MATTHEW PALAVIDIS
VICTOR FATTORETTO
MATTHEW SHIELDS

303-304 & 282-298 Lawrence Hargrave Drive, Thirroul

Revised Noise Impact Assessment

SYDNEY
9 Sarah St
MASCOT NSW 2020
(02) 8339 8000

ABN 98 145 324 714
www.acousticlogic.com.au

Project ID	20211271.1
Document Title	Revised Noise Impact Assessment
Attention To	Rocking Horse Construction Pty Ltd

Revision	Date	Document Reference	Prepared By	Checked By	Approved By
0	28/02/2022	20211271.1/2802A/R0/VF	VF		VF
1	11/03/2022	20211271.1/1103A/R1/VF	VF		VF

TABLE OF CONTENTS

1 INTRODUCTION

Acoustic Logic Consultancy (AL) have been engaged to conduct an acoustic assessment of potential noise impacts associated with the proposed mixed used development to be constructed at 303-304 & 282-298 Lawrence Hargrave Drive, Thirroul.

This document addresses noise impacts associated with the following:

- Traffic noise impacts from surrounding roads;
- Rail noise and vibration impacts from adjacent railway;
- Entertainment noise impacts from local venues and
- Noise emissions in principle from mechanical plant to service the building.
- Noise related contentions filed in SOFAC dated 16th September 2021.

AL have utilised the following documents and regulations in the assessment of noise associated with the development:

- The Wollongong City Council Development Control Plan 2009;
- NSW Environmental Protection Authority (EPA) Noise Policy for Industry (NPfI) 2017;
- NSW Department of Planning and Environment's document – Developments near Rail Corridors or Busy Roads – Interim Guideline 2008; and
- AS/NZS 2107:2016 '*Acoustics – Recommended design sound levels and reverberation times for building interiors*.
- NSW Department of Planning Apartment Design Guide (2015) (ADG)

This assessment has been conducted in accordance with the Architecture & Building Works architectural drawings for DA submission. (See Appendix C)

The report has been prepared for the sole purpose of a development application assessment and should not be used or relied on for any other purpose.

2 SITE DESCRIPTION / PROPOSED DEVELOPMENT

It is proposed to construct a mixed use development consisting of:

- Two levels of basement carparking
- Ground level/podium retail and loading dock
- Three levels of residential apartments

The site is bounded by the following:

- Lawrence Hargrave Drive and commercial developments to the South East
- King Street to the North East, with both commercial and residential developments
- Illawarra Railway to the West

A site map, measurement location and surrounding receivers are presented in below. Existing Acoustic Environment

Acoustic monitoring was conducted to establish the ambient noise levels which will be used as a basis for this assessment.

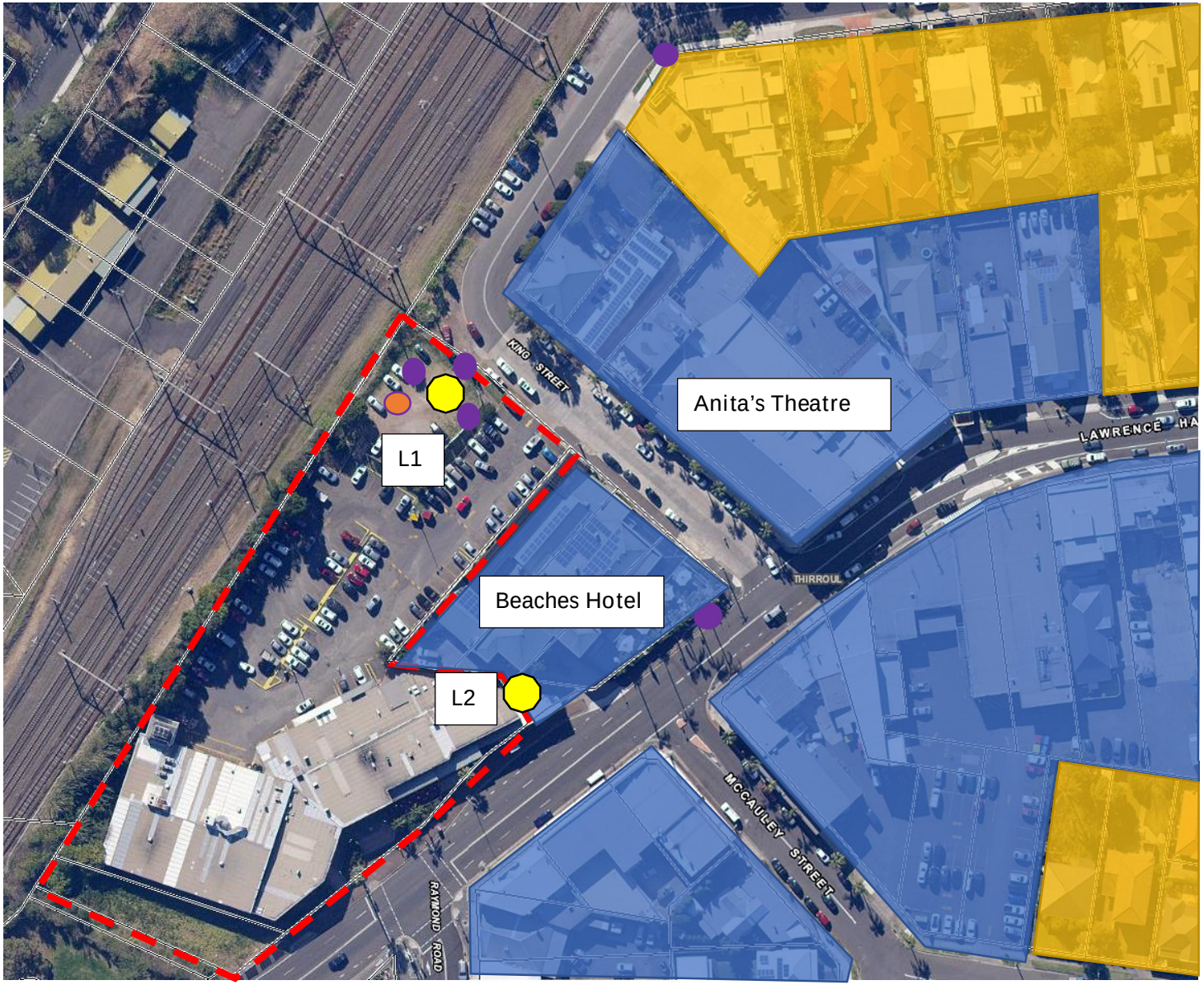


Figure 2-1: Site and Measurement Location

3 EXISTING ACOUSTIC ENVIRONMENT

Noise monitoring has been undertaken to obtain the following data:

- Background noise levels.
- Traffic and railway noise levels.
- Noise levels generated by the Beaches Hotel.

Figure 1 above shows the monitoring locations used.

3.1 NOISE DESCRIPTORS

Ambient noise constantly varies in level from moment to moment, so it is not possible to accurately determine prevailing noise conditions by measuring a single, instantaneous noise level.

To quantify ambient noise, a 15 minute measurement interval is typically utilised. Noise levels are monitored continuously during this period, and then statistical and integrating techniques are used to characterise the noise being measured.

The principal measurement parameters obtained from the data are:

L_{eq} - represents the average noise energy during a measurement period. This parameter is derived by integrating the noise levels measured over the measurement period. L_{eq} is important in the assessment of noise impact as it closely corresponds with how humans perceive the loudness of time-varying noise sources (such as traffic noise).

L_{90} – This is commonly used as a measure of the background noise level as it represents the noise level heard in the typical, quiet periods during the measurement interval. The L_{90} parameter is used to set noise emission criteria for potentially intrusive noise sources since the disturbance caused by a noise 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.

L_{10} is used in some guidelines to measure noise produced by an intrusive noise source since it represents the average of the loudest noise levels produced at the source. Typically, this is used to assess noise from licenced venues.

L_{max} is the highest noise level produced during a noise event, and is typically used to assess sleep arousal impacts from short term noise events during the night. It is also used to assess internal noise levels resulting from aircraft and railway ground vibration induced noise.

L_1 is sometimes used in place of L_{max} to represent a typical noise level from a number of high level, short term noise events.

3.2 BACKGROUND NOISE LEVELS

Background noise levels which will be used as a basis for this assessment are detailed below.

