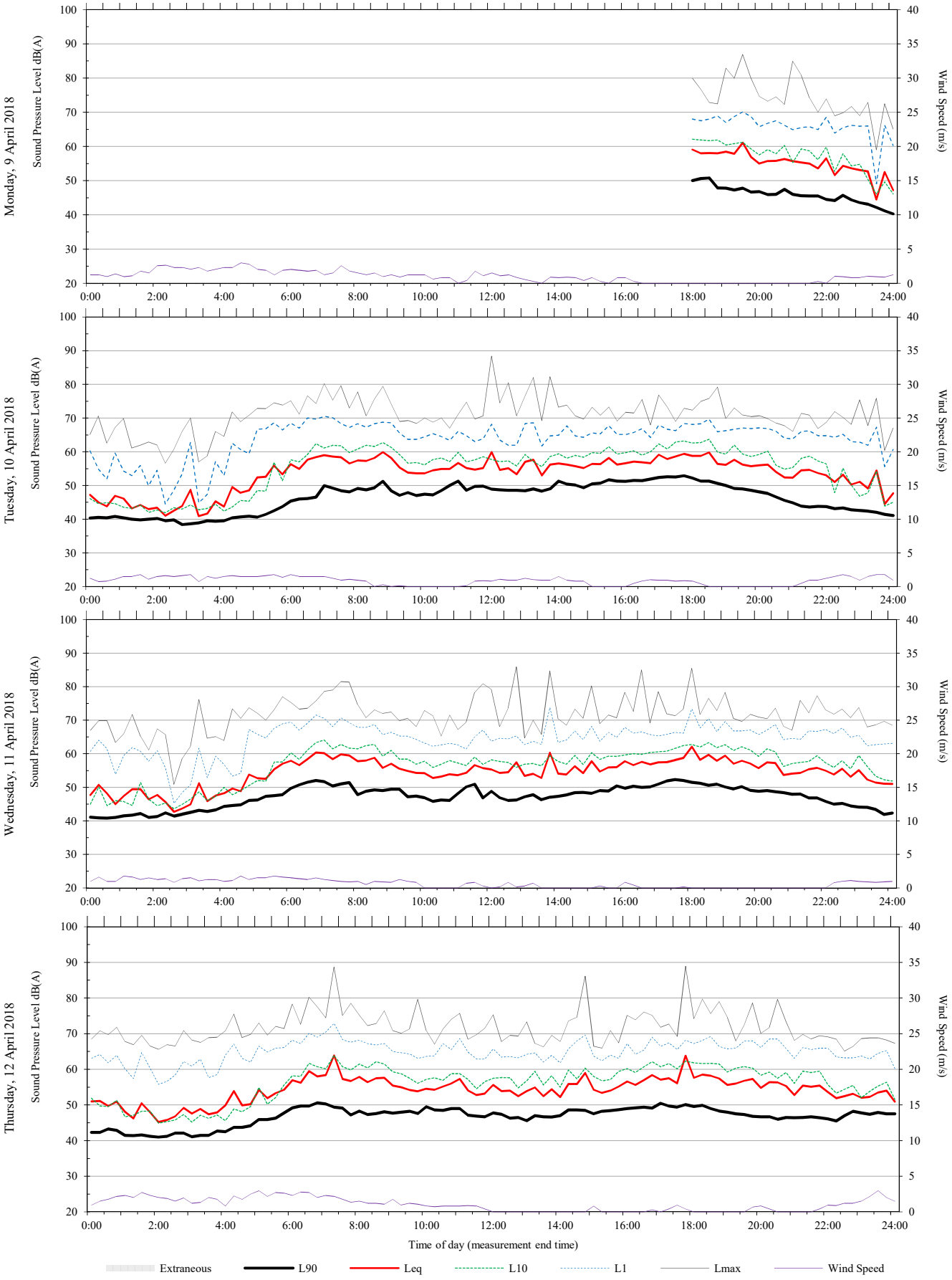
ML5 – 22 Parkside Crescent, Campbelltown

