Wagga Wagga Base Hospital - Stage 3 Redevelopment

SSD Application - Acoustic Assessment

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TABLE OF CONTENTS

1 INTRODUCTION

Acoustic Logic Consultancy (ALC) have been engaged by Health Infrastructure NSW (HI) to undertake an assessment of potential noise and vibration impacts resulting from the proposed Stage 3 development of the Wagga Wagga Base Hospital redevelopment project.

This report will:

- Address relevant SEAR's and the NSW Environmental Protection Authority's (EPA) noise and vibration criteria, applicable to the subject proposal.

- Identify nearby noise and vibration sensitive receivers and anticipated operational and construction noise and vibration sources with the potential to adversely impact these receivers.

- Conduct a preliminary assessment of potential impacts and where required, determine building and/or management controls necessary to reduce impacts and ensure compliance.

The following legislative documents have been referenced;

- NSW Department of Planning (DoP) Secretary's Environmental Assessment Requirements (SEAR) Requirements – SSD 9033.

- NSW DoP *"Development Near Rail Corridors and Busy Roads – Interim Guideline".*

- NSW Environmental Protection Authority (EPA) *Noise Policy for Industry (NPfI) 2017.*

- NSW EPA *Road Noise Policy*.

- NSW EPA *Interim Construction Noise Guideline (ICNG)*.

2 SITE DESCRIPTION AND PROPOSED WORKS

Wagga Wagga Base Hospital is located on the southern site of Edward Street/Stuart Highway, at the intersection of Edward Street and Docker Street. The hospital campus boundary is bounded by Edward Street to the north, Docker Street to the west, Rawson Lane to the south and Murray Street to the east.

In its existing state the hospital campus comprises of on-grade car parking spaces to the north and east of the site. The car park to the east is separated from the site by Lewis Drive which forms the main access to the hospital and through the site. Primary access to the site is from the north, off Edward Street and multiple access points from the east via Doris Roy Lane, Yabtree Street and Yathong Street.

The proposed stage 3 development consists of a six-storey Ambulatory Care Building, including a rooftop Plant Room, all above an undercroft parking level. The Ambulatory Care Building will provide the following Units:

- 28 flexible Aged Care Beds, including 4 dedicated beds for Acute Delirium.
- 24 Rehabilitation beds, including inpatient therapy and ADL facilities shared with the Aged Care and Older Persons Health inpatient units.
- A 24 bed Older Person's Mental Health Inpatient Unit, including 8 T-BASIS beds.
- A 20 chair Renal Dialysis Unit plus 4 training chairs (2 x HD and 2 x peritoneal) collocated with other Extended Hours Services.
- Ambulatory Clinics, Rehabilitation and Allied Health, comprising 60 bookable (electronic patient flow management system) Interview / Consult rooms and Gym / Allied Health treatment spaces. Services accessing this area will include Primary and Community Health, Outpatients, Prosthetics and Orthotics, Mental Health, Drug and Alcohol, and Oral Health services (8 Dental Chairs).
- An education area including library, conference rooms (60 seats total) and a lecture theatre (100 seats).
- Extended Hours Services including Hospital in the Home, Integrated Care, Rapid Assessment Clinic, After Hours GP, and Infusions using 10 treatment spaces and 6 consultation rooms and shared support areas with renal dialysis.
- Workforce and office accommodation will be provided for staff associated with Stage 3, refined through New Ways of Working (NWW).
- The NWW assessment will be also extended to Support Services staff, including Patient Flow, IT, Health Share, Health Information Services, Pastoral Care and Volunteer Services.

2.1 SURROUNDING AFFECTED RECEIVERS

The hospital precinct largely encompasses residential properties with local road networks carrying low to medium volumes of traffic. Stuart Highway/Edward Street is the major road corridor adjoining the hospital campus site to the north and carries medium to high volumes of traffic.

The surrounding potentially affected receivers as a result of the proposed stage 3 development are presented below;

- Existing residential properties to the west, across Docker Street.
- Existing residential properties to the east, along Doris Roy Lane and Yabtree Street.
- The Heritage Motor Inn.

Figures 1 and 2 below illustrates locations of unattended noise monitor, attended noise measurements, hospital campus overall site and proposed stage 3 site and surrounding sensitive land uses.

Figure 1 – Site Description (source: Google Maps)

Figure 2 – Proposed Stage 3 Development

3 NOISE DESCRIPTORS

Environmental noise constantly varies. Accordingly, it is not possible to accurately determine prevailing environmental noise conditions by measuring a single, instantaneous noise level.

To accurately determine the environmental noise a 15-20 minute measurement interval is utilised. Over this period, noise levels are monitored on a continuous basis and statistical and integrating techniques are used to determine noise description parameters.

In analysing environmental noise, three-principle measurement parameters are used, namely L_{10}, L_{90} and L_{eq}.

The L_{10} and L_{90} measurement parameters are statistical levels that represent the average maximum and average minimum noise levels respectively, over the measurement intervals.

The L_{10} parameter is commonly used to measure noise produced by a particular intrusive noise source since it represents the average of the loudest noise levels produced by the source.

Conversely, the L_{90} level (which is commonly referred to as the background noise level) represents the noise level heard in the quieter periods during a measurement interval. The L_{90} parameter is used to set the allowable noise level for new, potentially intrusive noise sources since the disturbance caused by the new source will depend on how audible it is above the pre-existing noise environment, particularly during quiet periods, as represented by the L_{90} level.

The L_{eq} parameter represents the average noise energy during a measurement period. This parameter is derived by integrating the noise levels measured over the 15-minute period. L_{eq} is important in the assessment of traffic noise impact as it closely corresponds with human perception of a changing noise environment; such is the character of environmental noise.

4 EXISTING ACOUSTIC ENVIRONMENT

Unattended long-term monitoring and attended short term measurements were conducted within and around the hospital precinct, to quantify the existing acoustic environment.

4.1 UNATTENDED NOISE MONITORING

Unattended noise monitoring was conducted using two Acoustic Research Laboratories noise monitors. The monitors were set to an A-weighted fast response mode, recording continuously at 15-minute intervals. Both monitors were calibrated at the start and end of the monitoring period using a Rion NC-73 calibrator. No significant drift was noted. Monitoring was conducted as follows;

- **Monitor 1** – Installed in the backyard of the residential property at 1 Yathong Street, along the northern boundary. Background noise levels measured by this logger are representative of ambient noise levels at the residential receivers to the east of the hospital precinct. This monitoring was conducted prior to the commencement of the operations of the new Acute hospital building, with all mechanical plant/equipment associated with this building not in operation during the monitoring period. The noise monitor was installed on site between the 6th – 12th October 2015. Refer to Appendix 1 for this logging data.

- **Monitor 2** – Installed in the frontyard of the residential property at 32 Docker Street, along the eastern boundary. Background noise levels measured by this logger are representative of ambient noise levels at the residential receivers to the west of the hospital precinct. The noise monitor was installed on site between the 15th – 22nd May 2018. Refer to Appendix 2 for this logging data. Refer to Appendix 3 for photographs of monitor location.

4.1.1 Monitoring Results

Background noise levels measured by both the noise monitors are detailed below.

Table 1 – Measured Ambient and Background Noise Levels along Yathong Lane (Monitor 1)

Date	Measured Rating Background Noise Level dB(A)$L_{90(period)}$			Measured Ambient Noise Level dB(A)$L_{eq(period)}$		
	Daytime (7am-6pm)	Evening (6pm-10pm)	Night (10pm-7am)	Daytime (7am-6pm)	Evening (6pm-10pm)	Night (10pm-7am)
06/10/2015	-	37	-	-	47	-
07/10/2015	45	41	36	49	48	47
08/10/2015	45	43	37	50	49	46
09/10/2015	46	41	40	52	47	46
10/10/2015	43	41	37	50	49	43
11/10/2015	39	41	36	48	47	43
12/10/2015	-	-	36	-	-	44
	MEDIAN			**AVERAGE**		
	45	**41**	**36**	**50**	**48**	**45**

Section 3.4 of the NSW Environment Protection Authority (EPA) Industrial Noise Policy document outlines the following with regards to meteorological impacts on noise monitoring:

"Noise monitoring should not be conducted (or the data should be excluded) when average wind speeds (over 15-minute periods or shorter) at microphone height are greater than 5 m/s, or when rainfall occurs."

However, the same section of this policy also outlines that;

"Exceptions to this rule are allowed, provided the proponent is able to show that the wind-induced noise on the microphone, and sound levels due to rain, are at least 10 dB below the noise levels (that is, background and/or ambient) under investigation."

Weather conditions during the monitoring period have been assessed and the periods of inclement weather are highlighted in the logging data in Appendices 1.

- Little to no rain was recorded during the monitoring period. Five events were noted in total all on the 11 October, and the subsequent 15-minuite measurements were excluded from the data.

- On review of the monitoring data, the measured L_{90} noise levels during high wind speed days generally do not increase background noise levels significantly as periods with little to no wind. This demonstrates that even though wind speeds measured at Wagga Airport exceed EPA guidelines, either:

    - The wind speed on site at this time was significantly lower than at Wagga Airport (which is likely given the weather station at Wagg Airport is located on an empty field, whilst the site is a built-up area) and/or

    - The wind on site was not sufficiently consistent to increase background noise levels compared to calm periods.

Nevertheless, periods where it appears that adverse weather have affected the noise monitoring data have been eliminated when determining the rating background noise level at the site, which is presented in the section above. For example,

Table 2 – Comparing Weather Affected Data with non-affected Data (Monitor 1)

Time	Wind Affected Data (6 October 2015)		Clear Data (8 October 2015)		Difference	
	$L_{eq(15mins)}$	$L_{90(15mins)}$	$L_{eq(15mins)}$	$L_{90(15mins)}$	$L_{eq(15mins)}$	$L_{90(15mins)}$
14:30	48	43	48	44	1	-2
14:45	48	46	51	44	-3	1
15:00	49	46	48	45	0	1
15:15	51	46	50	44	1	1
15:30	52	49	49	44	4*	5*
15:45	54	50	49	45	5*	5*
16:00	55	50	49	44	6*	6*
16:15	53	50	50	45	3*	5*
16:30	53	49	50	45	3*	4*
16:45	53	49	50	45	2	4*
17:00	52	48	51	46	1	3*
17:15	53	49	51	47	2	3*
17:30	52	49	49	45	3*	3*

* Level not used as it is affected by adverse weather conditions.

Table 3 – Measured Ambient and Background Noise Levels along Docker Street (Monitor 2)

Date	Measured Rating Background Noise Level dB(A)$L_{90(period)}$			Measured Ambient Noise Level dB(A)$L_{eq(period)}$		
	Daytime (7am-6pm)	Evening (6pm-10pm)	Night (10pm-7am)	Daytime (7am-6pm)	Evening (6pm-10pm)	Night (10pm-7am)
15/05/2018	-	47	-	-	66	-
16/05/2018	53	48	41	67	65	59
17/05/2018	53	48	41	66	64	61
18/05/2018	53	47	41	67	66	59
19/05/2018	48	45	40	67	65	59
20/05/2018	45	43	41	66	64	59
21/05/2018	53	44	41	67	64	58
22/05/2018	53	-	40	66	-	58
	MEDIAN			AVERAGE		
	53	**47**	**41**	**67**	**65**	**59**

Weather conditions during the monitoring period have been assessed and the periods of inclement weather are highlighted in the logging data in Appendices 2.

- No rain was recorded during the monitoring period.
- On review of the monitoring data, the measured L_{90} noise levels during high wind speed days generally do not increase background noise levels significantly as periods with little to no wind. This demonstrates that even though wind speeds measured at Wagga Airport exceed EPA guidelines, either:
    - The wind speed on site at this time was significantly lower than at Wagga Airport (which is likely given the weather station at Wagg Airport is located on an empty field, whilst the site is a built-up area) and/or
    - The wind on site was not sufficiently consistent to increase background noise levels compared to calm periods.

Nevertheless, periods where it appears that adverse weather have affected the noise monitoring data have been eliminated when determining the rating background noise level at the site, which is presented in the section above. For example;

Table 4 – Comparing Weather Affected Data with non-affected Data (Monitor 2)

Time	Wind Affected Data (21 May 2018)		Clear Data (17 May 2018)		Difference	
	$L_{eq(15mins)}$	$L_{90(15mins)}$	$L_{eq(15mins)}$	$L_{90(15mins)}$	$L_{eq(15mins)}$	$L_{90(15mins)}$
13:30	66	55	65	54	1	1
13:45	66	54	66	54	0	1
14:00	66	53	66	55	0	-2
14:15	67	57	65	52	2	5*
14:30	66	55	65	54	1	1
14:45	67	57	66	55	1	2
15:00	67	57	68	56	0	2
15:15	67	56	66	56	1	0
15:30	68	60	69	56	-1	3*
15:45	66	58	67	56	0	2
16:00	67	58	67	57	0	0
16:15	67	57	67	58	0	-1
16:30	67	55	67	57	0	-2

* Level not used as it is affected by adverse weather conditions.