3.2.1 Measurement Equipment

Unattended noise monitoring at Location 1 was conducted using an Acoustic Research Laboratories Pty Ltd noise logger.

At Location 2 an Acoustic Research Laboratories Pty Ltd Ngara (Type 1) logger was used. Audio files were also recorded which enabled post processing of audio and spectral data.

The loggers were programmed to store 15-minute statistical noise levels throughout the monitoring period. The equipment was calibrated at the beginning and the end of the measurement period using a Rion NC-73 calibrator; no significant drift was detected. All measurements were taken on A-weighted fast response mode.

3.2.2 Measurement Locations

An unattended noise monitor was installed in carpark of the project site, refer to Figure 2-1 (Location L1). Another monitor was located near the Beaches Hotel (Location 2) on the roof over the existing toilet block.

3.2.3 Measurement Period

Unattended Noise monitoring was conducted from Thursday the 22th of August to Thursday the 6th of September 2019 (Location 1). Additional monitoring of the Beaches Hotel noise was conducted from 21st December 2021 to 4th January 2022 and 12th January to 27th January 2022 at Location 2, which is summarised in Appendix B.

3.2.4 Measured Background Noise Levels

The rating background noise levels (RBL) established from the unattended noise monitoring are detailed in the table below.

NSW EPA's RBL assessment procedure requires determination of background noise level for each day (the ABL) then the median of the individual days as set out for the entire monitoring period, with adverse weather periods excluded. The assessment background noise levels and the RBL's calculated using this procedure are summarised in the following table.

Weather affected data was excluded from the assessment. The processed Rating Background Noise Levels (median of the lowest 10th percentile noise levels during operation time period) are presented in the tables below.

Unattended and attended noise measurements have been undertaken as per the procedures outlined in Fact Sheet A and B of the NSW EPA Noise Policy for Industry.

Weather affected data (rain fall and wind speeds above 5m/s) have been excluded from the assessment as per Fact Sheet A and B. Where interval periods (day, evening and night) have weather affected data of 18%, 13% and 11% respectively, these periods have been excluded from the assessment.

Onsite attended and unattended noise measurements indicate that the acoustic environment for the project site are as below.

Table 1 – NPfI Assessment Background Noise Levels – Location 1

Location	Date	ABL		
		Day	Evening	Night
L1	Thursday 22 August 2019	-	49	45
	Friday 23 August 2019	48	47	45
	Saturday 24 August 2019	48	47	45
	Sunday 25 August 2019	47	45	43
	Monday 26 August 2019	50	-	44
	Tuesday 27 August 2019	50	47	45
	Wednesday 28 August 2019	47	48	43
	Thursday 29 August 2019	-	-	-
	Friday 30 August 2019	52	49	46
	Saturday 31 August 2019	50	47	46
	Sunday 01 September 2019	48	47	43
	Monday 02 September 2019	49	45	43
	Tuesday 03 September 2019	47	47	45
	Wednesday 04 September 2019	48	45	44
	Thursday 05 September 2019	48	45	42
	Friday 06 September 2019	-	-	-
	RBL	48	47	44

It is noted that when determining weather affected noise data at Location 2 in the table below, the wind speed measured at the weather station (typically at 10m above ground level) has been corrected by a factor of 0.667 to account for the noise logger being located at the roof level where boundary layer effects result in lower wind speeds, as well as the effect of the surrounding buildings (refer to Appendix B for detailed results).

Weather data was obtained from records provided by the Bureau of Meteorology for the weather station located at Bellambi AWS, NSW.

Table 2 – NPfI Assessment Background Noise Levels – Location 2

Location	Date	ABL		
		Day	Evening	Night
L2	Monday 20 December 2021	-	52	45
	Tuesday 21 December 2021	55	51	43
	Wednesday 22 December 2021	54	53	-
	Thursday 23 December 2021	55	54	-
	Friday 24 December 2021	-	52	42
	Saturday 25 December 2021	-	46	-
	Sunday 26 December 2021	-	-	-
	Monday 27 December 2021	-	-	-
	Tuesday 28 December 2021	-	-	40
	Wednesday 29 December 2021	53	52	39
	Thursday 30 December 2021	-	-	42
	Friday 31 December 2021	-	-	50
	Saturday 01 January 2022	-	-	40
	Sunday 02 January 2022	-	-	43
	Monday 03 January 2022	53	53	42
	Tuesday 04 January 2022	54	-	-
	Wednesday 12 January 2022	-	-	-
	Thursday 13 January 2022	54	51	41
	Friday 14 January 2022	53	53	41
	Saturday 15 January 2022	-	-	42
	Sunday 16 January 2022	-	52	-
	Monday 17 January 2022	-	-	-
	Tuesday 18 January 2022	-	-	-
	Wednesday 19 January 2022	-	-	-
	Thursday 20 January 2022	-	-	-
	Friday 21 January 2022	54	56	49
	Saturday 22 January 2022	52	55	43
	Sunday 23 January 2022	50	48	40
	Monday 24 January 2022	53	44	39
	Tuesday 25 January 2022	53	48	43
	Wednesday 26 January 2022	53	51	40
	RBL	53	52	42

The following table summarises the rating background noise levels determined for the day, evening and night periods as defined in the NPfI.

Table 3 – Summarised Rating Background Noise Level

Location	Time of Day	Rating Background Noise Level dB(A)$L_{90(period)}$
L1	Day (7am-6pm)	48
	Evening (6pm-10pm)	47
	Night (10pm-7am)	44
L2	Day (7am-6pm)	53
	Evening (6pm-10pm)	52
	Night (10pm-7am)	42

3.3 RAILWAY NOISE LEVELS

Noise from the railway was measured using long term unattended monitoring at Location 1. Additional attended monitoring was conducted on the 6th of September 2019, between 9am and 11am.

3.3.1 Results

The measured noise levels are presented below. The representative levels were determined using the procedure in the NSW EPA Road Noise Policy, there being no equivalent guideline for assessing railway noise.

Table 4 –Railway Noise Levels – Unattended Monitor L1

Location	Summary of Measured Existing Railway Noise Level	
	Daytime (7am-10pm) dB(A) $L_{Aeq\ (15hour)}$	Night time (10pm-7am) dB(A) $L_{Aeq\ (9hour)}$
Location 1 (carpark)	57dB(A)$L_{eq(15hour)}$	54dB(A)$L_{eq(9hour)}$

Note: noise levels monitored would include carpark noise (during the day in particular) and therefore provides a conservative measure of railway noise.

3.4 TRAFFIC NOISE LEVELS

Traffic noise levels were measured using attended and unattended monitoring (from the logger at Location 2).

Table 5 –Traffic Noise Levels – Attended Measurements

Location	Measured Traffic Noise Level, Leq dB(A)
King Street (6.5m from kerb)	53
272 Lawrence Hargrave Drive (3m from kerb)	68

The unattended noise monitor indicated there was a 3 dB(A) difference between the 15 hour and 9 hour levels. Assuming the attended daytime noise levels measured represent the 15 hour (daytime) noise level, the 9 hour level can be estimated by subtracting the measured 15hr/9hr noise difference (which is a conservative assumption given that the hotel contributes to night time noise levels on some nights).

The design noise levels used were therefore 68 dB(A) L_{eq} 15hr and 65 dB(A) levels are presented below.

Table 6 –Design Traffic Noise Levels

Location	Summary of Measured Traffic Railway Noise Level	
	Daytime (7am-10pm) dB(A) $L_{Aeq\ (15hour)}$	Night time (10pm-7am) dB(A) $L_{Aeq\ (9hour)}$
At 23m from Lawrence Hardgrave Drive, Thirroul)	68dB(A)$L_{eq(15hour)}$	65dB(A)$L_{eq(9hour)}$

4 TRAFFIC AND RAILWAY NOISE

4.1 NOISE INTRUSION GUIDELINES

- The Wollongong City Council Development Control Plan 2009;
- NSW Department of Planning and Environment's document – Development Near Rail Corridors or Busy Roads – Interim Guideline/NSW Infrastructure SEPP; and
- Australian and New Zealand AS/NSZ 2107:2016 *'Recommended design sound levels and reverberation times for buildings'.*

4.1.1 The Wollongong City Council Development Control Plan 2009 (DCP)

The Wollongong City Council DCP outlines recommendations for acoustic privacy within residential apartments in

- Chapter B01 – Residential Development, section 6.7; and
- Chapter B03 – Mixed Use Development, section 4.17

However it does not specify any specific acoustic criteria or internal noise level requirements, which can be adopted for this assessment. Therefore, we will adopt the requirements from the documents outlined below.