Date	**L_{A90} Background noise levels, dB(A)[4]**			**L_{Aeq} Ambient noise levels, dB(A)**		
	Day[1]	**Eve[2]**	**Night[3]**	**Day[1]**	**Eve[2]**	**Night[3]**
Monday-09-April-2018	-	46	39	-	57	52
Tuesday-10-April-2018	48	44	41	57	56	53
Wednesday-11-April-2018	46	47	41	57	57	53
Thursday-12-April-2018	47	46	44	57	56	54
Friday-13-April-2018	46	43	39	57	60	60
Saturday-14-April-2018	47	44	39	58	60	52
Sunday-15-April-2018	45	43	40	58	55	56
Monday-16-April-2018	46	43	-	57	55	-
Representative Weekday[5]	**46**	**45**	**41**	**57**	**57**	**55**
Representative Weekend[5]	**46**	**43**	**40**	**58**	**58**	**54**
Representative Week[5]	**46**	**44**	**40**	**57**	**57**	**55**

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Eve is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

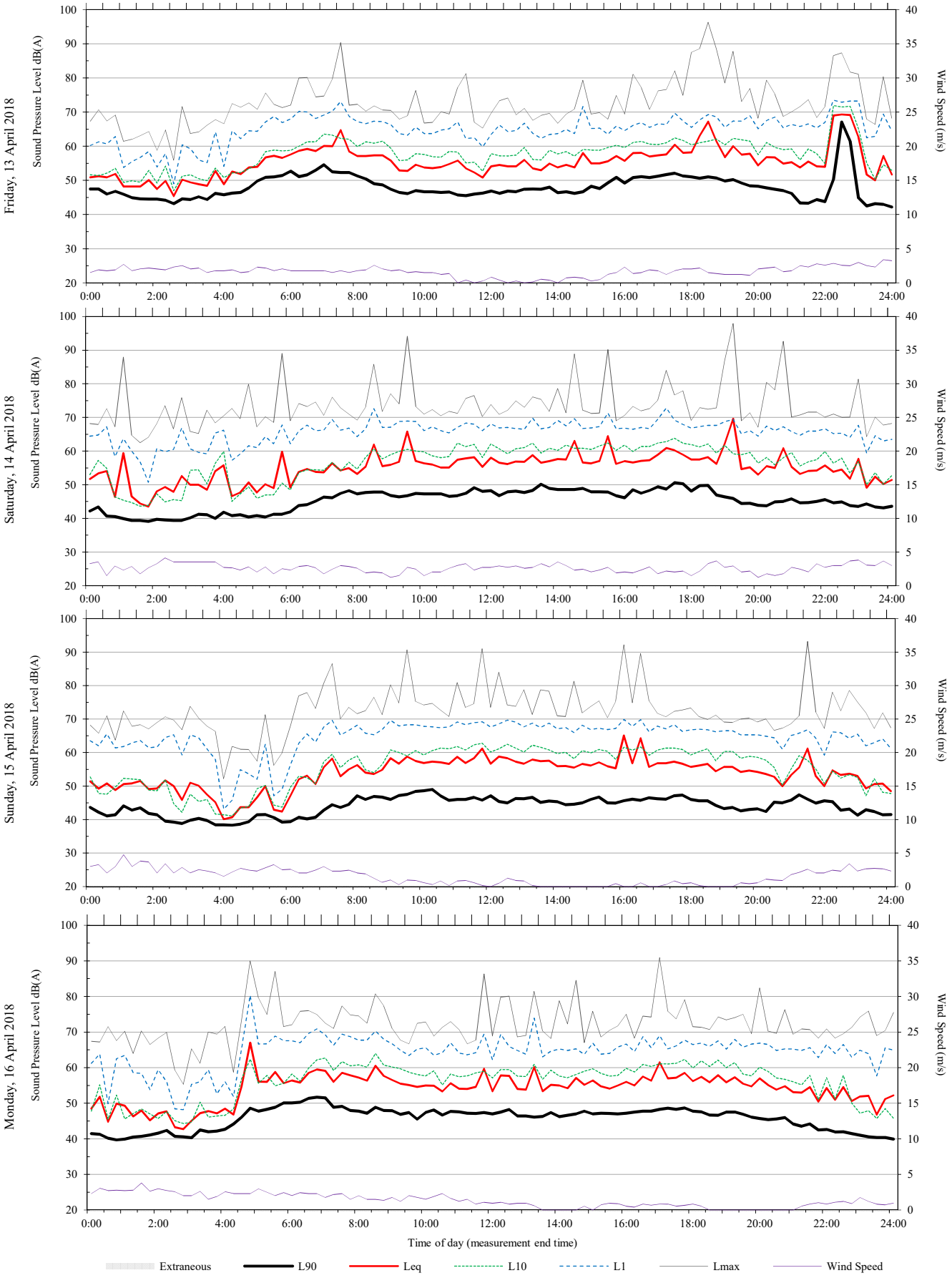
Unattended monitoring: 22 Parkside Crescent (Free Field)