4.2 ATTENDED NOISE MEASUREMENTS

Attended noise measurements were also conducted at several locations around the site, as illustrated in Figure 1. Measurements were conducted to ascertain the existing acoustic environment.

Attended measurements were obtained using a Norsonics Type 140 Sound Level Analyser. The Sound Level Analyser was calibrated at the beginning and the end of the measurement using a Norsonics Type 1251 Sound Level Calibrator. No significant drift was noted. All measurements were conducted on A-weighted fast response mode. There were no significant periods of adverse weather conditions during the measurement period. The calibration certificate for the sound level meter is attached in Appendix 4.

Measured levels and description of the acoustic environment is detailed below;

Table 5 – Attended Noise Measurements

Measurement Location (see figure 1)	Time of Day	Measured Noise Level	Description
Location 1 – Eastern boundary of 32 Docker Street	Wednesday 23rd May 2018 Between 10am – 12pm	65dB(A)$L_{eq(15mins)}$ 54dB(A)$L_{90(15mins)}$	Measured noise level primarily impacted by traffic noise (constant) along Docker Street. No distinct mechanical noise from Hospital precinct or any other surrounding property noted during the measurement.
Location 2 – Western boundary of hospital precinct (adjacent to Harvey House)		62dB(A) $L_{eq(15mins)}$ 51dB(A) $L_{90(15mins)}$	Measured noise level primarily impacted by traffic noise (constant) along Docker Street. Some impacts from regular pedestrian foot traffic. No distinct mechanical noise from Hospital precinct or any other surrounding property noted during the measurement.
Location 3 – Northern boundary of hospital precinct (approx. 3m from Edward Street)		71dB(A) $L_{eq(15mins)}$ 59dB(A) $L_{90(15mins)}$	Measured noise level primarily impacted by traffic noise (constant) along Edward Street. Some impacts from dogs barking across the road. No distinct mechanical noise from Hospital precinct or any other surrounding property noted during the measurement.
Location 4 – Northern boundary of subject stage of development (adjoining existing hospital carpark)		58dB(A) $L_{eq(15mins)}$ 50dB(A) $L_{90(15mins)}$	Measured noise level primarily impacted by traffic noise (constant) along Edward Street and to a lesser extent vehicles arriving/departing hospital carpark. Some impacts flights flying overhead and pedestrian foot traffic. No distinct mechanical noise from Hospital precinct or any other surrounding property noted during the measurement.
Location 5 – Doris Roy Lane (Heritage Motor Inn)		55dB(A)$L_{eq(15mins)}$ 44dB(A)$L_{90(15mins)}$	Measured noise level primarily impacted by some vehicle movements along Doris Roy Lane. Birds chirping also noted. Faint mechanical hum noted from Heritage Motor in direction and also hospital.

5 EXTERNAL NOISE (TRAFFIC) IMPACT ASSESSMENT

Traffic noise from vehicle movements primarily along Sturt Highway/Edward Street and to a lesser extent along Docker Street, will be external noise sources with the potential to impact on the amenity of future receivers within the proposed stage 3 development.

5.1 ASSESSMENT CRITERIA

5.1.1 NSW Department of Planning (DoP) *"Development Near Rail Corridors and Busy Roads – Interim Guideline"*

Section 3.6.1 of this guideline nominates recommended maximum internal noise level criteria for non-residential buildings, with the relevant criteria detailed below.

Table 6 – DoP Recommended Maximum Internal Noise Level Criteria

Type of Occupancy		Time of Day	Recommended Noise Level dB(A)L_{eq}
Hospitals	Wards	When in use	35
	Any other noise sensitive areas		45

5.2 RECOMMENDED TREATMENTS

Architectural design is not finalised at this early stage. However, based on the measured traffic noise levels on site, ALC confirm that compliance with the recommended maximum internal noise level criteria detailed in Table 3 above can be achieved, with the following minimum treatments;

- Single glazing to all façade glazed elements. Glazing will vary from STC 27 – 35 acoustic performance, depending on size and location. All glazed elements have generally been assumed as fixed, and will need to be installed with full perimeter rubber acoustic seals.

- Light-weight façade elements – Standard constructions which will include steel studs, top hats, acoustic insulation and plasterboard or Fibre Cement (FC) sheet linings.

6 NOISE EMISSION ASSESSMENT

The following have been identified as the primary operational noise emission sources associated with the proposed stage 3 development;

- Noise impacts from any external mechanical plant and equipment associated with the subject proposal.
- Noise impacts from additional traffic generated by the subject proposal.

6.1 ASSESSMENT CRITERIA

6.1.1 NSW DoP SEAR SSD9033 Requirements

9. 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)*

17. Construction Hours

Identify proposed construction hours and provide details of the instances where it is expected that works will be required to be carried out outside the standard construction hours.

6.1.2 NSW EPA Noise Policy for Industry (2017)

Noise sources covered by this code will include vehicle noise (generated on the site) and mechanical services noise. Both the Intrusiveness and the Project Amenity criteria (as set out below) must be complied with.

6.1.2.1 NSW EPA NPfI - Intrusiveness Noise Goals

Intrusiveness criteria permit noise generation to be no more than 5dB(A) above existing background noise levels. The criteria are as follows:

Table 7 – EPA Intrusiveness Criteria

Location	Time of Day	Measured Rating Background Noise Levels dB(A)$L_{90(period)}$	Intrusiveness Noise Objective dB(A)$L_{eq(15min)}$ (Background + 5dB)
Residential Receivers to the west (along Docker Street)	Day Time (7am - 6pm)	53	58
	Evening (6pm - 10pm)	47	52
	Night (10pm - 7am)	41	46
Heritage Motor Inn and Residential Receivers to the east	Day Time (7am - 6pm)	45	50
	Evening (6pm - 10pm)	41	46
	Night (10pm - 7am)	36	41

6.1.2.2 NSW EPA NPfI - Project Amenity Goals

Project amenity criteria are determined based on the land use in the area (residential/commercial/industrial). The residential land use is then further categorised into rural, sub-urban and urban areas.

For the purpose of this assessment the existing residential dwellings will be considered suburban.

Table 8 – EPA Project Amenity Criteria

Noise Receiver	Amenity Noise Level – dB(A)$L_{Aeq(15min)}$		
	Daytime	Evening	Night
Existing Residential (Suburban)	53	43	38
Commercial	65	65	65

However, we note that the noise emission goals in the table above should be modified for areas already effected by pre-existing road traffic noise, as detailed in section 2.4.1 of the NPfI. We note that the residences located along Docker Street are affected by high traffic noise levels, as detailed in Table 3, which are all >10dB above the recommended amenity noise levels.

The Project Amenity criteria are therefore adjusted in accordance with the requirements outlined in section 2.4.1 of the NPfI guidelines = $L_{eq,\ period(traffic)}$ minus 15dB(A). Resulting levels are presented below.

Table 9 – EPA Project Amenity Criteria (adjusted)

Noise Receiver	Amenity Noise Level – dB(A)$L_{Aeq(15min)}$		
	Daytime	Evening	Night
Existing Residential (Suburban)	52	50	44
Commercial	65	65	65

6.1.3 Sleep Arousal Assessment

Potential sleep arousal impacts should be considered for noise generated before 7am or after 10pm.

Short duration, intermittent noise events (such as car engine starting, car door slamming) are typically assessed for potential sleep disturbance.

As recommended in the NPfI, to assess potential sleep arousal impacts, a two-stage test is carried out:

- Step 1 – Section 2.5 *Maximum noise level event assessment* from the NPfI states the following:

  Where the subject development/premises night-time noise levels at a residential location exceed:

  - $L_{Aeq,15min}$ *40dB(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 greater,*

  a detailed maximum noise level event assessment should be undertaken.

Based on the above the following noise objectives apply:

Table 10 – Sleep Arousal Criteria (*Average*/L_{eq} Noise Levels)

Location	Time of Day	Measured Rating Background Noise Levels dB(A)L_{90}	Rating Background Level + 5dB(A)	Governing Criteria dB(A)$L_{Aeq(15mins)}$
Residential Receivers to the west (along Docker Street)	Night (10pm - 7am)	41	46	46
Heritage Motor Inn and Residential Receivers to the east		36	41	41

Table 11 – Sleep Arousal Criteria (*Maximum*/L_{Max} Noise Levels)

Location	Time of Day	Measured Rating Background Noise Levels dB(A)L_{90}	Rating Background Level + 15dB(A)	Governing Criteria dB(A)$L_{Aeq(15mins)}$
Residential Receivers to the west (along Docker Street)	Night (10pm - 7am)	41	56	56
Heritage Motor Inn and Residential Receivers to the east		36	51	52

- Step 2 - If there are noise events that could exceed the average/maximum criteria detailed in the tables above, then an assessment of sleep arousal impact is required to be carried out taking into account the level and frequency of noise events during the night, existing noise sources, etc. This test takes into account the noise level and number of occurrences of each event with the potential to create a noise disturbance. As is recommended in the explanatory notes of the EPA NPfI, this more detailed sleep arousal test is conducted using the guidelines in the EPA Road Noise Policy. Most relevantly, the Road Noise Policy states:

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

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

6.1.4 NSW EPA Road Noise Policy

For land use developments with the potential to create additional traffic on public streets the development should comply with the requirements of the Road Noise Policy.

Noise levels generated by traffic should not exceed the noise levels set out in the table below when measured at a nearby property.

Table 12 – Criteria for Traffic Noise Generated by New Developments

Road Type	Time of day	Permissible Noise Generation
Sub-Arterial Roads	Day (7am to 10pm)	60 dB(A)$L_{eq(15hr)}$
	Night (10pm to 7am)	55 dB(A)$L_{eq(9hr)}$
Local Roads	Day (7am to 10pm)	55 dB(A)$L_{eq(1hr)}$
	Night (10pm to 7am)	50 dB(A)$L_{eq(1hr)}$

However, if existing noise levels exceed those in the table above, section 3.4 of the Road Noise Policy is applicable, which requires noise impacts are reduced through feasible and reasonable measures. However, in determining what is feasible/reasonable, the Policy notes that an increase of less than 2dB(A) is a minor impact and would be barely perceptible.

6.2 PRELIMINARY ASSESSMENT

Operational noise sources with the potential to impact on the amenity of surrounding sensitive land users include;

- Noise emissions from any external mechanical plant and equipment associated with the subject proposal.
- Vehicular noise on site (use of car parks, vehicle circulation).
- Noise created on public roads as a result of additional traffic generated by the proposal.

6.2.1 Noise from External Mechanical Plant & Equipment

Detailed acoustic review of mechanical design and equipment selections cannot be undertaken at approval stage, as plant selections and locations are not finalised. However, an indicative assessment of typical noise mechanical plant items, are presented below.

Typical noisy plant items will include:

- Cooling towers.
- Air handling plant (air handling units, supply/exhaust/outside air fans).
- Chillers.
- Emergency Backup Power Diesel Generator

With respect to the above, we note:

- Cooling towers
    - Two cooling towers are proposed to be located on the roof of the development (with louvres along the western façade).

- In the event the selected cooling tower sound power level (SWL) exceeds 85dB(A) per unit, there is potential for exceedance of the NSW EPA amenity noise limits, given the proximity of the cooling towers from the surrounding residential properties.

- To ensure compliance with INP requirements typical treatments will include:

    - Cooling towers installed with variable speed drives, to allow for reduced fan speed during periods of low load. Typically, a fan speed of no more than 50% would be expected at night-time.

    - Acoustic attenuator behind the louvre or selection of acoustic louvres. Alternatively, dedicated air intake and discharge attenuators to the cooling towers may be required.

- Chillers (assumed sound power of 102dB(A)).

    - Two chillers are proposed to be located within the level 5 plant room.

    - Plantroom housing the chillers should not have any external ventilation opening/louvre.

    - The chillers would need to have partitions constructed around them, separating them from other areas of the plant room (in order to control noise breaking out through louvres from the remainder of the plant room). The bounding partitions to the chiller area will typically need to be either concrete block (min 90mm) or an insulated stud wall construction (9mm fc sheet to each side of studwork with 75mm thick 11kg/m^3 insulation to the cavity.