4.1.2 State Environmental Planning Policy (SEPP) (INFRASTRUCTURE) 2007 (Infrastructure SEPP)

87 Impact of rail noise or vibration on non-rail development

(1) This clause applies to development for any of the following purposes that is on land in or adjacent to a rail corridor and that the consent authority considers is likely to be adversely affected by rail noise or vibration:

(a) residential accommodation,

(b) a place of public worship,

(c) a hospital,

(d) an educational establishment or centre-based child care facility.

(2) Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Secretary for the purposes of this clause and published in the Gazette.

(3) If the development is for the purposes of residential accommodation, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:

(a) in any bedroom in the residential accommodation—35 dB(A) at any time between 10.00 pm and 7.00 am,

(b) anywhere else in the residential accommodation (other than a garage, kitchen, bathroom or hallway)—40 dB(A) at any time.

4.1.3 NSW Department of Planning – *Development near Rail Corridors or Busy Roads – Interim Guideline (DNRCBR)*

The Interim Guideline then provides the time descriptors that are to be adopted in the assessment of road/rail noise (and not provided in SEPP Infrastructure. These are necessary in order to conduct an assessment of noise impacts.

Section 3.5 of the NSW Department of Planning's 'Development near Rail Corridors and Busy Roads (Interim Guideline)' states:

> *"The following provides an overall summary of the assessment procedure to meet the requirements of clauses 87 and 102 of the Infrastructure SEPP. The procedure covers noise at developments for both Road and Rail.*
>
> · *If the development is for the purpose of a building for residential use, the consent authority must be satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:*
>
> o *in any bedroom in the building: 35dB(A) at any time 10pm-7am*
>
> o *anywhere else in the building (other than a garage, kitchen, bathroom or hallway): 40dB(A) at any time."*

4.1.4 Australian and New Zealand AS/NSZ 2107:2016 '*Recommended design sound levels and reverberation times for buildings' (AS2107)*

AS2107-2016: Recommended design sound levels and reverberation times for building interiors recommends internal noise levels for internal spaces within residential and commercial buildings. Table 1, in Section 5 of AS2107-2016, gives the following recommended internal noise levels for and residential buildings near major roads and entertainment precincts.

Table 7 – Recommended Design Sound Level

Space/Activity Type	Recommended Design Sound Level
Living Areas	35 to 45 dB(A)L_{eq}
Sleeping Areas	35 to 40 dB(A)L_{eq}

4.1.5 Summarised Internal Noise Criteria

Based on the above requirements and guidelines, the adopted internal noise criteria are as follows:

Table 8 – Adopted Internal Noise Levels

Space / Activity Type	Required Internal Noise Level
Living Areas	40 dB(A)$L_{eq(15hr)}$
Sleeping Areas (Night Time)	35 dB(A)$L_{eq(9hr)}$

5 OTHER LOCAL NOISE SOURCES

There are two entertainment noise sources in the vicinity of the proposed development:

- Anita's Theatre located north-east of the development site opposite King Street
- Beaches Hotel, which shares a common boundary with the development site.

5.1 ANITA'S THEATRE

This venue operates as a theatre with various productions. All noise producing activities are located indoors.

There are existing residential receivers in Redman Avenue are a similar distance from Anita's as the proposed residences. Noise emissions from Anita's to these existing residences would be similar to that of the proposed residences. Existing compliance at these existing properties will likely result in compliance at the subject development.

Also, the proposed façade treatments to control railway and traffic noise impacts (and noise from the Beaches Hotel) will further mitigate noise from Anita's .

On the above basis, it is concluded that the occupants of the proposed residential development would not be adversely impacted by Anita's Theatre operation, nor would it impose additional noise obligations on Anita's ' operation.

5.2 BEACHES HOTEL

Noise intrusion from the Beaches Hotel was initially determined assuming a sound level of 65 dB(A) at the commercial boundary of the hotel. This is the Amenity Noise Level for commercial receivers adopted in the NSW Noise Policy for Industry. In other words, this is the noise level that the Hotel should be required to comply with assuming the proposed development site remained as a commercial use.

As per the request made by Wollongong City Council additional monitoring of events from the Beaches Hotel was conducted. Monitoring was conducted on two separate occasions over the Christmas/New Year periods 2020/21 and 2021/22, both periods corresponding to minimal or no Covid restrictions.

The monitoring conducted in 2020/21 is summarised in a previous report (refer Appendix B). The summarised noise levels measured in 2020/21 are shown in the following table. The L_{10} noise descriptor has been adopted as this is typically used to assessed noise emissions from licenced premises.

Table 9 – Event Noise Emissions Spectra (2020/21)

Event Date	31.5Hz	63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	dB(A) L_{10}
26/12/2020 19:30	68	66	63	57	58	58	55	49	37	62
27/12/2020 20:45	67	71	71	63	61	59	56	55	41	65
31/01/2020 21:30	68	69	66	61	62	61	56	50	40	65
01/01/2021 00:45	68	70	65	59	61	59	55	47	36	63
03/01/2021 20:45	70	69	66	61	61	61	56	58	49	65

*loudest 15minute period during the event from amplified music and patron noise

Monitoring was conducted over a number of days over the Christmas/New Year period. With the exception of New Years Eve (because this is atypical), music finished prior to 10pm.

The monitoring conducted over the Christmas/New Year period 2021/2022 is summarised below. The monitoring was conducted in a similar location to the previous monitoring. The logger location is closer to the Hotel than the nearest proposed residence and had full view of the hotel. The logging location is shown below. The hotel's outdoor patron area is also visible. The hotel has is a small carpark adjacent to the logging location and this area is also used for waste storage.

LOGGER LOCATION ADJACENT TO HOTEL

VIEW FROM ADJACENT LOGGER LOCATION TO HOTEL

The audio files recorded during the monitoring period were analysed to determine when noise from the hotel entertainment/patrons was audible, which typically occurred on Friday, Saturday and Sunday nights, typically up to 10am but sometimes ceasing prior to midnight. Appendix A shows the noise levels logged which have been annotated.

A noise event typically occurring between 5am and 9am was recorded which is believed to be from delivery vans associated with the existing retail on the site stopping on the street. Given the enclosed loading dock will remove this noise source, it was not assessed.

5.2.1 Patron/Music Noise from Outdoor Spaces

5.2.1.1 Street Terrace

A design noise level for music and patron noise intrusion to the proposed residences was determined by taking the maximum 15 minute L_{10} noise level (the L_{10} level being that typically adopted to assess noise from licenced premises) for each day that music noise was noted, and then calculating the L_{10} level (highest 10%) of those levels (excluding New Years Eve which is atypical). This gives a reasonable design basis for noise emissions. The logging location was close to a reflecting surface so 2.5 dB has been subtracted from the measured noise levels to determine the emitted noise level. Table 13 summarises the measured noise spectra and Table 14 the design noise level adopted.

An assessment of noise intrusion into the proposed dwellings from hotel patrons/music was based on internal noise level criteria that are 10dB(A) below the AS 2107 internal noise levels summarised in Table 7 . This takes into account the character of noise emitted from the licenced premises. Taking a typical 2 dB(A) difference between the L_{10} and L_{eq} descriptors results in assessment criteria of 32 dB(A) L_{10} in bedrooms and 37 dB(A) L_{10} in living rooms based on a repeatable 15 minute maximum L_{10} noise level (determined as previously indicated).

When calculating the façade incident noise levels for the various apartment locations the measured noise level was increased by 3 dB(A) to account for the patron area not being completely visible from the monitoring location, and subtracting the additional distance attenuation to the residences (which are further than the logging location) and any additional barrier effects from the balustrade and building forms.

5.2.1.2 Rear Terrace

There is also a north facing covered, external terrace which contains seating for approximately 80 patrons. The internal gaming lounge opens onto this deck through a louvre.

Noise predictions were made based on an internal noise level of 87 dB(A) L_{eq}, which represents a conservative design noise level for peak us of this space. Calculations were made taking into account the expected loss from the polycarbonate roof sheeting, additional distance and screening from the 1.5m barrier proposed for the boundary and other building elements that prevent direct line of sight to the terrace from most windows except those close to the common boundary.