ARUP



Unattended monitoring: 22 Parkside Crescent (Free Field)

ARUP



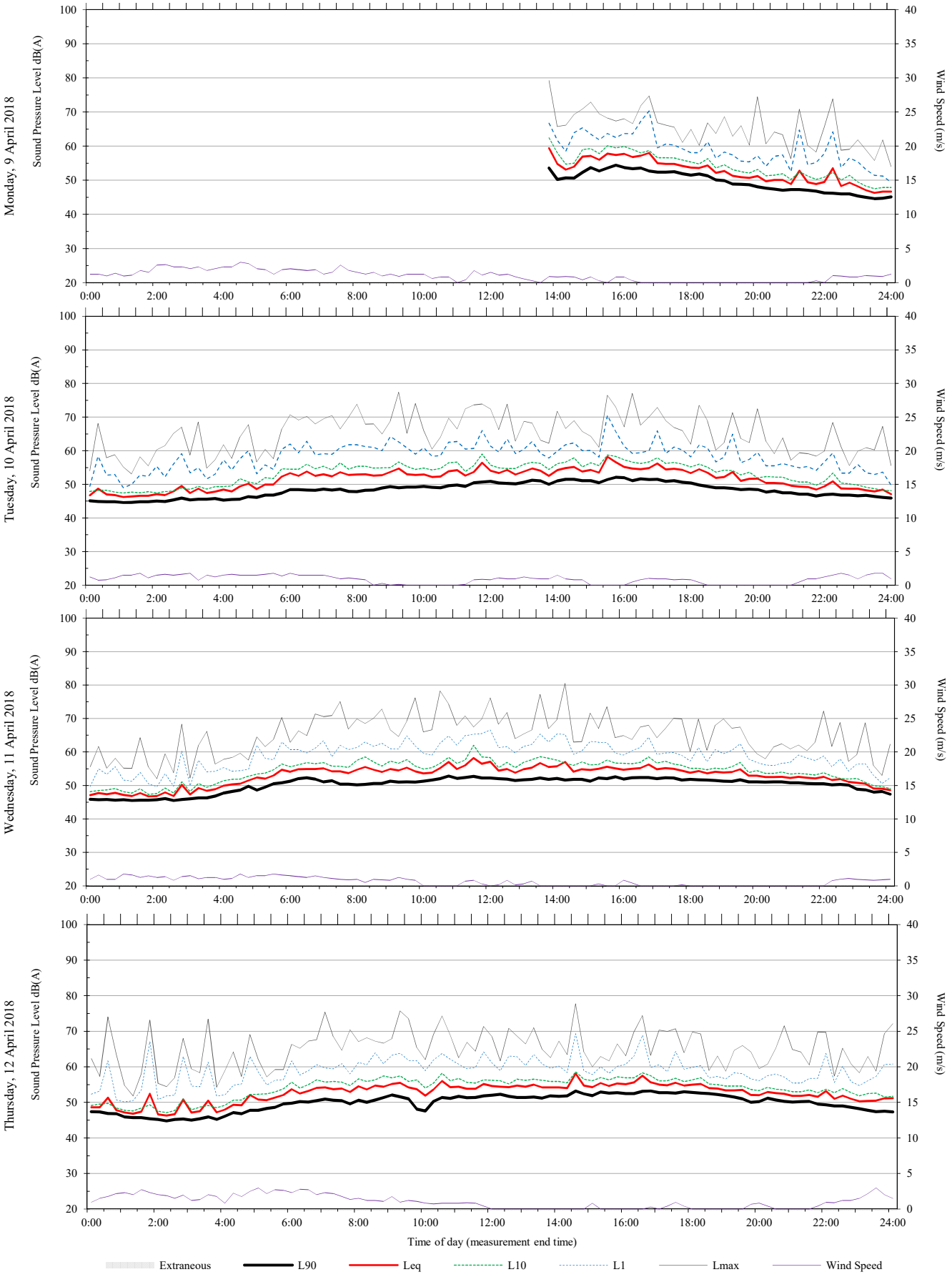
ML6 – 100 Parkside Crescent, Campbelltown (Campbelltown Hospital near CP5)