    - Light weight cladding to plant room walls and ceiling will potentially require lining of cladding element with FC or similar and internal multiple layer plasterboard sheeting to ensure noise breakout through wall/roof are compliant with INP requirements. Final plant room building shell design to be conducted following final chiller section and plant room location.

    - Typical vibration isolation would consist of 25mm static deflection springs sitting on a concrete plinth isolated from the structural slab using 10mm rubber matting.

- Level 5 plat room (Fans and AHU's)

    - Case radiated noise from AHU's and return air fans located within the plantroom are typically quieter than other plant noise sources (compared to chillers, pumps, generators etc).

    - Air handling unit exhaust and outside air ducting (both of which are typically ducted to outside) are to be acoustically reviewed following layout design by mechanical engineer/contractor to determine whether internal lining to this ductwork is required.

    - Major fans (typically with a sound power over 90(A) – such as return air fans, outside air fans etc.) will require acoustic treatment if located externally. This treatment would include construction of screens for rooftop fans and internal

lining to any exhaust/intake ductwork for in-line fan with openings on the roof/façade.

- Given the extent of mechanical plant proposed in this plantroom and the significant number of acoustic louvres, light weight external wall and roof construction is not recommended. Additionally, a majority of these louvres will require acoustic attenuators or alternatively will need to be sealed off to ensure compliance with the project noise emission goals.

- Emergency Backup Power Diesel Generators

  - One generator is proposed to be located in the new outdoor carparking space (south-west corner of site). There is also provision for a future generator to be located adjacent to this generator, if required.

  - Depending on the generator model selected, these may or may not have proprietary acoustic enclosures.

    - Diesel generators without proprietary acoustic enclosures:

      - These typically have a sound power level of approximately 125dB(A).

      - Acoustic treatment to air intake and discharge openings to the plant room typically require acoustic attenuators in the order of 2700mm long, 40% free area (Noise Control or equal).

      - In addition, given the proximity of the generators to the surrounding residential receivers (along Docker Street) and other hospital buildings, the generator will need to be enclosed in building, with additional treatment to any louvres for intake/discharge.

      - The building will typically need to be of masonry construction with insulated walls and soffit (internally).

    - Diesel generators that do have proprietary acoustic enclosures:

      - Typically, these units have a noise emission level of approximately 75dB(A) at 7 metres. While this substantially reduces the need for acoustic treatment, there is still typically a small amount of additional treatment required.

      - Given the proposed location of the diesel generator and no other option for treatments (if located in plantroom attenuators behind louvres or acoustic louvres), we recommend;

        - Selecting generator with a noise emission level of <65 dB(A) @ 7 metres.

        - Additionally, relocating the generator to allow for screening by existing hospital buildings, from the residential receivers along Docker Street. Or relocating

the generator within a plantroom (or constructing a plantroom).

- ❖ Alternatively, construct a screen to act as a barrier for noise emissions from the generator to the residential properties along Docker Street. The screen will be a solid construction, located 1-2m from the generator and extend higher and past the sides of the generator.

- ➢ In addition (regardless of generator/enclosure type) an appropriate exhaust gas muffler would be selected such that the resultant noise level at one metre from the exhaust gas discharge point is no more 65dB(A) (the discharge being directed away from the residents to the west and Harvey House).

ALC confirms that in all cases, mechanical plant and equipment can be sufficiently treated to ensure cumulative impacts can achieve compliance with the criteria detailed in section 6.1.

6.2.2 Noise from Car Parking Areas

The preferred masterplan proposed the following additional parking to the hospital precinct;

- Undercroft Parking Facility – 82 spaces.
- New on grade car parking to the north of Harvey House – 27 spaces.

Section 5.3 of the *Transport Impact Assessment* report (reference: N138820, dated 06/03/20178) prepared by GTA Consultants, outlines the proposed access locations to both these areas;

- Undercroft space – both options illustrate primary access (entry and exit) to occur via Edward Street and through CP1. There may be some cars departing via Doris Roy Lane.
- On grade car parking north of Harvey House – access (entry and exit) via Docker Street.
- ***Undercroft space***
    - No potential impacts are envisaged from vehicles accessing this space.
    - Both options illustrate access from Edward Street, with vehicle circulation occurring within CP1.
    - Section 6.1 of the traffic report predicts 76 and 92 peak vehicle trips during the AM and PM peak periods respectively.
    - Given the existing traffic noise from vehicle movements along Edward and Docker Street, the predicted additional traffic noise from vehicle circulation on site (via CP1 and into undercroft space), will not add to the existing noise levels at the surrounding sensitive receivers.
- ***On Grade parking north of Harvey House***
    - Access is proposed via Docker Street. This carpark has a maximum of 27 spaces.

- Given the existing traffic noise from vehicle movements along Docker Street, the predicted additional traffic noise from vehicle circulation within this carpark (a worst-case assumption of 12 cars in one 15-minute time period, which is highly unlikely), will not add to the existing noise levels at the residential properties along Docker Street.

- However, given the proximity of this car parking space to the existing residential properties along Docker Street, noise events occurring between 10pm and 7am should be assessed for potential sleep disturbance impacts.

- The transient noise assessment is based on the following assumptions:

    - Noise from the car engine as it leaves the site is 84dB(A).

    - The loudest typical peak noise event from the use of the car park will be from a car door closing or a car starting, both with an approximate sound power level of approximately 95dB(A)L_{Max}.

- Noise emissions are assessed against EPA Sleep Disturbance guidelines, as presented below.

Table 13 – Vehicle Movements to Docker Streets Residences Assessment (Sleep Arousal/L_{Max} Assessment)

Receiver Location	Noise Source	Predicted Noise Level dB(A)$L_{1(1min)}$	Criteria dB(A)L_{Max}	Compliance
Boundary of residential properties along Docker Street (44 – 50 Docker Street)	Cars circulating in carpark and departing	<40	56	Yes
	Car Engine/Door Slamming at drop off zone	48		

6.2.3 Noise Generated by Additional Traffic on Public Roads

Noise generated on public roads as a result of additional traffic associated with the subject proposal, must be assessed against the provisions of the NSW EPA Road Noise Policy.

As detailed above, section 5.3 of the traffic report, primary access to the subject proposal will occur;

- Via Edward Street and through CP1. There may be some cars departing via Doris Roy Lane.

- Via Docker Street.

Section 6.1 of the traffic report predicts 76 and 92 peak vehicle trips during the AM and PM peak periods respectively.

This will result in little to no impact (1 – 2 dB(A) increase in existing noise level – not perceptible to human ear) on these existing roadways, given the existing traffic volumes on these roadways.

7 CONSTRUCTION NOISE AND VIBRATION IMPACTS

7.1 PROPOSED HOURS OF WORK

The preliminary construction management plan outlines the following hours of operation for all construction activities and delivery of materials to and from the site;

- Monday to Friday – 7am to 6pm.
- Saturdays – 7.30am to 5pm.
- Sundays and Public Holidays – No works.

7.2 ASSESSMENT CRITERIA

7.2.1 Noise Impacts

7.2.1.1 EPA Interim Construction Noise Guideline

EPA guidelines adopt differing strategies for noise control depending on the predicted noise level at the nearest residences:

- *"Noise affected" level*. Where construction noise is predicted to exceed the "noise effected" level at a nearby residence, the proponent should take reasonable/feasible work practices to ensure compliance with the "noise effected level". For residential properties, the "noise effected" level occurs when construction noise exceeds ambient levels by more than:
    - 10dB(A)$L_{eq(15min)}$ for work during NSW EPA recommended standard construction hours (7am-6pm Monday to Friday and 8am to 1pm on Saturdays); and
    - 5dB(A)$L_{eq(15min)}$ for work outside of standard construction hours.
- "*Highly noise affected level".* Where noise emissions are such that nearby properties are "highly noise effected", noise controls such as respite periods should be considered. For residential properties, the "highly noise effected" level occurs when construction noise exceeds 75dB(A)$L_{eq(15min)}$ at nearby residences.

A summary of noise emission goals for both standard hours of construction and outside standard hours are presented.

Table 14 – Construction Noise Emission Goals

Location	"Noise Affected" Level - dB(A)$L_{eq(15min)}$	"Highly Noise Affected" Level - dB(A)$L_{eq(15min)}$
Residential Receivers to the west	(NSW EPA Recommended Standard Construction Hours) – 59 (Saturdays – 7.30am to 8am) – 45 (Saturdays – 1pm to 5pm) – 50	75
Heritage Motor Inn and Residential Receivers to the east	(Normal Construction Hours) – 55 (Saturdays – 7.30am to 8am) – 41 (Saturdays – 1pm to 5pm) – 46	75

7.2.1.2 Australian Standard 2436-1981 "Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites"

The Australian Standard AS2436 states that where all reasonable and available measures have been taken to reduce construction noise, mitigation strategies may be put in place to reduce levels noise levels to within a reasonable and acceptable level.

For the control and regulation of noise from construction sites, AS 2436:1981 nominates the following:

a. That reasonable suitable noise criterion is established,

b. That all practicable measures be taken on the building site to regulate noise emissions, including the siting of noisy static processes to locations of the site where they can be shielded, selecting less noisy processes, and if required regulating construction hours, and

c. The undertaking of noise monitoring where non-compliance occurs to assist in the management and control of noise emission from the construction site.

The guideline reflects on feasible and reasonable mitigation strategies, management controls and public liaising in the effort to reach realistic comprises between construction sites and potential noise affected receivers.

Based on these criteria the following procedure will be used to assess noise emissions:

- Predict noise levels produced by typical construction activities at the sensitive receivers.
- Adopt management conditions as per AS 2436 in the event of a non-compliance.

7.2.2 Vibration Impacts

Excavation and earth retention works (piling) are the primary vibration generating activities.

Given the distance between the site and the nearest residential properties, no vibration impacts are envisaged.

7.3 PRELIMINARY CONSTRUCTION NOISE ASSESSMENT

With respect to general construction noise, the impacts on nearby development will be dependent on the activity in question and where on the site the activity is undertaken. Excavation and piling works tend to be the loudest typical construction activity.

Work close to the boundaries will have greatest potential impact on the residents surrounding the site. Detailed acoustic assessment of individual activities cannot be undertaken prior to knowing the activities/construction methods proposed, their duration and location.

However, based on Initial analysis:

- Excavation/soil retention phase – Intrusive noise emissions are typical expected during excavation and earth retention (piling), with equipment items typically having sound power levels of approximately 115 – 120dB(A)$L_{eq(15min)}$. Some exceedance of the EPA *"Noise Effected"* target levels may occur at the boundary of existing residences along Docker Street and Heritage Motor Inn. Noise levels exceeding the *"Highly Noise Effected"* level of 75dB(A) at the residences are unlikely to occur for extended periods.

- During erection of structure, it is the use of hand tools (jack hammers, angle grinders etc.) and concrete pumps which are the loudest typical activity (sound power levels of approximately 105dB(A)$L_{eq(15min)}$). Intermittent exceedances of the EPA *"Noise Effected"* levels may occur at the boundary of existing residences along Docker Street and the Heritage Motor Inn. Little to no exceedance is predicted at the boundary of the residential receivers to the east, as majority of works will be screened by existing buildings on site. Noise levels exceeding the *"Highly Noise Effected"* level of 75dB(A) is unlikely to occur.

- Once construction of the building shell is complete, noise from hand tools will be relatively low, as the new building façade will provide considerable noise attenuation. Once the building shell is largely complete, use of hand tools in internal areas is unlikely to exceed EPA recommended levels. Vehicle noise and crane noise will create the greatest possibility of noise disturbance during this phase.

Noise impacts can be minimised using the following:

- Careful planning/scheduling of noisy works, particularly when located near the property boundaries.

- Location of static plant (concrete pumps, cranes) as far as practicable away from the boundaries is recommended.

- Use of augured rather than driven or vibratory piling should be considered if feasible.

- Location of vehicular access points during construction away from local roads (Docker Street and Dorsi Roy Lane). Edward Street should be used as the main access point (entry and exit) for all major construction traffic as this roadway is an existing sub-arterial road with high volumes of traffic.

- Letter box drops or similar consultation/notification methodology to all surrounding residents, informing them on activities with the potential to result in noise levels reaching the "Highly Noise Effected" noise level. Leaflet should advise of the proposed processes/methodology and likely duration.