Table 10 – Rear Terrace Design Peak Sound Pressure Level,dB L_{eq}

63	125	250	500	1000	2000	4000	8000	A-wt
78	79	80	83	84	79	71	61	87

Table 11 – Rear Terrace Roof Design Transmission Loss,dB

63	125	250	500	1000	2000	4000	8000
1	2	4	7	13	13	15	18

5.2.2 Glass Waste and Carpark

Other noise hotel noise sources included general garbage collection and noise from glass tipping into bins. These events occur over a relatively short period (< 15 minutes). The latest monitoring indicates that this glass tipping may occur during the night period. Therefore, the potential impact on sleep has been assessed.

The monitoring indicates that noise levels up to 95 dB(A) were produced. Taking an estimated distance of 10m to the bins gives a sound power level of 123dB(A). This emission level was used with the measured noise spectrum to assess noise intrusion, taking into account the distance loss from source to receiver, and any (where applicable) barrier attenuation provided by balconies, and buildings and the proposed 1.5m high barrier around the hotel carpark.

EPA guidelines indicate that an internal noise of less than 42 dB(A) L_{max} would be clearly acceptable and not result in adverse impacts, and that maximum noise events between 50 and 55 dB(A) at night are unlikely to cause awakenings. A design noise level of 45 dB(A) L_{max} has been adopted, taking into account the character of glass noise, but that glass waste noise does not always occur at night (post 10pm) and is limited in duration.

The carpark is used for general storage and staff car parking. The treatment needed to address glass waste noise will also adequately address noise from these activities.

Table 12 – Glass Waste Sound Power Level (normalised to 0 dB(A)),dB L_{max}

63	125	250	500	1000	2000	4000	8000	A-wt
-10.1	-4.9	-10.9	-13.4	-6.5	-7.2	-3.1	-11.7	0.0

Table 13 – Event Noise Emissions Spectra (2021/22)*

Event Date	31.5Hz	63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	L_{10} dB(A)
24/12/2021	69	74	71	57	58	58	54	47	36	63
26/12/2021	65	70	67	59	58	59	60	59	46	66
14/01/2022	65	73	68	61	61	61	57	51	38	65
15/01/2022	75	78	76	67	66	64	60	52	42	69
16/01/2022	71	79	77	63	61	63	58	50	40	67
21/01/2022	69	70	65	59	60	60	57	48	36	64
22/01/2022	71	74	72	64	64	63	58	52	38	67

*loudest 15minute period during the night's event from amplified music and patron noise. Includes façade reflection

Table 14 – Event Noise Emissions Design Level (2021/22)*

	31.5Hz	63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	L_{10} dB(A)
Design	69	74	71	61	61	61	57	51	39	65

*2.5 dB façade reflection removed

6 NOISE INTRUSION ANALYSIS

Traffic and rail noise intrusion into the proposed development was assessed using the measured noise levels presented above. The assessment was conducted to determine compliance with the adopted internal noise levels summarised in Table 8 (combined noise from rail and traffic).

Calculations were then undertaken considering the orientation of windows, barrier effects (where applicable), the total area of glazing, façade transmission loss and typical room absorption characteristics. In this way the likely interior noise levels can be predicted.

Internal noise levels produced by Beaches Hotel emissions were calculated in a similar way, firstly calculating the façade incident levels (as indicated above) and then calculating the glazing requirement needed to achieve internal noise levels not exceeding the design criteria.

6.1 COMPLYING CONSTRUCTIONS

The following complying constructions were determined from the analysis.

6.1.1 Glazed Windows and Doors

The following constructions are recommended to comply with the project noise objectives. Constructions are to be reviewed/confirmed by the project acoustic consultant prior to construction.

Aluminium framed/sliding doors and windows will be satisfactory provided they meet the following criteria. All external windows and doors listed are required to be fitted with Q-Ion type acoustic seals. (Mohair Seals are unacceptable).

Thicker glazing may be required for structural, safety or other purposes. Where it is required to use thicker glazing than scheduled, this will also be acoustically acceptable.

For façade requirements see the recommended constructions are listed in the table below and glazing markups included in the appendix.

It is recommended that only window systems having test results indicating compliance with the required ratings obtained in a certified laboratory be used where windows with acoustic seals have been recommended. In addition to complying with the minimum scheduled glazing thickness, the R_w rating of the glazing fitted into open-able frames and fixed into the building opening should not be lower than the values listed in the Table 15. Where nominated, this will require the use of acoustic seals around the full perimeter of openable frames and the frame will need to be sealed into the building opening using a flexible sealant.

Table 15 – Minimum Rw of Glazing (with Acoustic Seals)

Glazing Assembly	Minimum Rw of Installed Window
6mm Float	29
6.38mm Laminated	31
10.38mm Laminated	35
12.38mm Laminated	37
10.38mm laminated/100 airgap/10.38mm	45
10.38mm laminated/100 airgap/10.38mm	49

6.1.2 External Wall and Roof Construction

The non-glazed external façade element and roof is proposed to be constructed out of either concrete or masonry construction, no additional upgrades will be required for acoustics.

In the event that any penetrations are required thru the external skin, an acoustic sealant should be used to minimise all gaps.

6.1.3 Apartment Entry Doors

Apartment entry doors will be via internal corridors and as such, constructions will be formulated pursuant to the Building Code of Australia.

6.1.4 Mechanical Ventilation

With respect to natural ventilation of the dwelling, the NSW Department of Planning document Development near Busy Roads and Rail Corridors - Interim Guideline dictates that:

> *If internal noise levels with windows or doors open exceed the criteria by more than 10dB(A), 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.*

With windows open, the allowable internal noise goal is permitted to be 10dB(A) higher than when the windows are closed (i.e. – allowable level in bedrooms becomes 45dB(A), and 50dB(A) in living rooms).

Some units cannot achieve the requirements above with windows/doors open. Therefore, it is recommended that apartments which face the Illawarra Rail line and Lawrence Hardgrave Drive have supplementary fresh air (using either mechanical ventilation or fresh air though one of the other facades) is recommended to ensure ventilation requirements of AS1668 are achieved in these areas.

Similarly, rooms impacted by noise from the hotel (internal noise levels exceeding the windows closed criteria by more than 10 dB(A)) should be provided with a supplementary ventilation system to allow the windows to be closed, if desired.

In the event that a supplementary ventilation system is proposed to be installed, this should be acoustically designed to ensure that the acoustic performance of the acoustic treatments outlined above is not reduced and does not exceed Council criteria for noise emission to nearby properties.

7 RAILWAY VIBRATION ASSESSMENT

Trains induce ground borne vibration that is transmitted through the subsoil. These vibrations can be perceptible close to railways, as tactile vibrations and as structure borne noise.

7.1 PROJECT VIBRATION OBJECTIVES

A rail vibration assessment has been conducted based off the requirements of the following acoustic noise criteria/standards;

- British Standard BS 7385:1990 Part 2 *'Evaluation and measurement for vibration in buildings – part 2'*;
- Australian Standard AS2670:1990 *'Vibration and Shock – Guide to the evaluation of human exposure to whole body vibration';*
- NSW Department of Environment and Conservation's document *'Assessing Vibration: A Technical Guideline';*
- NSW Department of Planning's – '*Developments near Rail Corridors or Busy Roads – Interim Guideline'.*

7.1.1 Tactile Vibration

Human comfort is normally assessed with reference to the British Standard BS 7385 Part 2 1993 or Australian Standard AS 2670.2 1990.

The Interim Guideline references the DECCW *Assessing Vibration- A technical guideline* which recommends that habitable rooms should comply with the criteria therein which is in line with the requirements of British Standard BS 6472:1992 "Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)".

British Standard BS 6472:1992 "Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)" is recommended by the RIC's and SRA's Interim Guidelines for Councils "Consideration of rail noise and vibration in the planning process" as this standard includes guidance for the assessment of human response to building vibration including intermittent vibrations such as that caused by trains.

Human response to vibration has been shown to be biased at particular frequencies, which are related to the orientation of the person. This standard provides curves of equal annoyance for various orientations. These curves are applied as correction filters such that an overall weighted acceleration level is obtained. As the orientation of the resident is unknown or varying the weighting filter used is based on the combined base curve as given in ISO 2631 & Australian Standard 2670 "Evaluation of Human Exposure to Vibration and Shock in Buildings (1 to 80Hz)" which represents the worst case of the X, Y and Z axes. Filtered measurements are made in all three co-ordinate axes and the highest value axis used.