Date	**L_{Aeq} Noise levels**		**$L_{Aeq\ 1hr}$ Noise levels (upper 10th percentile)**	
	Day[1]	**Night[2]**	**Day**	**Night**
Monday-29-January-2018	55	50	58	53
Tuesday-30-January-2018	54	51	55	55
Wednesday-31-January-2018	55	51	56	54
Thursday-01-February-2018	54	53	56	56
Friday-02-February-2018	55	50	57	53
Saturday-03-February-2018	58	54	62	57
Sunday-04-February-2018	56	51	59	55
Monday-05-February-2018	54	51	56	57
Tuesday-06-February-2018	53	49	54	54
Representative Weekday[3]	**54**	**51**	**55**	**55**
Representative Weekend[3]	**57**	**52**	**60**	**56**
Representative Week[3]	**55**	**51**	**57**	**55**

1. Day is 7:00am to 10:00pm
2. Night is 10:00pm to 7:00am
3. Logarithmic average of daily L_{Aeq}

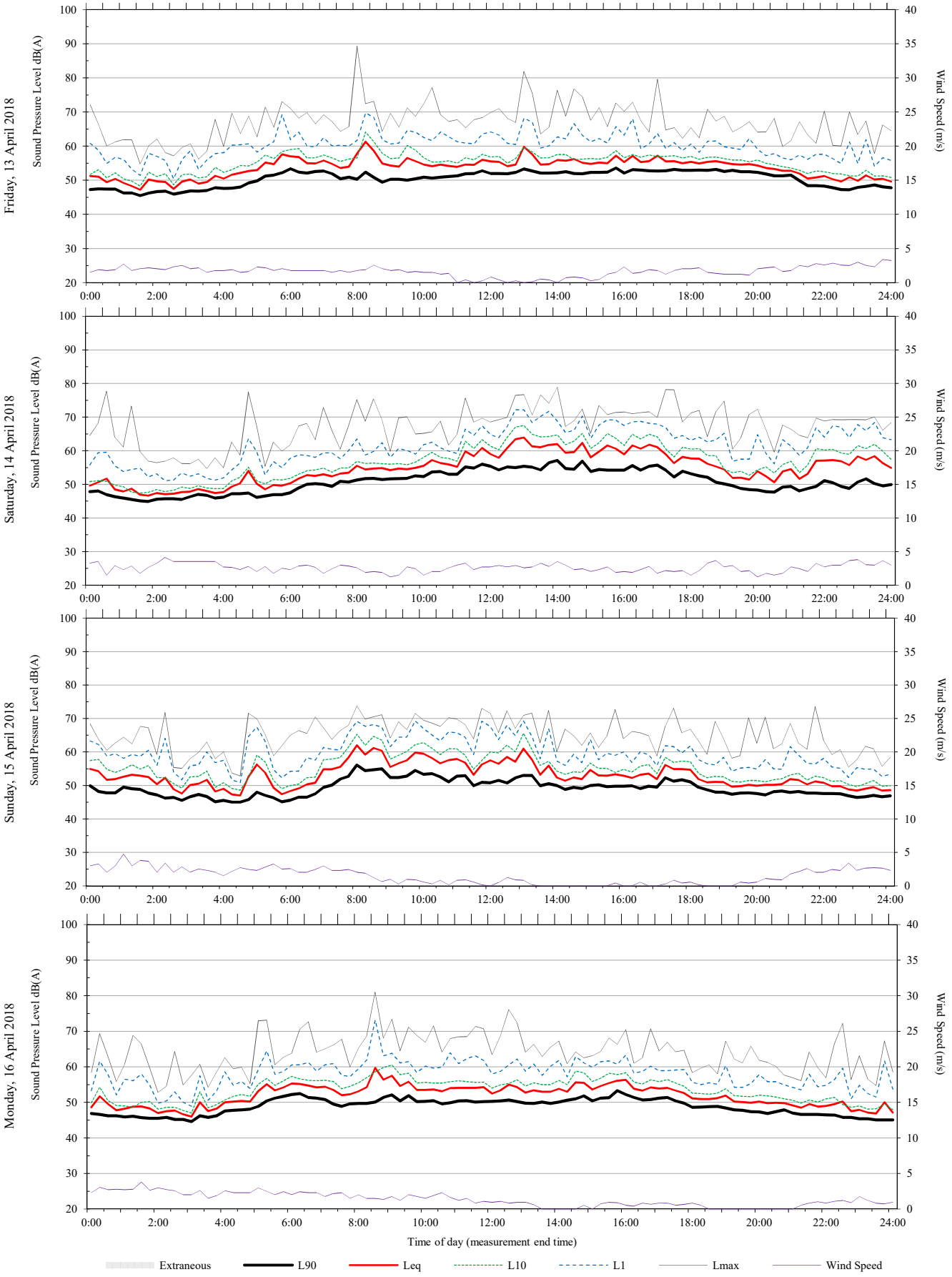
Unattended monitoring: 100 Parkside Cres (Campbelltown Hospital near CP5) (Free Field)