In light of the above, we recommend:

- On completion of the construction program, an acoustic review of proposed construction activities and plant/methods/selections should be undertaken to identify the extent and duration of potential exceedances of EPA construction noise management levels;

- Community consultation to inform adjacent property owners of potential noise sensitive activities;

- Identify feasible acoustic controls or management techniques (for example, selection of plant, use of screens around static plant, scheduling of noisy works, notification of adjoining land users, respite periods) when exceedance of management noise levels may occur;

- For activities where acoustic controls and management techniques still cannot guarantee compliant noise levels, implement a notification process whereby nearby residences are made aware of the time and duration of noise intensive construction processes; and

- Implementation of a noise monitoring program during construction to provide feedback back to the Builder to ascertain whether construction noise goals are being exceeded and determine additional management strategies.

Through adoption of the above, noise impacts on nearby residences can be suitably managed to prevent unreasonable impact.

8 RECOMMENDATIONS

We recommend the following acoustic treatments/management controls to ensure compliance with EPA noise emission guidelines.

- A detailed construction noise and vibration management plan should be implemented. Review of the mitigation techniques outlined in this report should be done, and implemented.

- Detailed acoustic review of all external plant items should be undertaken following equipment selection and duct layout design. Initial analysis indicates that with acoustic treatment, all plant items will be capable of meeting noise emission requirements. However, this is likely to require:

    - Noise screening (using either a dedicated noise screen or the building shell) for roof top plant.

    - Acoustic treatment to fan casing and lining of external ducting for major external fans.

    - Upgrade of plant room wall/roof construction for any plant room housing chiller plant.

    - Detailed acoustic review of external louvres for any plant room to determine whether acoustic louvres/attenuators are required.

9 CONCLUSION

Potential noise and vibration impacts from the proposed Stage 3 development of the Wagga Wagga Base Hospital redevelopment project, have been assessed in this report.

An analysis of typical operational noise (vehicle and mechanical plant/equipment) associated with the proposed stage of development, indicates that compliance with relevant noise emission criteria can be achieved, provided;

- A detailed acoustic review of mechanical plant should be undertaken once design is further progressed (plant selections and locations finalised). In-principal review indicates that acoustic treatment to any major plant items located externally is likely to be required (screens, in-duct attenuation, attenuators and enclosures). Through the appropriate selection of plant/equipment and ameliorative treatments, noise emissions are capable of complying with all existing legislation.

- No additional impacts are predicted from additional vehicle movements resulting from the subject proposal.

Similarly, detailed noise management practices should be implemented for the control of construction noise. In principal acoustic review indicates that earthworks, piling and erection of structure, have the potential to exceed EPA Interim Construction Noise Policy guidelines, particularly when working in areas near the eastern, southern and western boudanries. Noise mitigation through work scheduling and equipment selection should be considered. This should be implemented via a Noise/Vibration Management Plan, which should be determined once a construction program is complete.

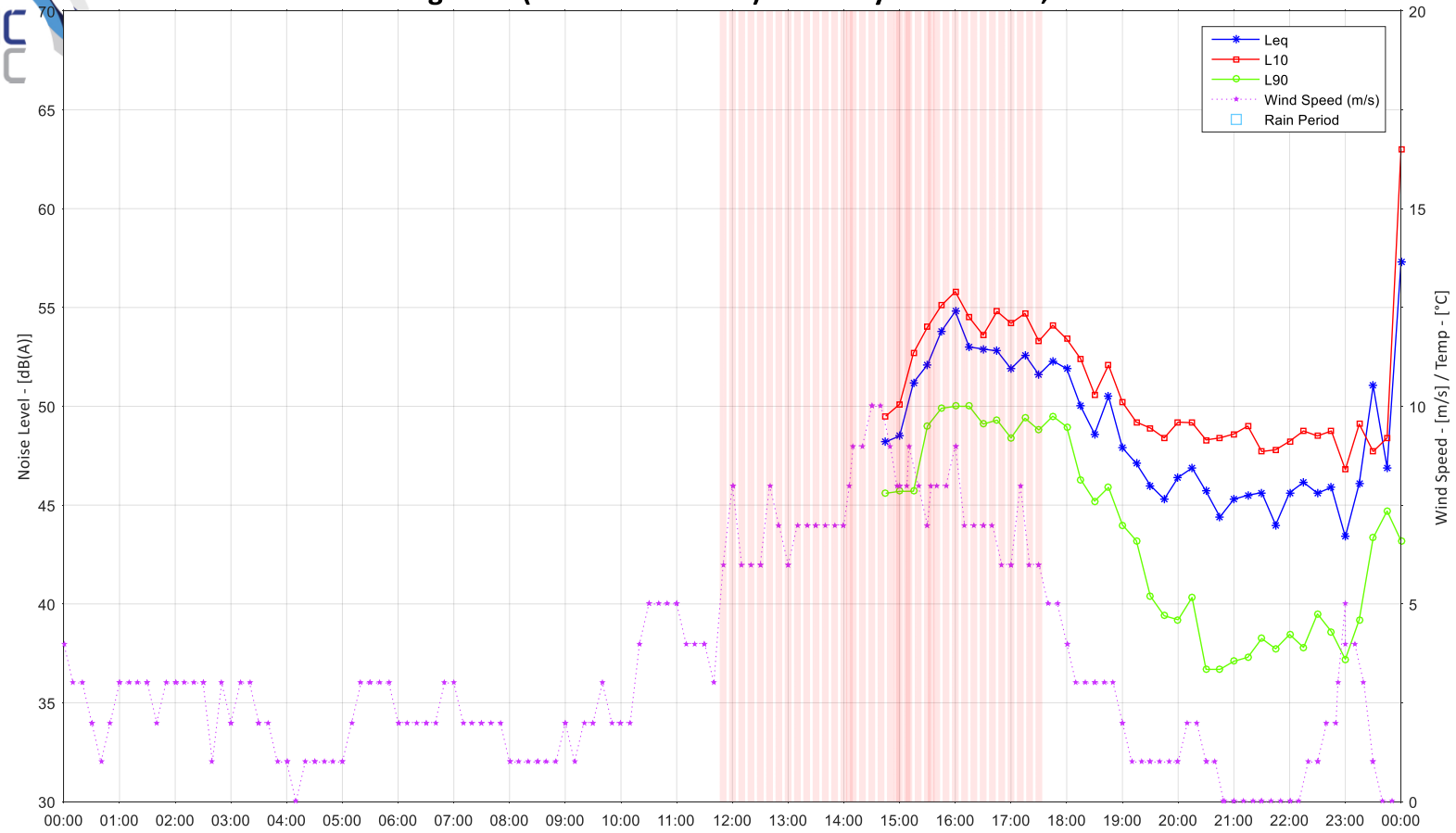
We trust this information is satisfactory. Please contact us should you have any further queries.