This standard assesses the annoyance of intermittent vibration by using the Vibration Dose Value (VDV). Alternatively the VDV may be estimated by the eVDV which is derived by a simpler calculation using an empirical factor. The VDV or eVDV is calculated for the two periods of the day being the "Daytime" (6am-10pm) and "Night time" (10pm-6am). The overall value is then compared to the levels in Table 16. For this project the aim will be for a low probability of adverse comment.

Table 16 - Vibration Dose Values ($m/s^{1.75}$) above which various degrees of adverse comment may be expected in residential buildings.

Place	Low Probability of adverse comment	Adverse comment possible	Adverse comment probable
Residential buildings 16hr day (Daytime)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8hr night (Night time)	0.13	0.26	0.51

7.1.2 Structure Borne Noise

The Department of Planning 'Development Near rail Corridors and Busy Road – Interim Guideline' only requires structure borne noise assessment to be conducted where buildings or adjacent lands are over railway tunnels. Section 3.6.2 of the standard states the following:

"...Where buildings are constructed over or adjacent to land over tunnels, ground-born noise may be present without the normal masking effects of air born noise. In such cases, residential buildings should be designed so that the 95th percentile of train pass-bys complies with a ground-born L_{Amax} noise limit of 40 dB(A) (daytime and 35 dB(A) (night time) measured using the "slow" response time setting on a sound level meter."

7.2 RAIL VIBRATION MEASUREMENTS

Rail noise measurements were conducted in line with the future proposed Western façade, which is the potentially worst affected façade.

Attended train vibration measurements were conducted on the 6th September 2019. A Svantek 958 Vibration Analyser was used for the vibration measurements. The analyser was fitted with three Svantek SV80 accelerometers.

The measured vibration levels, duration of train passby and the number of rail movements per hour were used to determine the overall vibration dose (VDV) at the proposed development for both daytime and night time periods. The results are presented the table below.

Table 17 - Vibration Dose Values

Time Period	Calculated VDV $m/s^{1.75}$	Criteria VDV $m/s^{1.75}$	Compliance
Day (7am – 10pm)	0.023	0.2 to 0.4	Yes
Night (10pm -7am)	0.018	0.13	Yes

In the event the future train use increases, say by 10%, predicted eVDV will not increase significantly (no more than approximately 0.001 more than the levels predicted in the table above) and will not impact recommended vibration isolation treatments.

7.2.1 Structure Borne Noise Generated by Train Movements

Vibration measurements were also carried out at locations of the proposed habitable space faces away from rail corridor. The structure borne noise generated by the vibration has been predicted below based on the measured vibration level from 1Hz to 10KHz.

Table 18 –Predicted Structure Borne Noise dB(A) L_{Max}

Location	Predicted Structure Borne Noise Level	Criteria	Compliance
Western façade	<35dB(A)L_{max}	35 dB(A) L_{max}	Yes

In any case, the proposed dwellings will also be exposed to levels of air borne noise, so there is no requirement to comply with the structure borne noise level.

7.3 RECOMMENDATIONS

Measurements above indicated that the overall vibration dose (VDV) at the proposed development for both daytime and night time period comply with the requirements of British Standard BS 7385 Part 2 1993 or Australian Standard AS 2670.2 1990. Structure borne noise generated by the train movements to the project site complies with the requirements of The Department of Planning 'Development Near Rail Corridors and Busy Road – Interim Guideline' therefore no vibration isolation is required for the proposed development.

8 NOISE EMISSION ASSESSMENT

A noise emission assessment has been carried out to ensure noise emitted from the use of the site is in accordance with the requirements listed below.

8.1 NOISE EMISSION CRITERIA

8.1.1 The Wollongong City Council Development Control Plan 2009

The Wollongong City Council DCP does not specify any noise emission which can be adopted for this assessment. Therefore, we will adopt the requirements from the documents outlined below.

8.1.2 NSW Environmental Protection Authority (EPA) document – 'Noise Policy for Industry (NPfI) 2017

The NPfI provides guidelines for assessing noise impacts from developments. The recommended assessment objectives vary depending on the potentially affected receivers, the time of day, and the type of noise source. The NPfI has two requirements which both have to be complied with namely, an amenity criterion and an intrusiveness criterion.

8.1.2.1 Intrusiveness Criterion

The guideline is intended to limit the auditability of noise emissions at residential receivers and requires that noise emissions measured using the L_{eq} descriptor not exceed the background noise level by more than 5dB(A). The lower of the measured background noise levels for each period have been adopted.

Table 19 – NPfI Intrusiveness Criteria

Receiver	Time of Day	Background Noise Level dB(A)$L_{90(15min)}$[(1)]	Intrusiveness Criteria (background + 5dB(A) $L_{eq(15mins)}$)
Residential Receiver	Day (7am-6pm)	48	53
	Evening (6pm-10pm)	47	52
	Night (10pm-7am)	42	47

Note 1: Rating background noise levels have been adopted as per the lowest RBLs across Locations 1 and 2.

8.1.2.2 Amenity Criterion

The guideline is intended to limit the absolute noise level from all noise sources to a level that is consistent with the general environment.

The NPfI sets out acceptable noise levels for various land uses. Table 2.2 on page 11 of the policy has four categories to distinguish different residential areas. They are rural, suburban, urban and urban/industrial interface. The surrounding receivers and land uses located in a commercial district next to an arterial road. Taking this into account and the measured ambient noise levels an urban category has been adopted for nearby residences.

Table 20 – NPfI Project Amenity Criteria

Type of Receiver	Time of Day	Amenity Criteria dB(A)$L_{eq(15mins)}$
Residential (Urban)	Day (7am-6pm)	58
	Evening (6pm-10pm)	48
	Night (10pm-7am)	43
Commercial	When in use	63

8.1.3 Summarised Noise Emission Criteria

Summary for noise emission criteria for noise emission associated with the development has been summarised below.

Table 21 – Summary of Noise Emission Criteria

Receiver	Time of Day	Background Noise Level dB(A)$L_{90(period)}$	Amenity Criteria dB(A)$L_{eq(15mins)}$	Intrusiveness Criteria (Background + 5dB(A)$L_{eq(15mins)}$)	Project Noise Emission Goal dB(A)$L_{eq(15mins)}$
Residential (Urban)	Day (7am-6pm)	48	58	53	53
	Evening (6pm-10pm)	47	48	52	48
	Night (10pm-7am)	42	43	47	43
Commercial	When in use	-	63	-	63

8.2 MECHANICAL PLANT NOISE

Detailed plant review has not been undertaken at this stage, as plant selections have not been determined. A detailed acoustic review of mechanical plant is recommended prior to the issue of a CC to determine acoustic treatments to control noise and vibrations emissions to satisfactory levels.

9 COMMUNAL OPEN SPACE

The ADG Objective 4H-1 guidance note indicates that communal open spaces should be located at least 3m from bedrooms. The proposed communal spaces are at least 3m from any bedrooms, or may be effectively made 3m from any bedrooms by making windows non-openable, with a minimum 5% of floor area of openable window area available from windows outside the 3m distance.

Communal open space provides the opportunity for the residents to participate in a range of outside activities. For these spaces, it is typical that for a significant proportion of the time they are either not used, or used for passive purposes that do not generate significant noise.

ADG Section 4J envisages that there will be situations where occupants need to choose between more noise and less natural ventilation (refer Figure 4J-2). Activities in the communal area can be managed with by-laws (restricting the types of activities and times of use) to provide an appropriate balance between use of the space and amenity of residences facing the communal space. The noise producing activities carried out in communal open space would include a range of activities similar to what would normally occur in residential back yards or public parks. In comparison, it is easier to regulate the activities in communal spaces.

10 SITE PLANNING

The proposed development has been planned with buildings around a central communal open space. Two of the boundaries of the site are impacted by traffic noise and one by railway noise. This arrangement screens the communal area from noise. Impacts to residences facing the noise sources are mitigated as indicated in this assessment to comply with the relevant guidelines. Facades facing the communal open space also then experience reduce noise exposure.

An alternative site arrangement with a number of buildings perpendicular to the noise sources would minimise the dwellings exposed to the highest external noise levels, but would expose more dwellings to noise because noise will permeate deeper into the site and also affect any communal open space. Internal noise levels with windows closed would not be improved given that the same noise objectives would apply in both scenarios.