ARUP



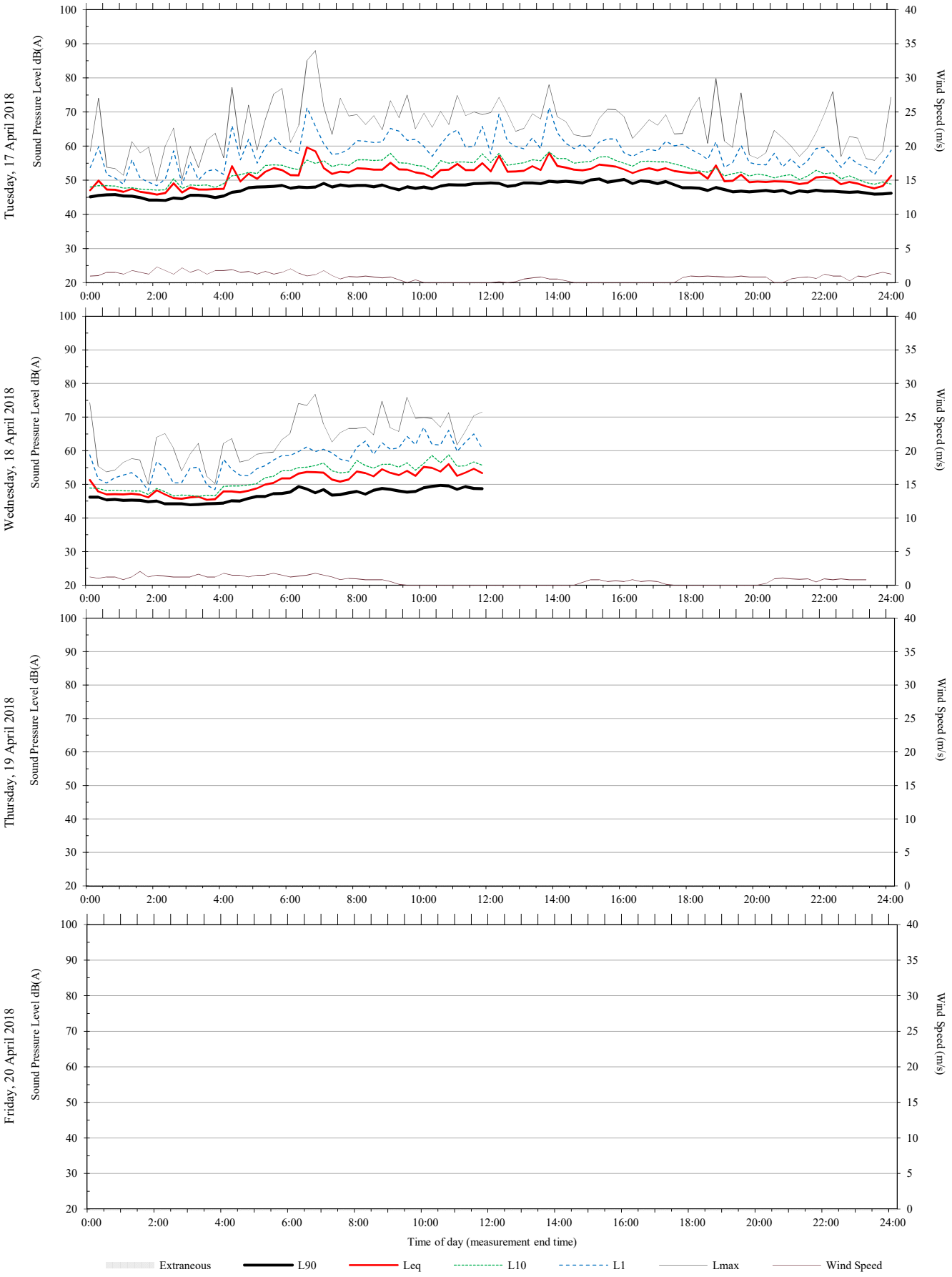
Unattended monitoring: 100 Parkside Cres (Campbelltown Hospital near CP5) (Free Field)