Yours faithfully,

Acoustic Logic Consultancy Pty Ltd
Yogendra Kalkunte

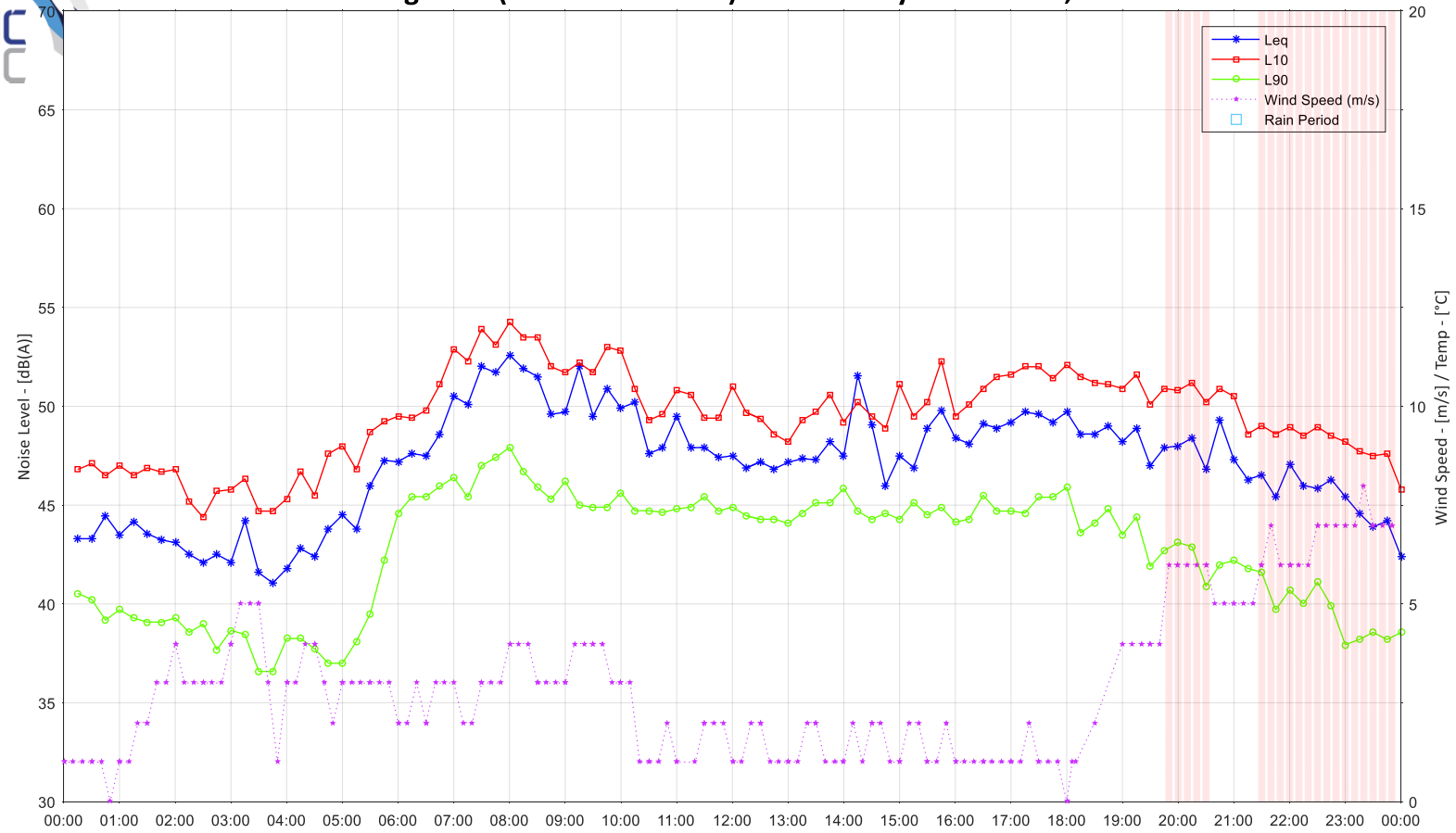
APPENDIX 1 – MONITOR 1 LOGGING DATA

Yathong Lane (WWBH Ambient): Tuesday 06 October, 2015



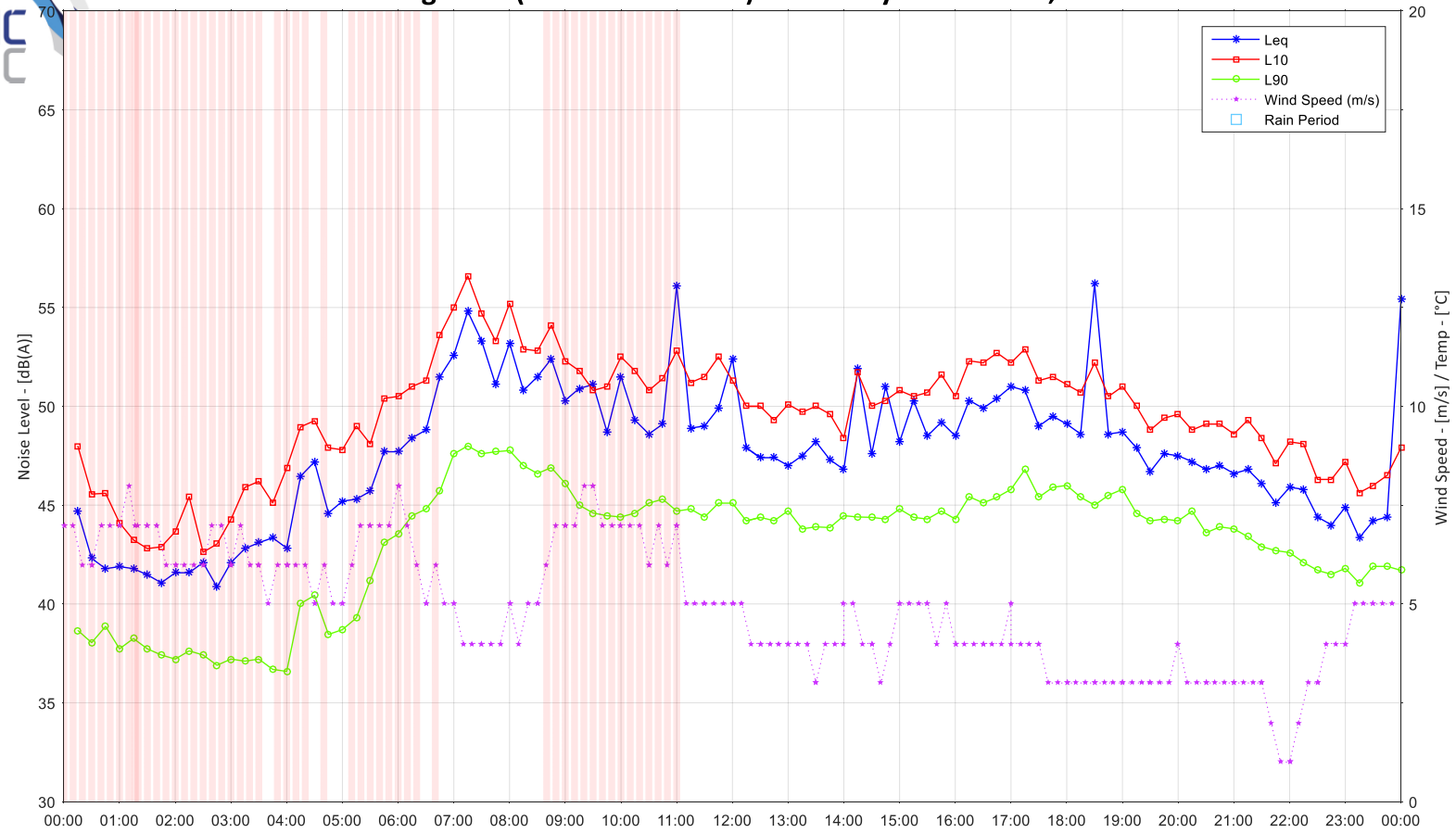
- Adverse Weather

Yathong Lane (WWBH Ambient): Wednesday 07 October, 2015



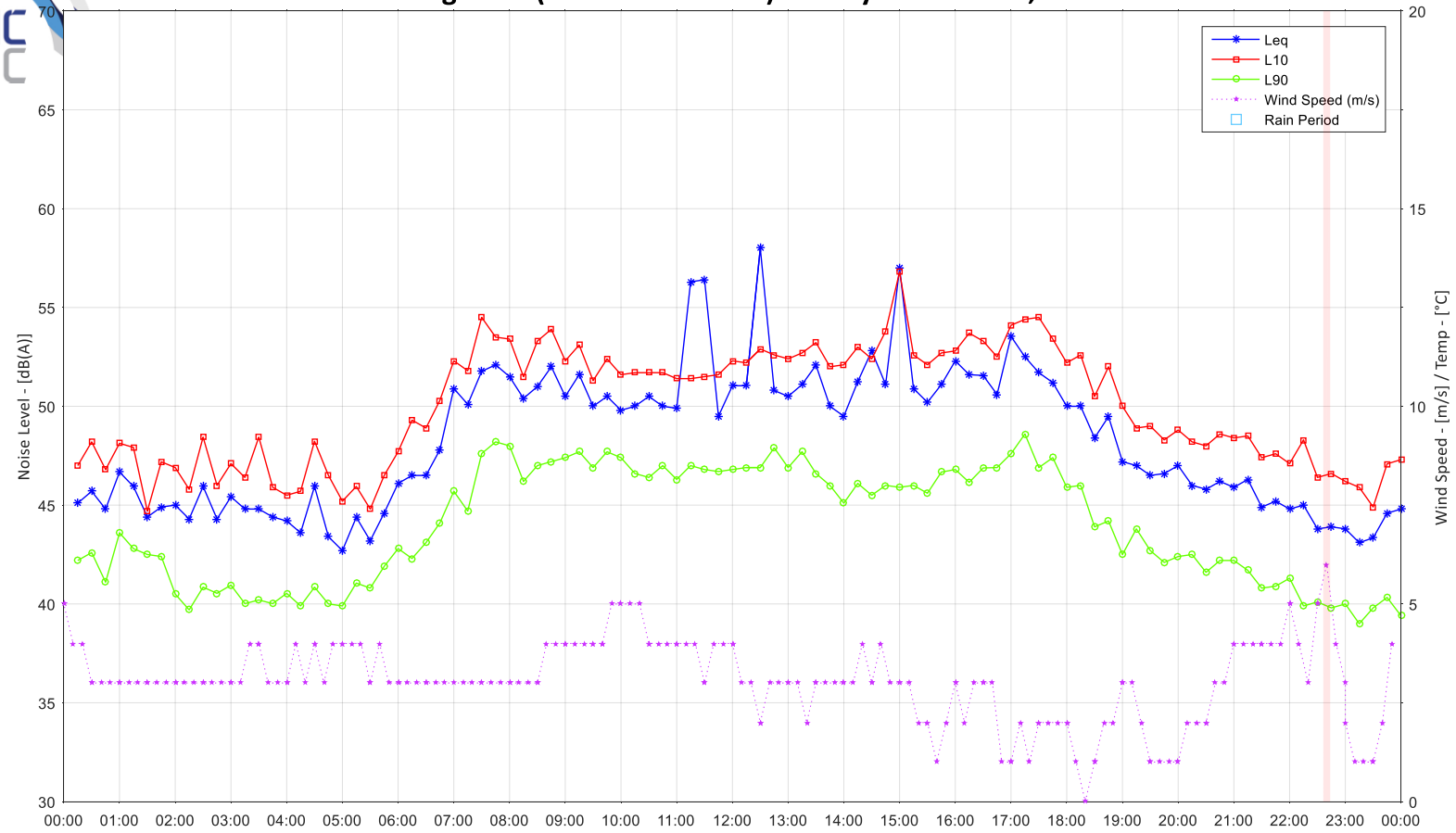
- Adverse Weather

Yathong Lane (WWBH Ambient): Thursday 08 October, 2015