The proposed awning to the eastern façade, and Level 2 of the buildings facing Lawrence Hargrave Drive have been set back from the boundary; both measures moderate traffic noise levels by screening vehicle noise as recommended in DNRCBR.

11 CONCLUSION

This report presents an acoustic assessment of noise impacts associated with the proposed mixed use development to be located at 303-304 & 282-298 Lawrence Hargrave Drive, Thirroul. Based on the information provided above we conclude that the proposed development is capable of complying with the following guidelines:

- The Wollongong City Council Development Control Plan 2009;
- NSW Environmental Protection Authority (EPA) Noise Policy for Industry (NPfI) 2017;
- NSW Department of Planning and Environment's document – Developments near Rail Corridors or Busy Roads – Interim Guideline 2008; and
- AS/NZS 2107:2016 '*Acoustics – Recommended design sound levels and reverberation times for building interiors*.

The report provides constructions/treatments that would achieve compliance with the recommended assessment criteria.

Noise emissions criteria for operational plant noise emissions have been determined and the recommended criteria are presented in this report to satisfy the requirements from the following documents;

- The Wollongong City Council Development Control Plan 2009;
- NSW Environmental Protection Authority (EPA) Noise Policy for Industry (NPfI) 2017;

A detailed acoustic review of the noise emissions from the proposed development should be undertaken at CC stage

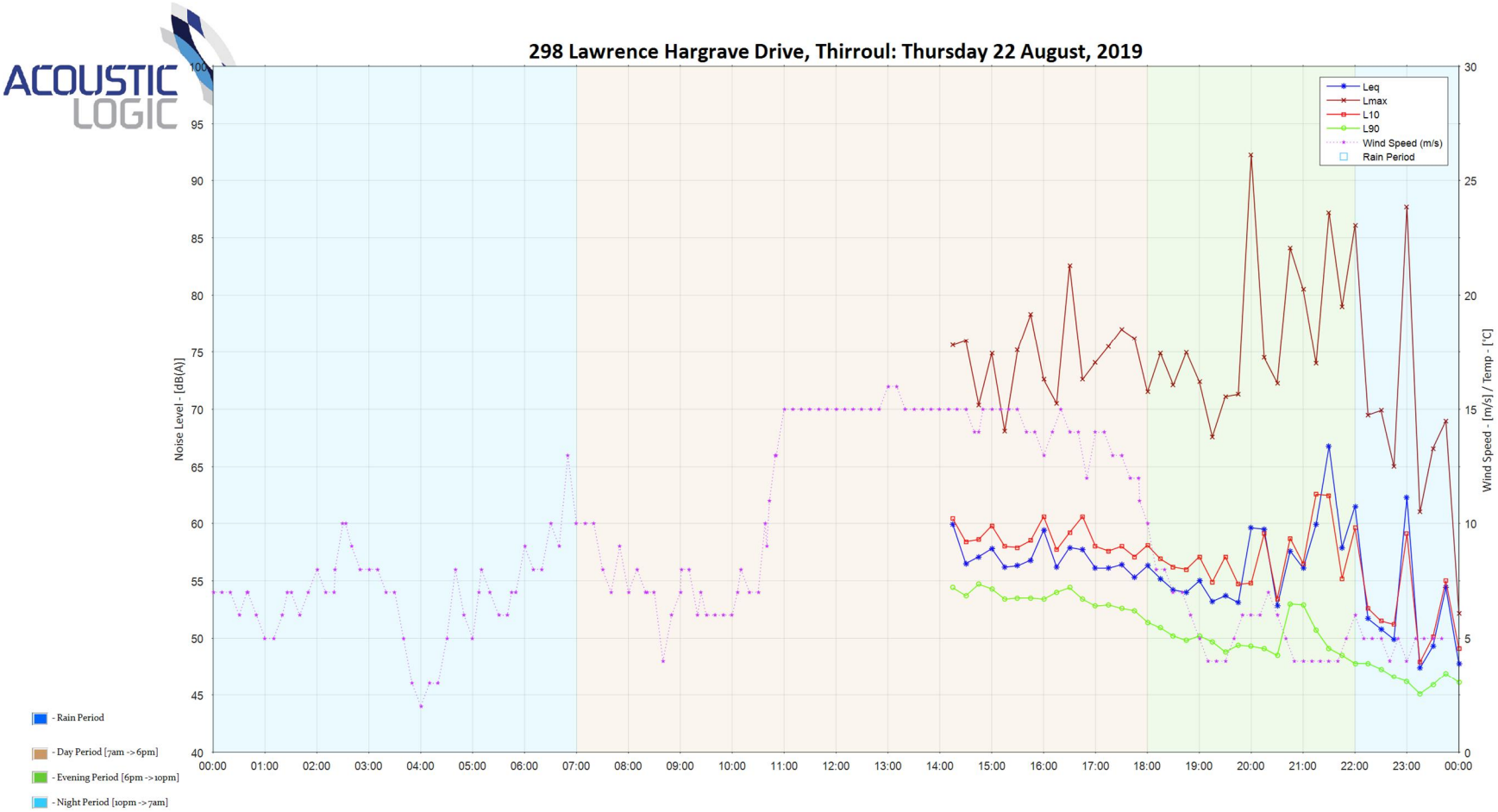
Yours faithfully,

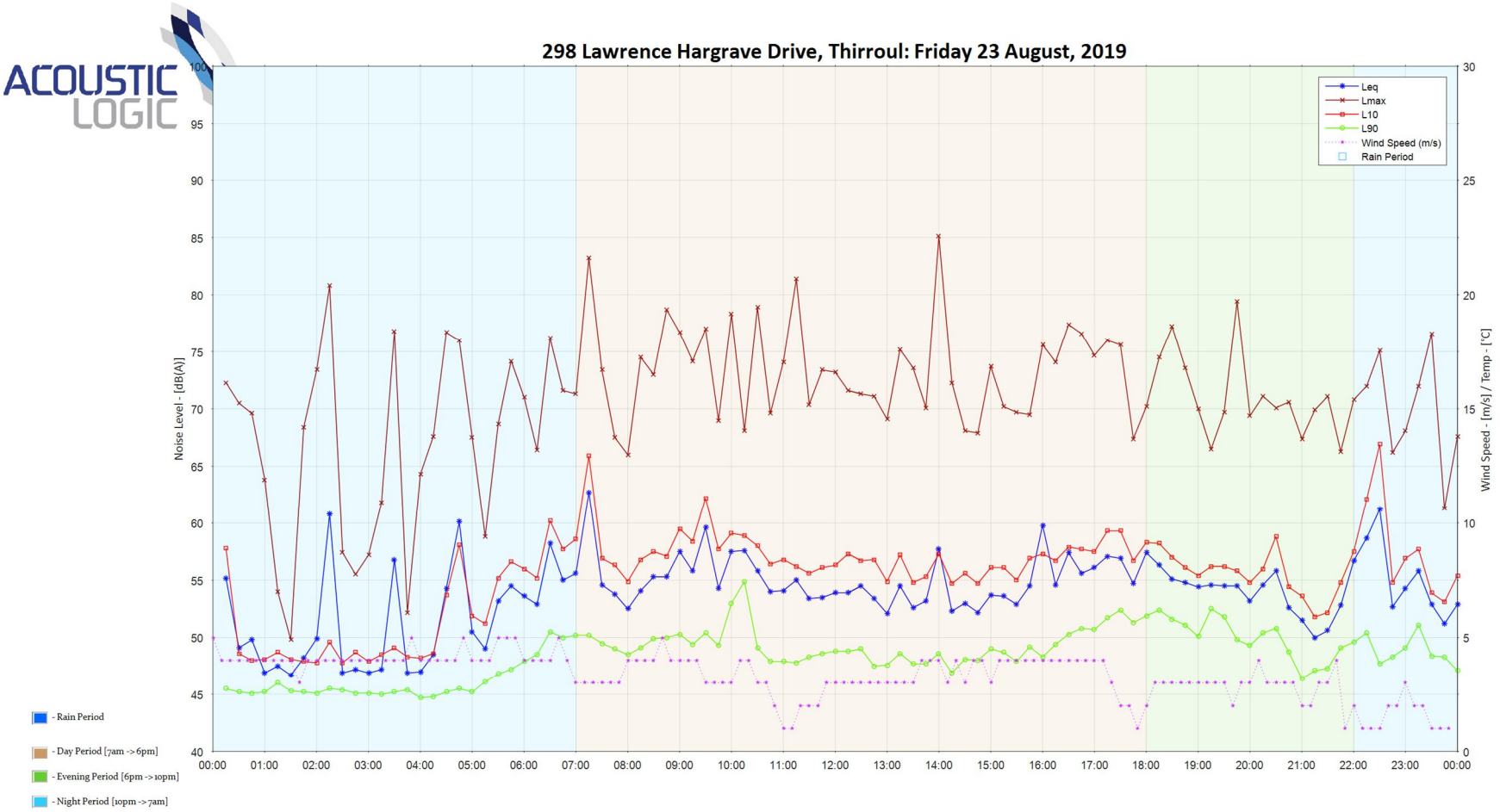
Acoustic Logic Pty Ltd
Victor Fattoretto