ARUP



Unattended monitoring: 100 Parkside Cres (Campbelltown Hospital near CP5) (Free Field)

ARUP



Appendix C

Building services summary

C1 Mechanical services

Table 26 summarise mechanical plant and equipment concerning Building 1.

Table 26: Major equipment schedule—Building 1

Item of Equipment	Quantity[1]	Location[1]
Air handling unit	127	TBC
Conditioner water pump	6	Level 3
Chiller	6	Level 3
Chilled water primary pump	6	Level 3
Air compressor	2	Level 3 plant
Cooling tower	3	Level 9 MH
Computer room air conditioner	2	TBC
Exhaust air fan	60	Roof and level 3 plant
Fan coil unit	121	On floor
Heating hot water units	6	Level 1
Heating hot water air/dirt separator	1	Level 1
Heating hot water primary pump	5	Level 1
Heating hot water secondary pump	8	Level 1
Kitchen exhaust fan	1	Roof
Outdoor condenser units	11	Level 00, Level 3 and Roof
Relief/return air fan	127	TBC
Smoke exhaust fan	8	Roof
Stair pressurisation fan	8	Roof
Steam boilers	2	Level 1
Suction air	15	Level 3 plant
Toilet exhaust fan	9	Level 3 and roof

Note:
1 – to be confirmed

Table 27 summarise new mechanical plant and equipment concerning existing buildings and Hospital Street.

Table 27: Major equipment schedule—Existing Buildings and Hospital Street

Item of Equipment	Quantity	Location
Building A		
Air handling unit	3	Level 2
Relief/return air fan	3	Level 2

Item of Equipment	Quantity	Location
Building A		
Building B		
Supply air fan	1	Level 1
Building D		
Air handling unit	4	TBC
Relief/return air fan	4	TBC
Cancer Therapy Centre (CTC)		
Air handling unit	4	CTC plant
Relief/return air fan	1	CTC plant
Exhaust air fan	4	CTC plant
Toilet exhaust fan	1	CTC plant
Chiller	1	CTC plant
Chilled water primary pump	4	CTC plant
Hospital Street		
Smoke exhaust fan	1	TBC
Air handling unit	1	TBC
Relief/return air fan	1	TBC

Note:
1 – to be confirmed

C2 Electrical services

Table 28 summarise electrical plant and equipment concerning Building 1. The current strategy surrounding existing hospital buildings is to reuse the existing diesel generators.

Table 28: Major equipment schedule—Building 1

Item of Equipment	Quantity	Location
Diesel generator	2	Level 3 plant

Note:
1 – to be confirmed

C3 Hydraulic services

Table 29 summarise electrical plant and equipment concerning Building 1. In addition to the below, some circulation pumps for hot water and RO[2] water are

[2] Reverse osmosis

expected to be introduced, however these pumps are not considered to be primary noise generating equipment.

Table 29: Major equipment schedule—Building 1

Item of Equipment	Quantity	Location
Diesel pump	2	Level 3 – adjacent FCR[1]
Electric fire services pump	2	Level 3 – adjacent FCR[1]
Electric potable water service (duplex) transfer pump	1	Level 3 – plant area
Potable water service (triplex) pressure pump	1	Roof – plant area
Fire services pump	1	Roof – plant area

Note:

1 – Fire Control Room