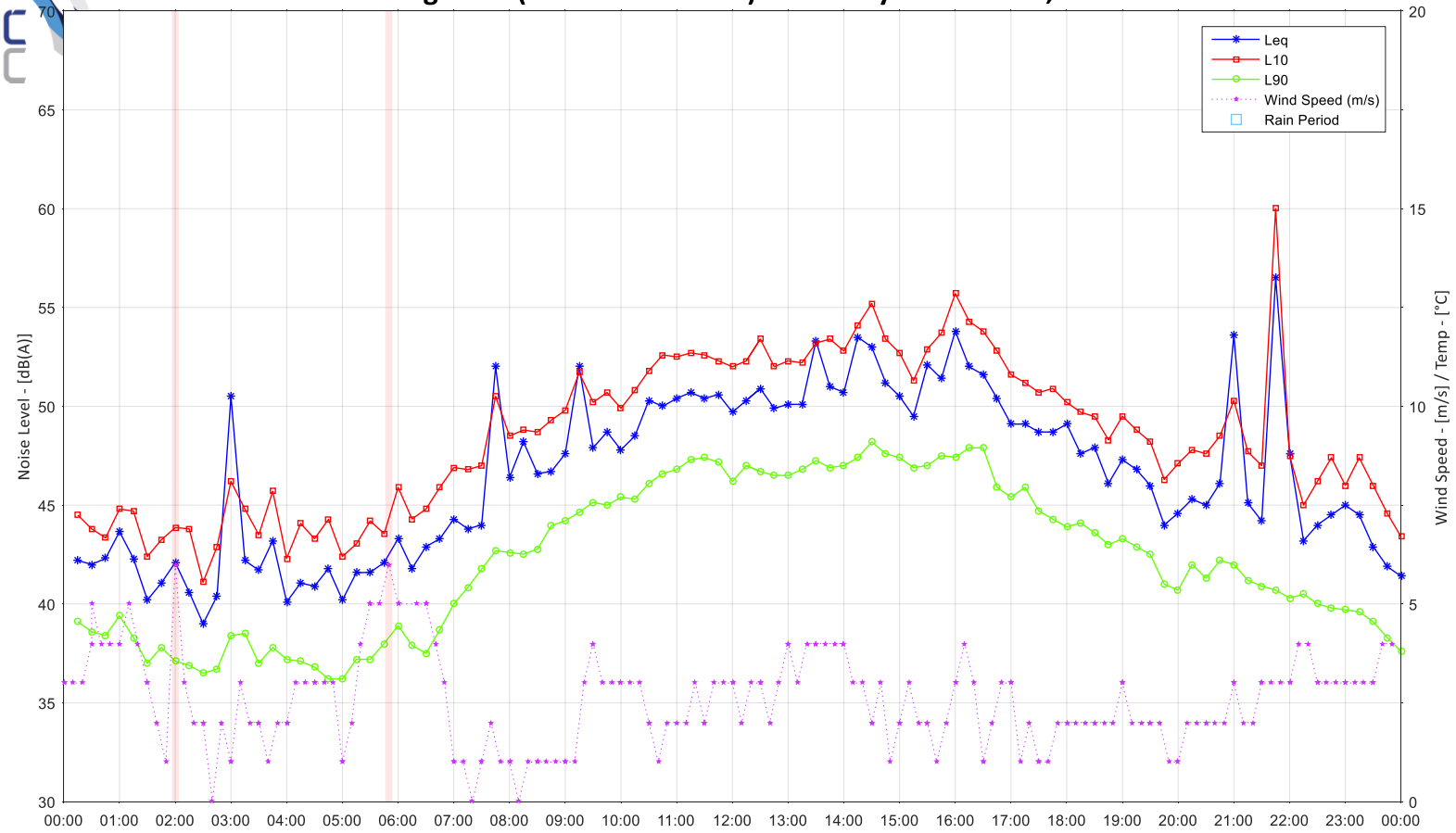
- Adverse Weather

Yathong Lane (WWBH Ambient): Friday 09 October, 2015



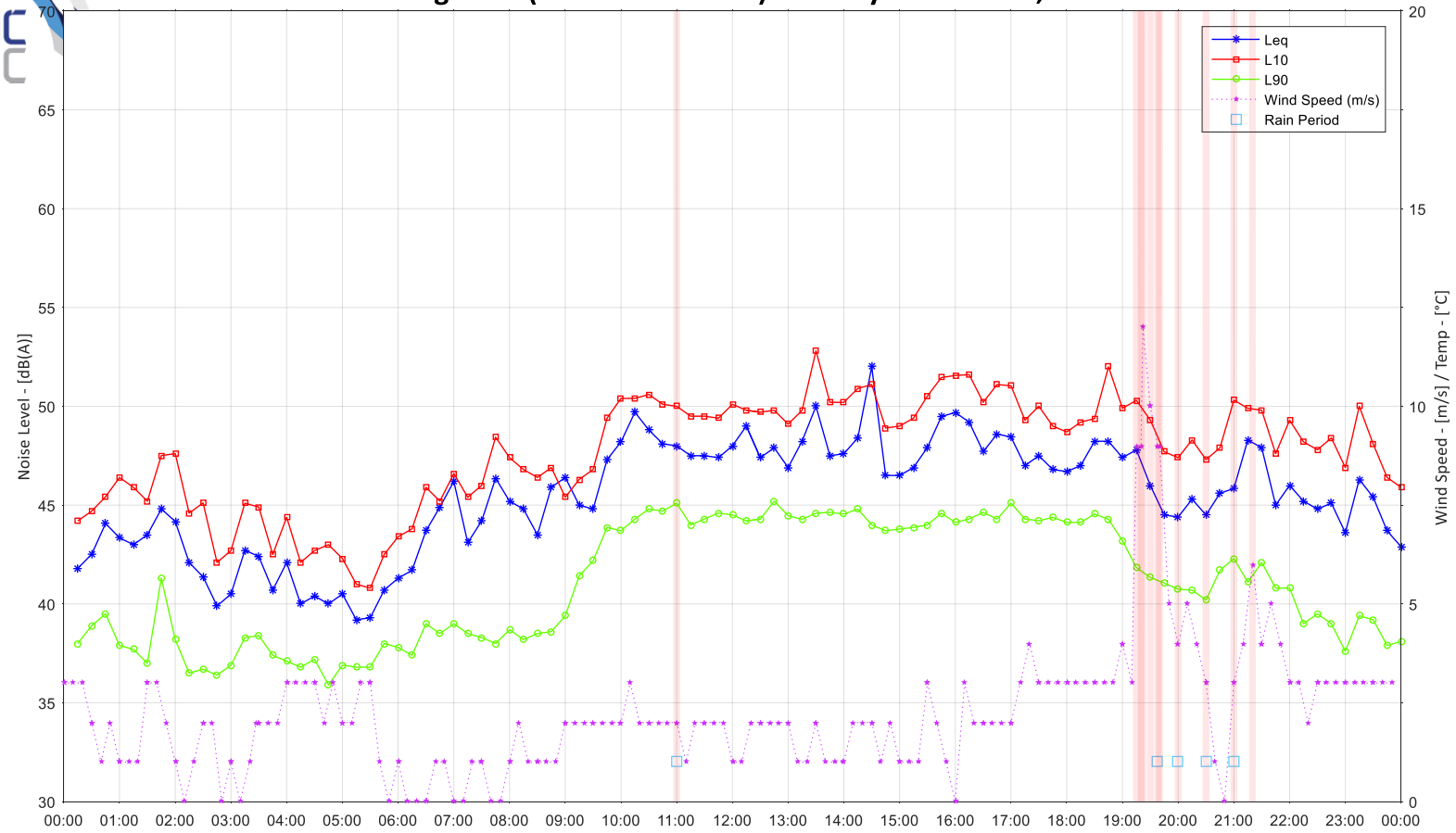
- Adverse Weather

Yathong Lane (WWBH Ambient): Saturday 10 October, 2015



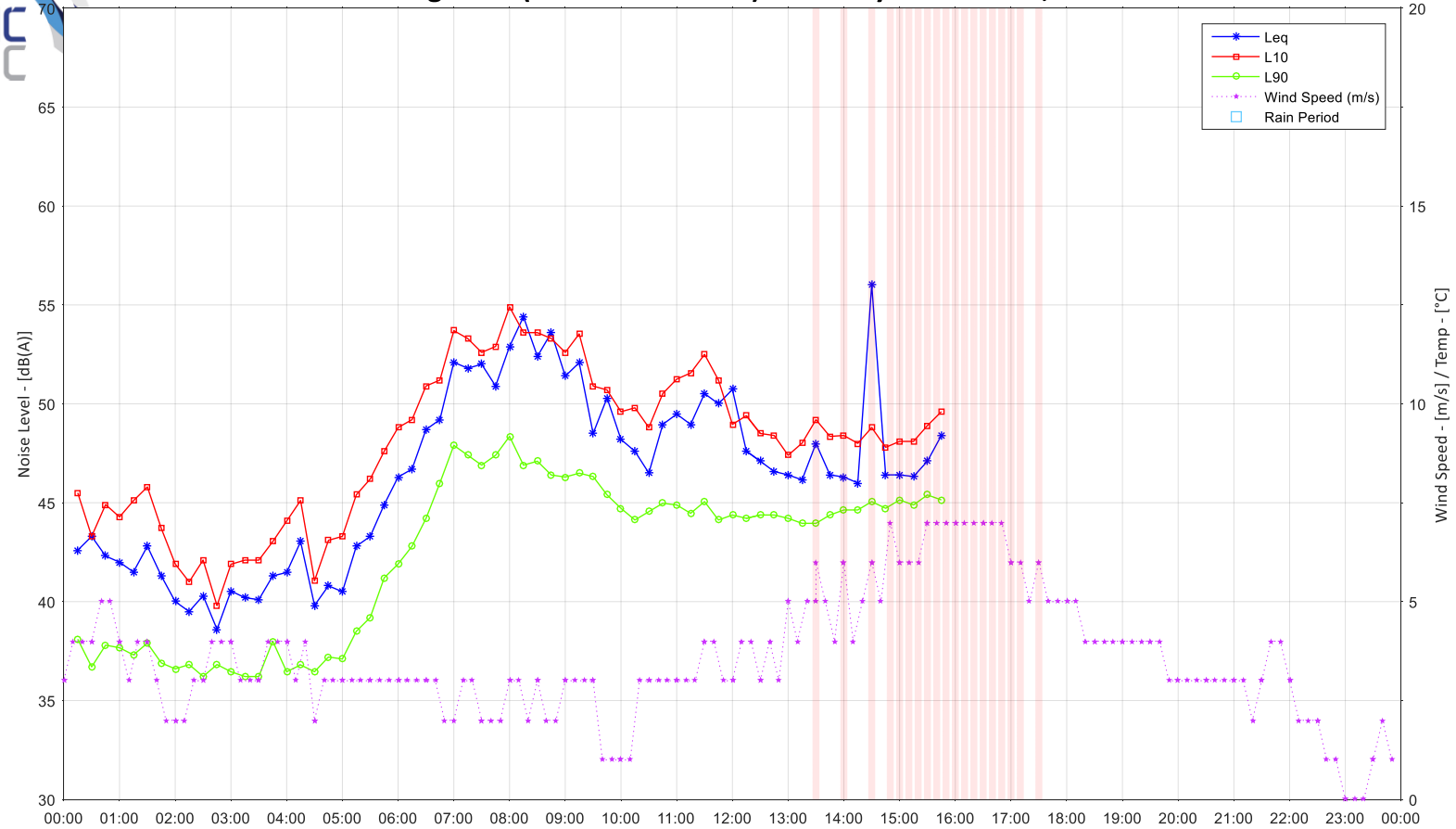
- Adverse Weather

Yathong Lane (WWBH Ambient): Sunday 11 October, 2015



- Adverse Weather

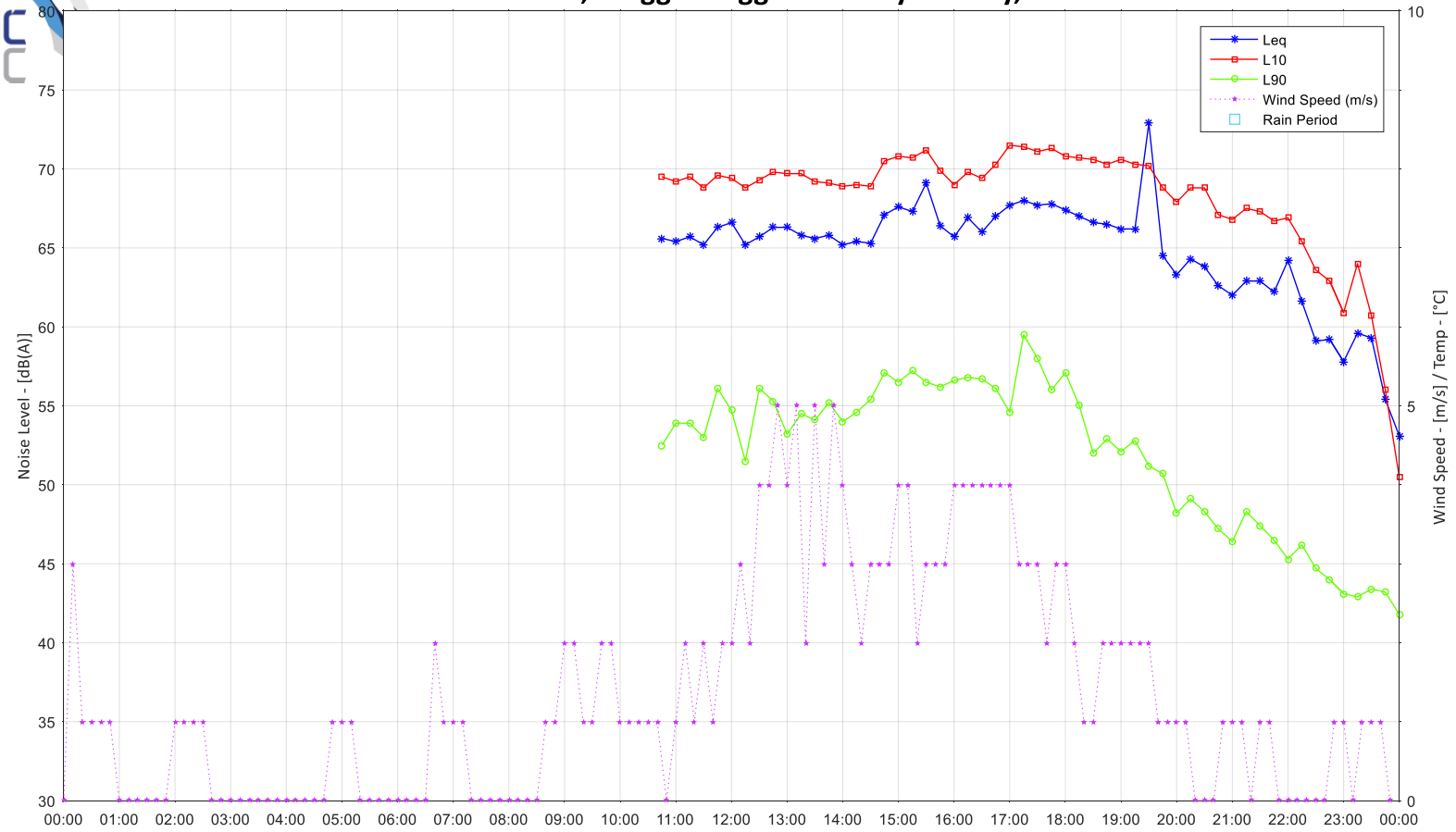
Yathong Lane (WWBH Ambient): Monday 12 October, 2015