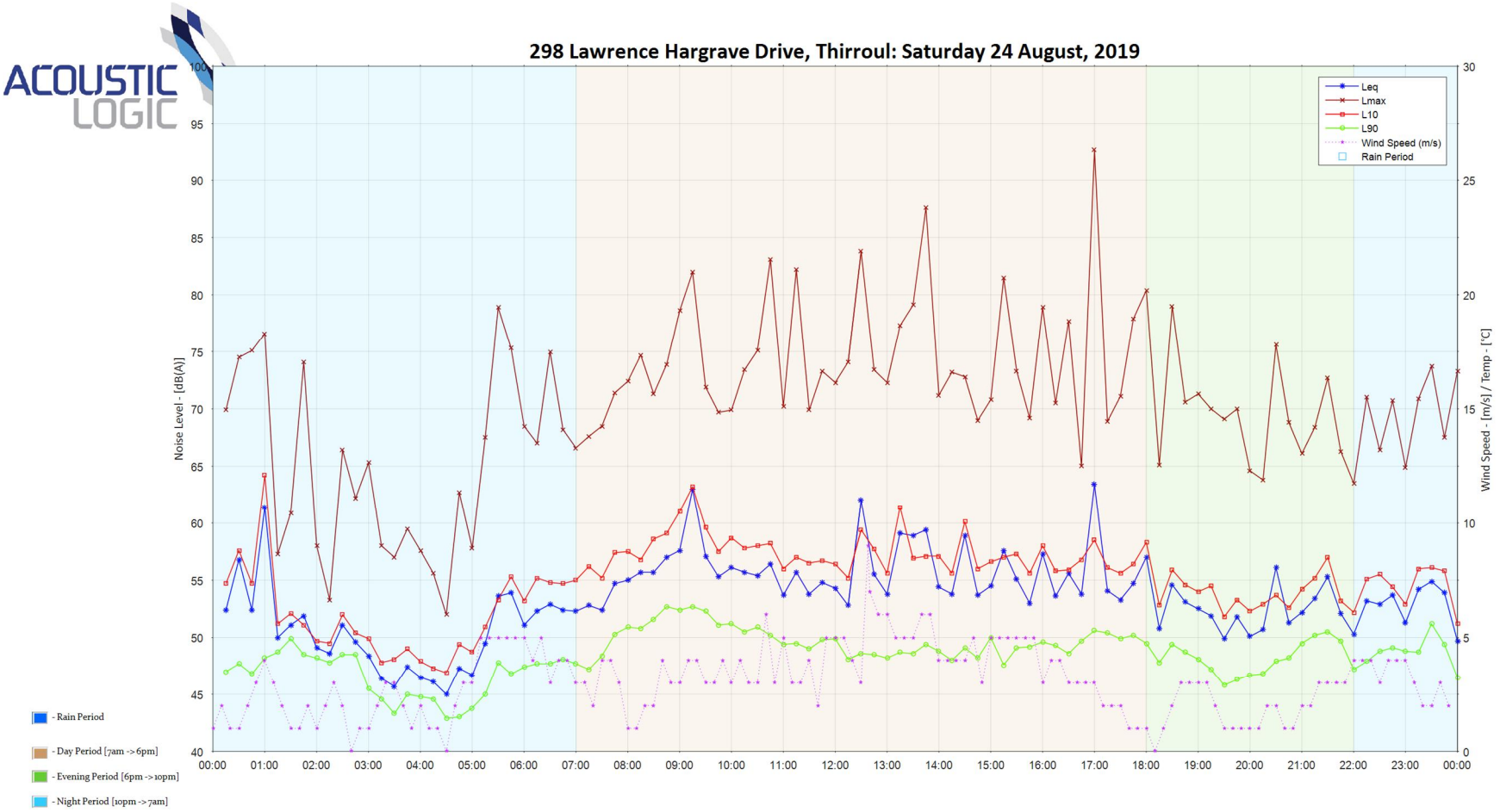
APPENDIX A – UNATTENDED NOISE MONITORING DATA