- Adverse Weather

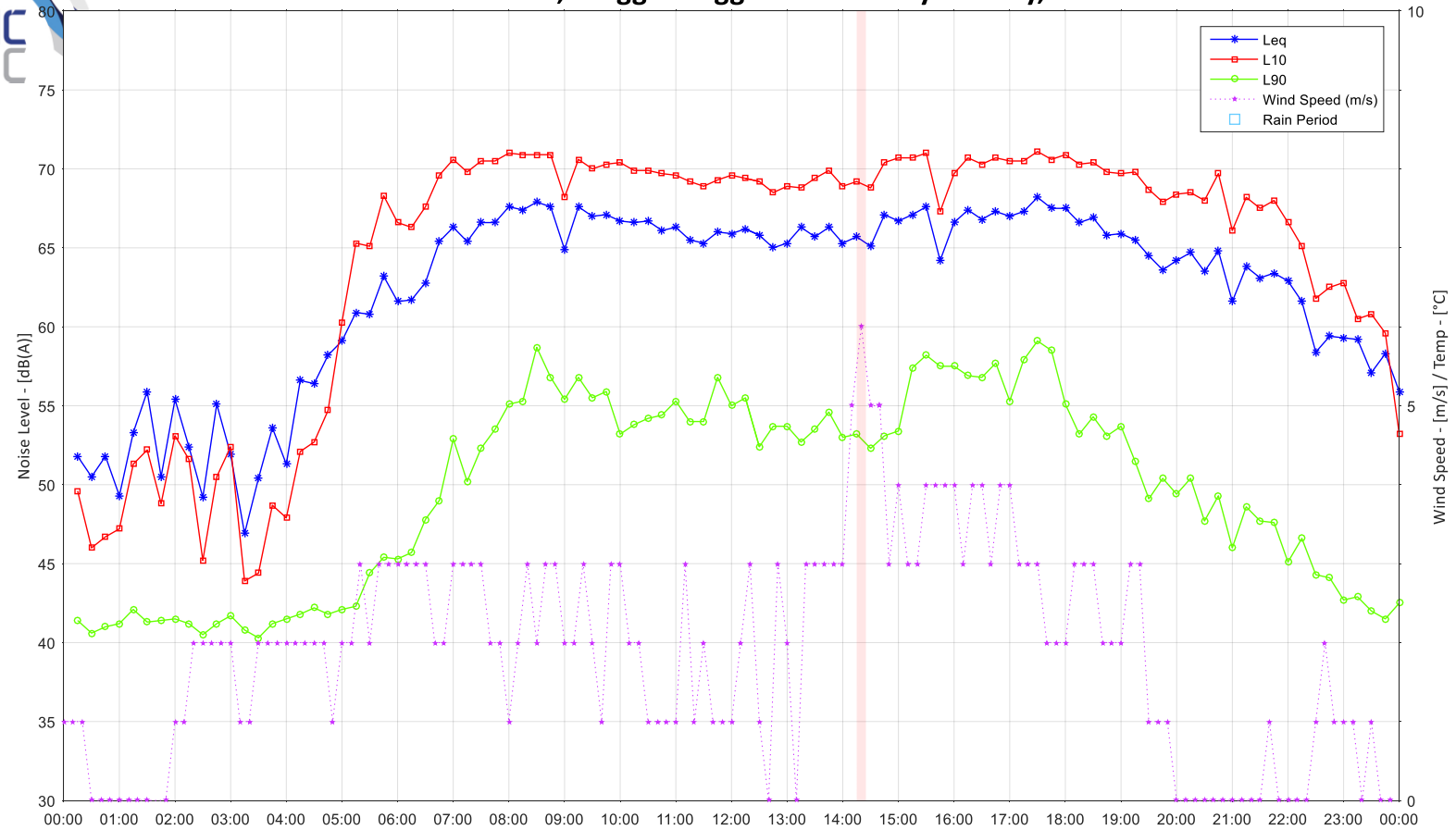
APPENDIX 2 – MONITOR 2 LOGGING DATA

32 Docker Street, Wagga Wagga: Tuesday 15 May, 2018



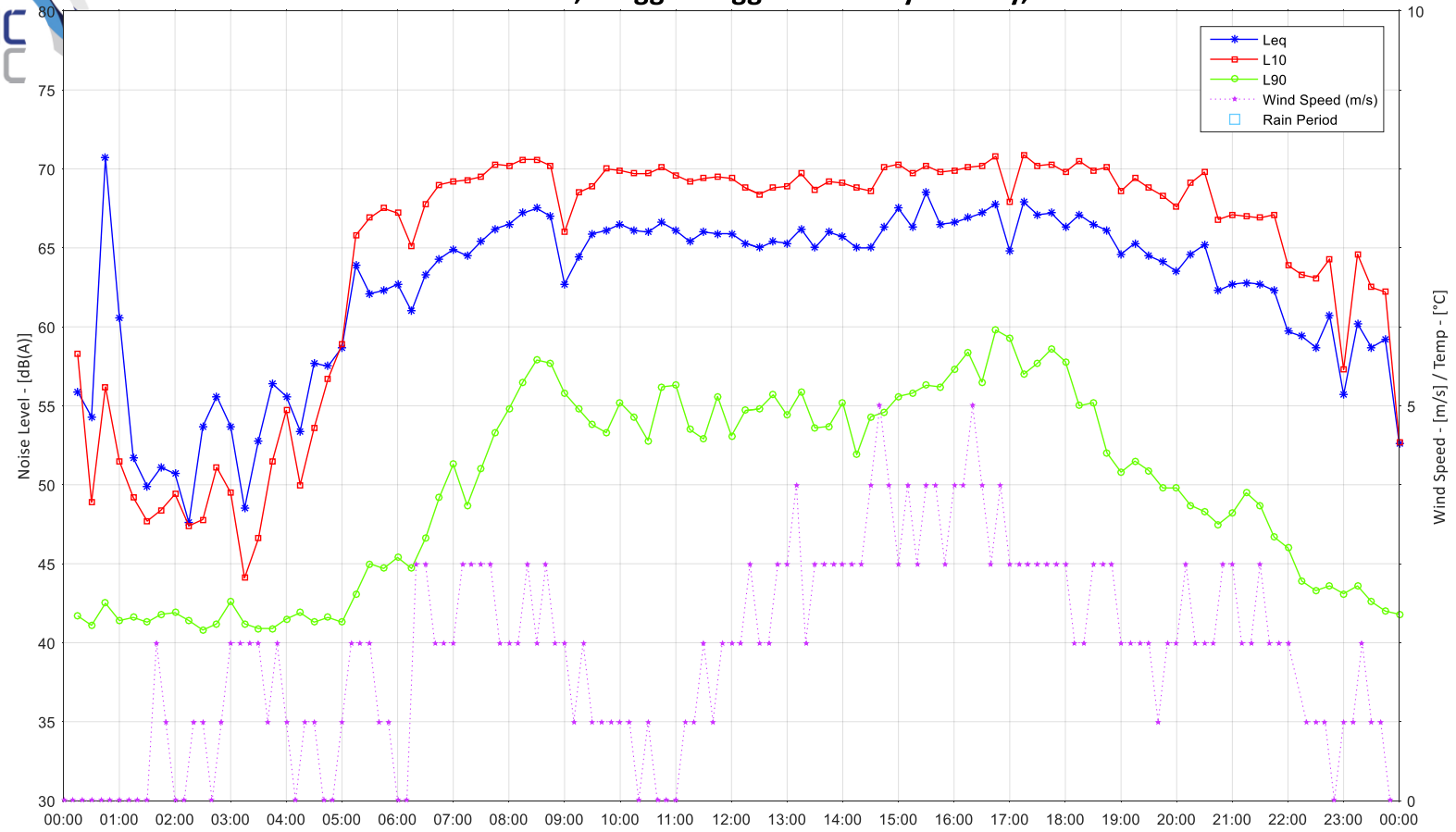
- Adverse Weather

32 Docker Street, Wagga Wagga: Wednesday 16 May, 2018



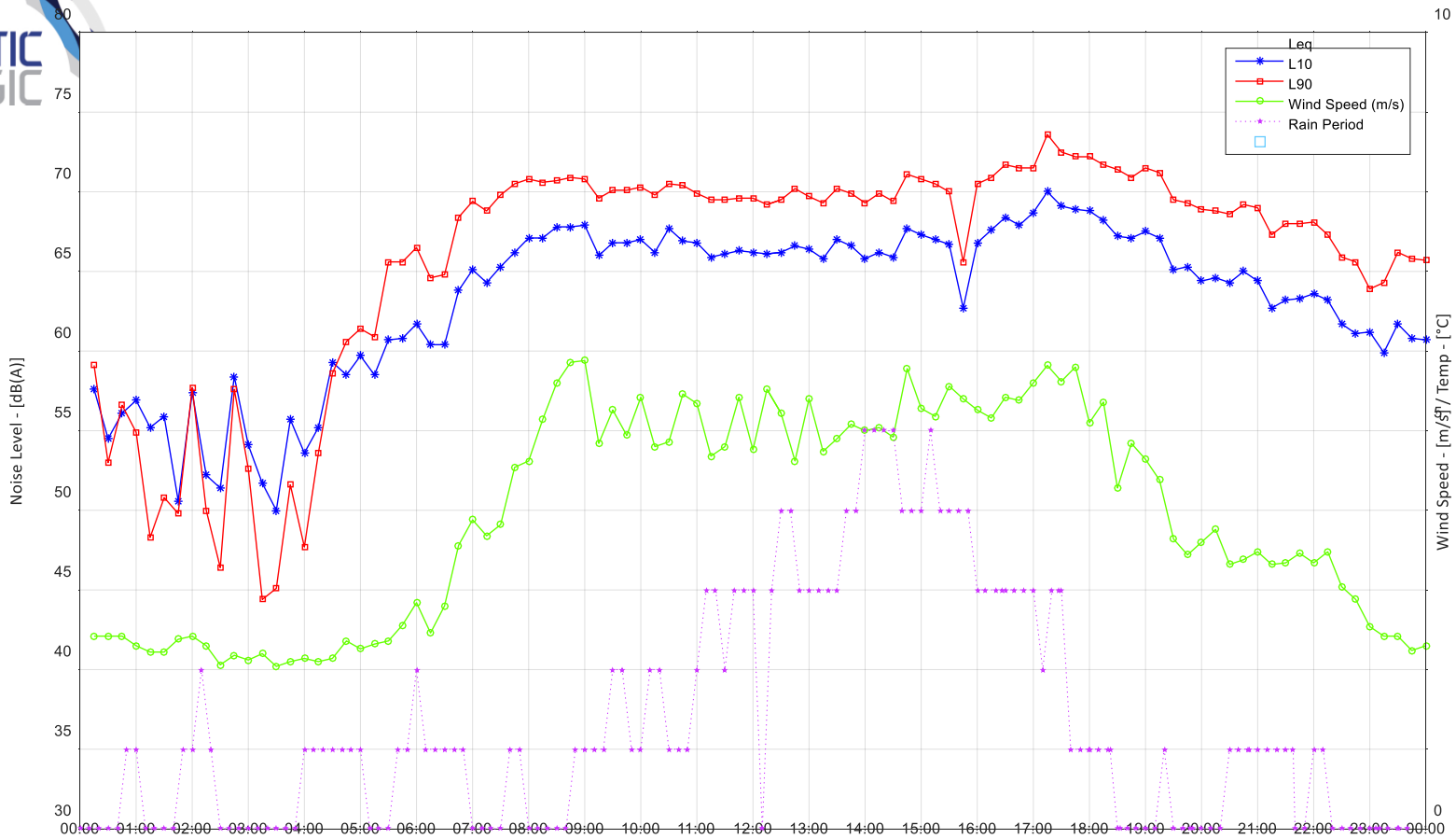
- Adverse Weather

32 Docker Street, Wagga Wagga: Thursday 17 May, 2018

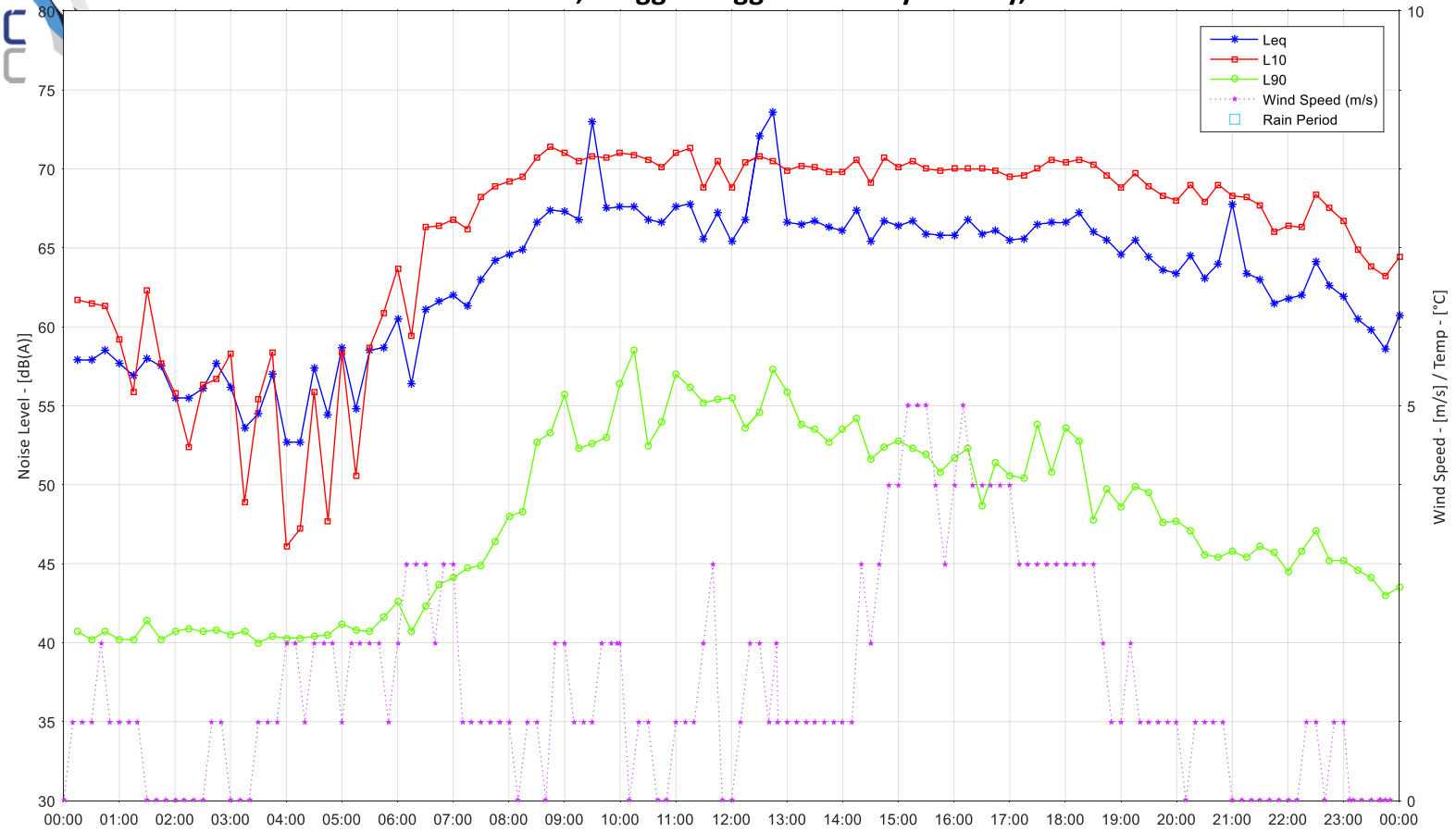


- Adverse Weather

32 Docker Street, Wagga Wagga: Friday 18 May, 2018

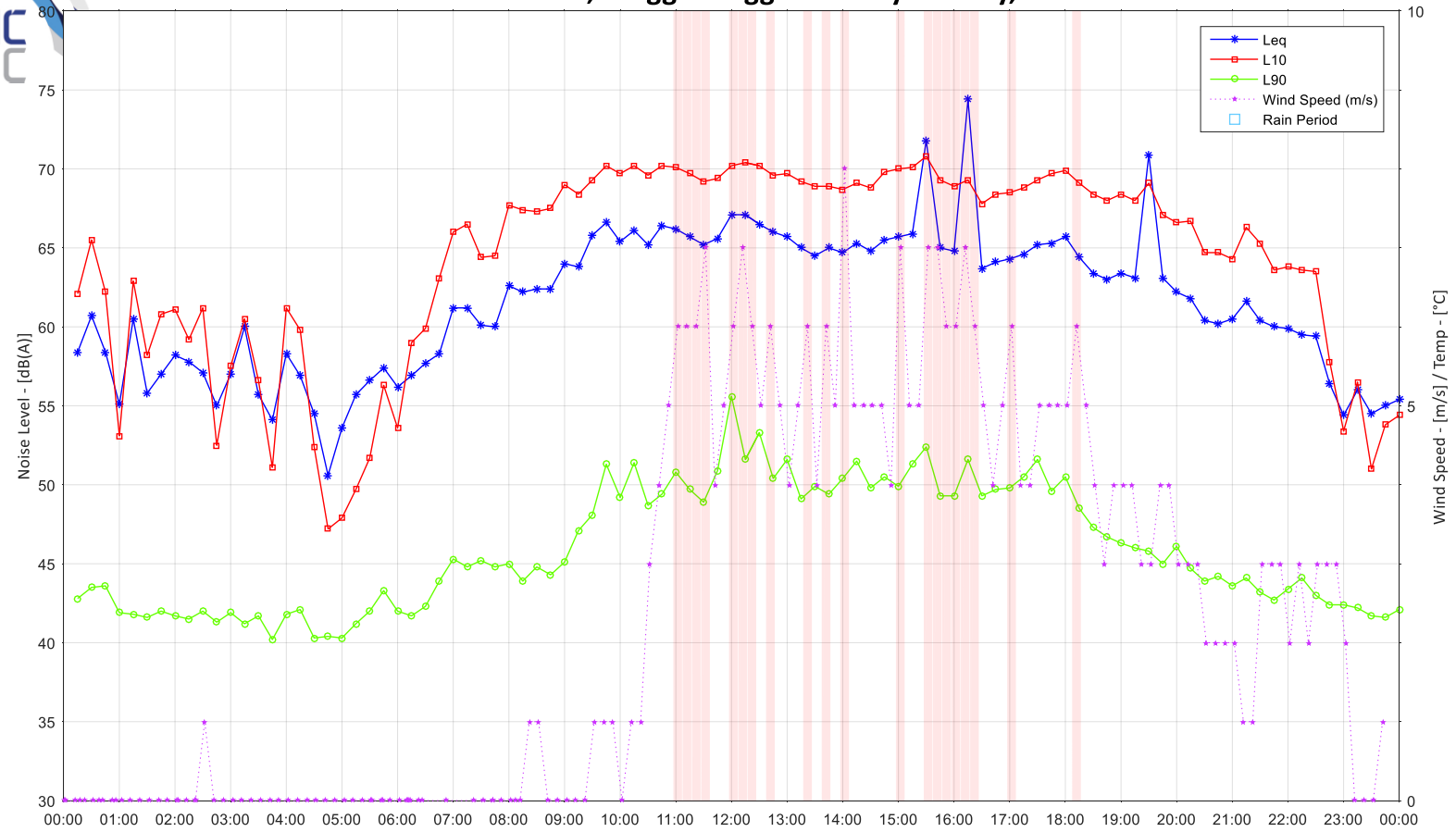


32 Docker Street, Wagga Wagga: Saturday 19 May, 2018



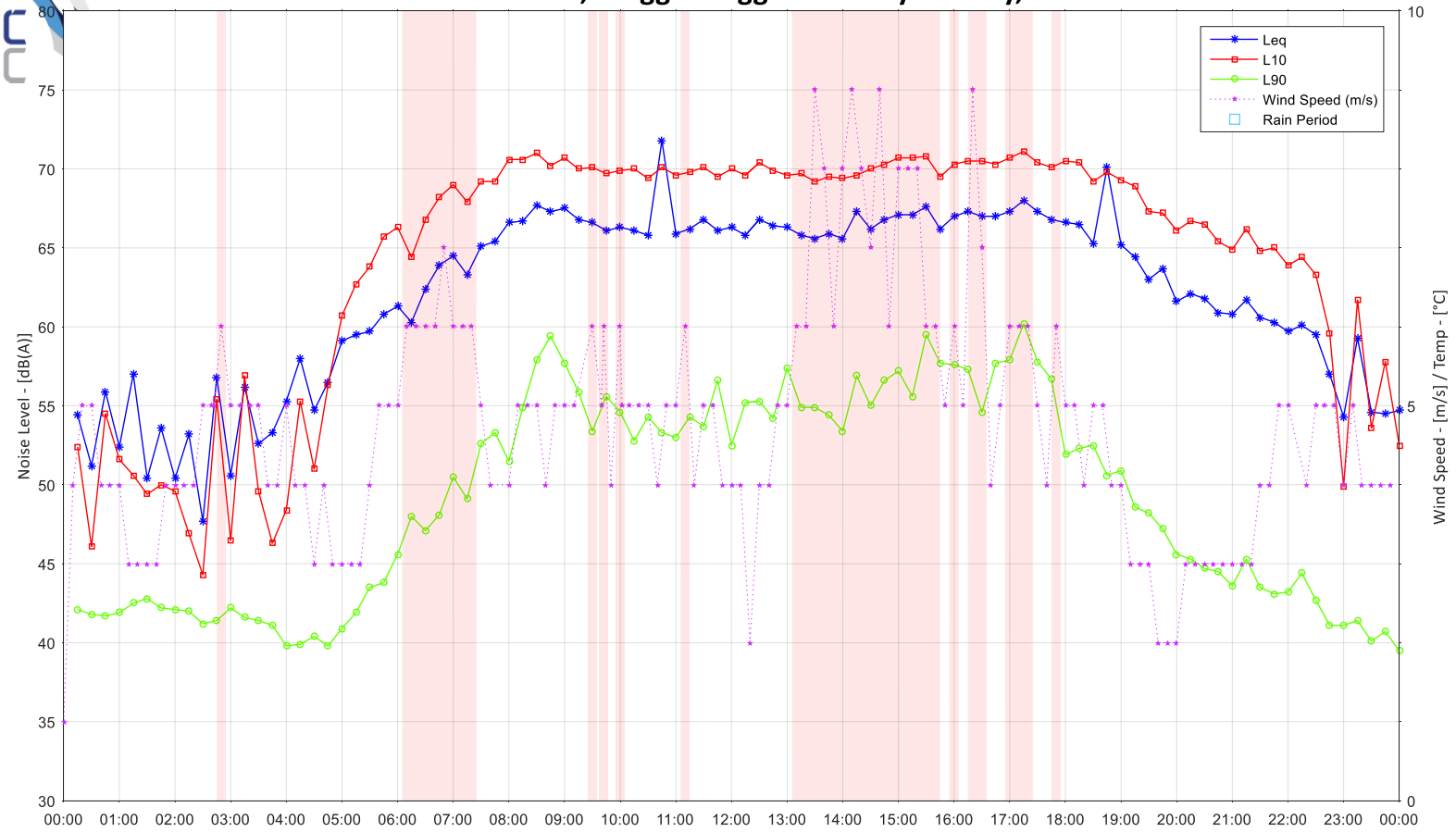
- Adverse Weather

32 Docker Street, Wagga Wagga: Sunday 20 May, 2018



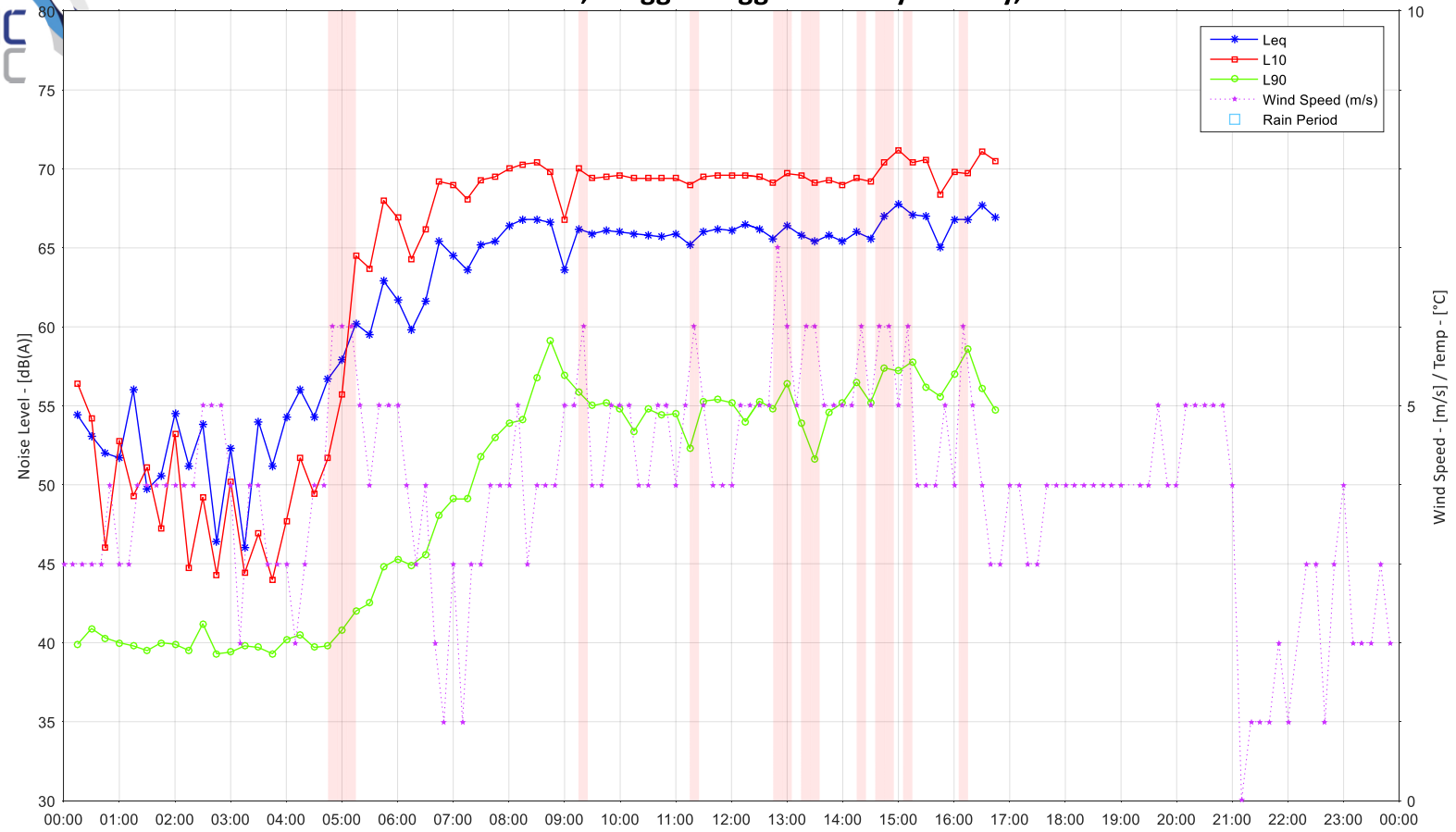
- Adverse Weather

32 Docker Street, Wagga Wagga: Monday 21 May, 2018



- Adverse Weather

32 Docker Street, Wagga Wagga: Tuesday 22 May, 2018



- Adverse Weather

APPENDIX 3 – MONITOR 2 LOCATION PHOTOGRAPHS

APPENDIX 4 – SOUND LEVEL METRE CALIBRATION CERTIFICATE

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: **SLM 19054 & FILT 1319**

Equipment Description:	Sound Level Meter		
Manufacturer:	Norsonic		
Model No:	NOR-140	**Serial No:**	1405928
Microphone Type:	1225	**Serial No:**	208208
Filter Type:	1/3 Octave	**Serial No:**	1405929
Comments:	All tests passed for class 1. (See over for details)		
Owner:	Acoustic Logic Consultancy 9 Sarah Street Mascot, NSW 2020		
Ambient Pressure:	1012 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	**Relative Humidity:**	30% ±5%
Date of Calibration:	29/06/2016	**Issue Date:**	29/06/2016

Acu-Vib Test Procedure: AVP10 (SLM) & AVP06 (Filters)

CHECKED BY: ..... **AUTHORISED SIGNATURE:** .....

Jack Kielt

Accredited for compliance with ISO/IEC 17025
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA
WORLD RECOGNISED ACCREDITATION

Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS

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