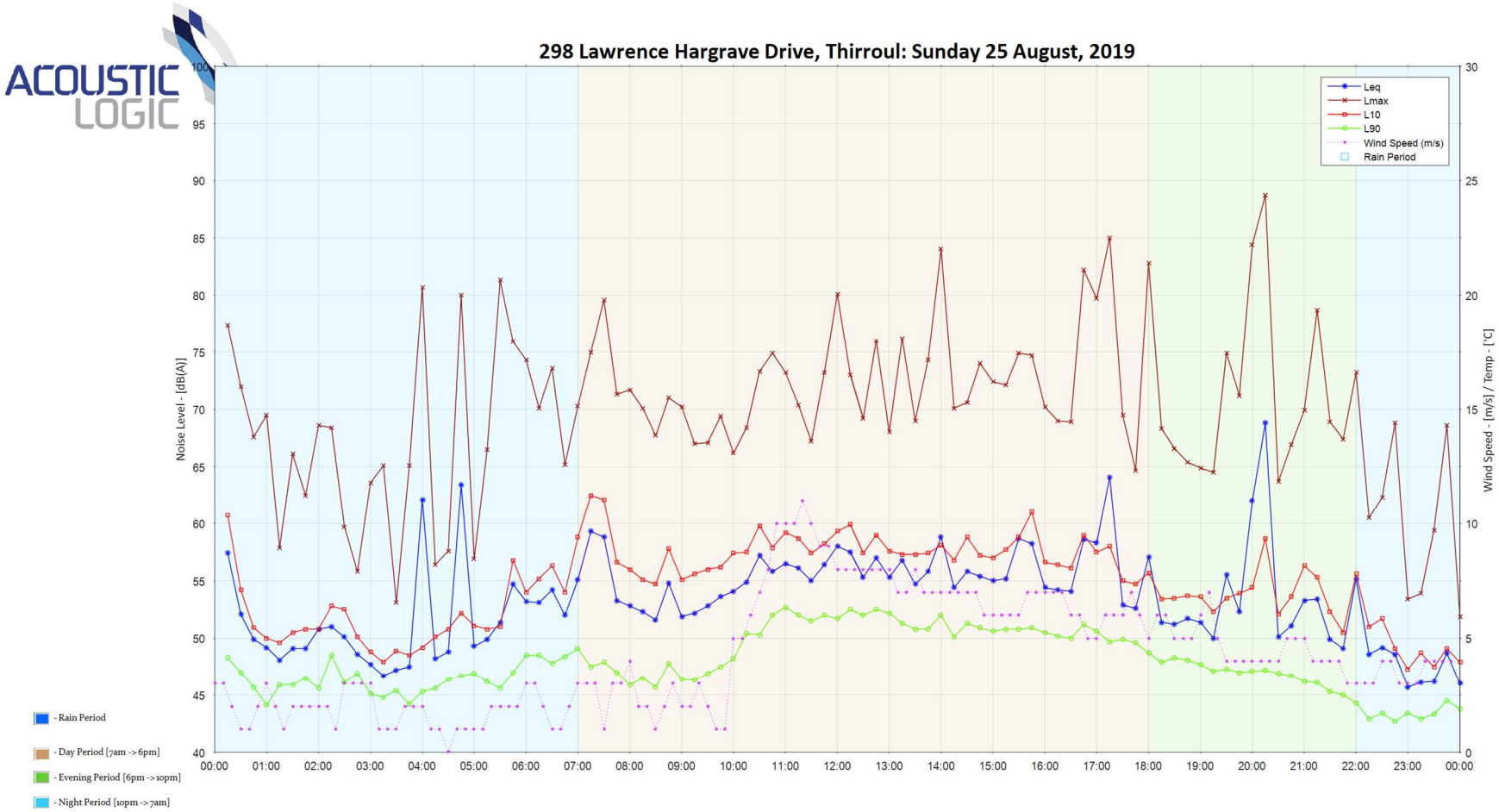
LOCATION 1

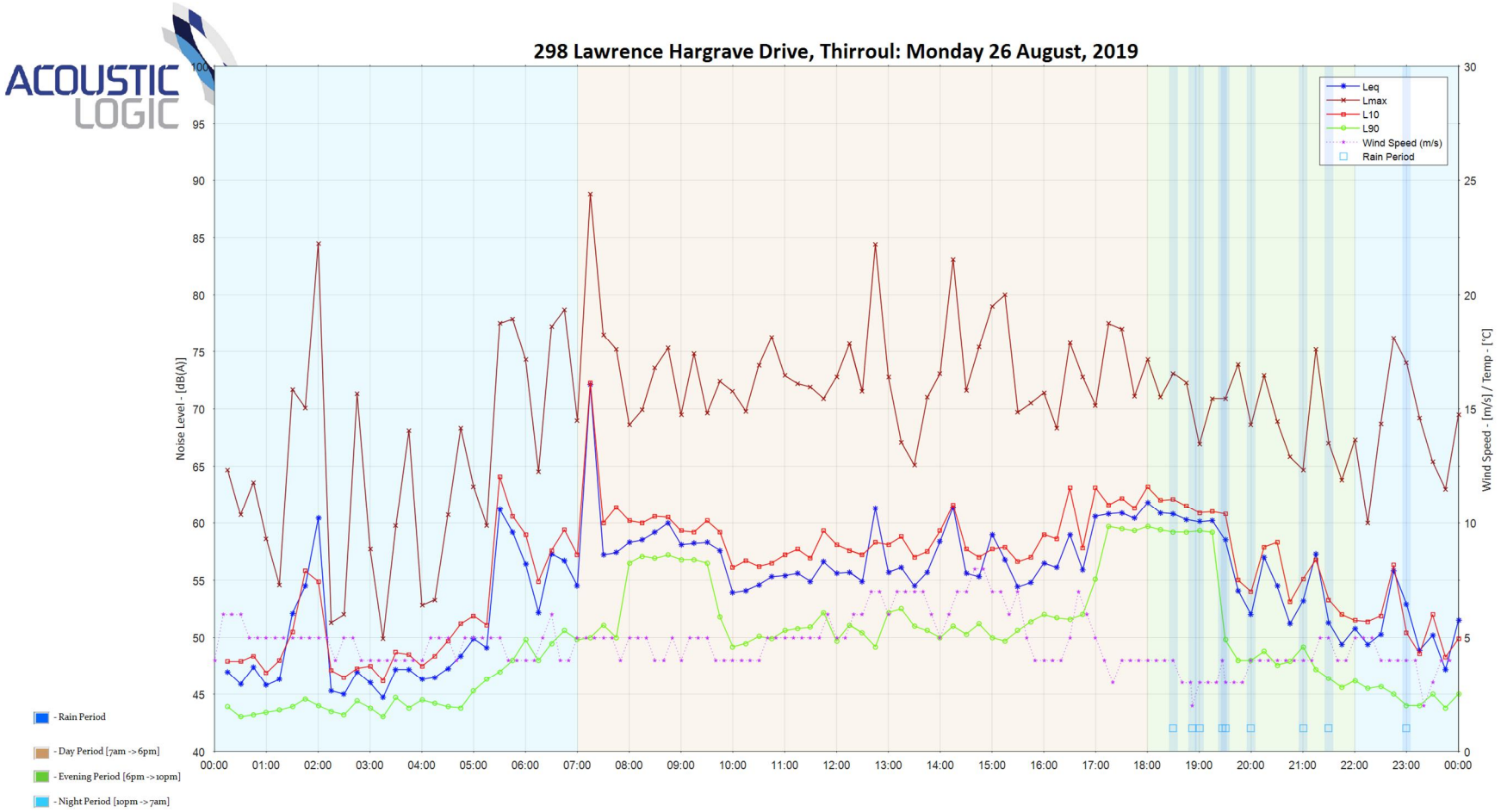
(Note : Wind speeds are raw speeds uncorrected for boundary layer reductions)

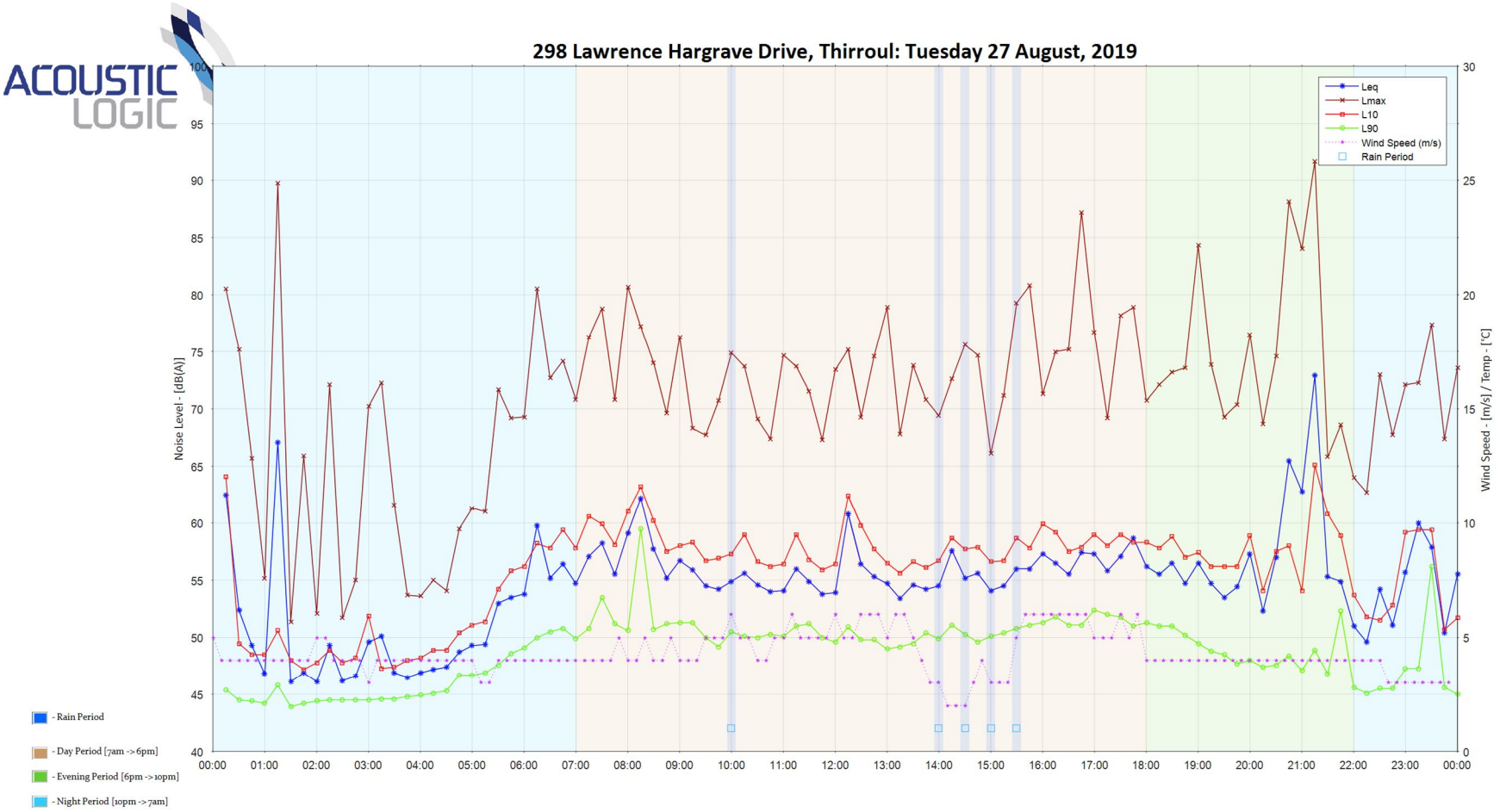

298 Lawrence Hargrave Drive, Thirroul: Thursday 22 August, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

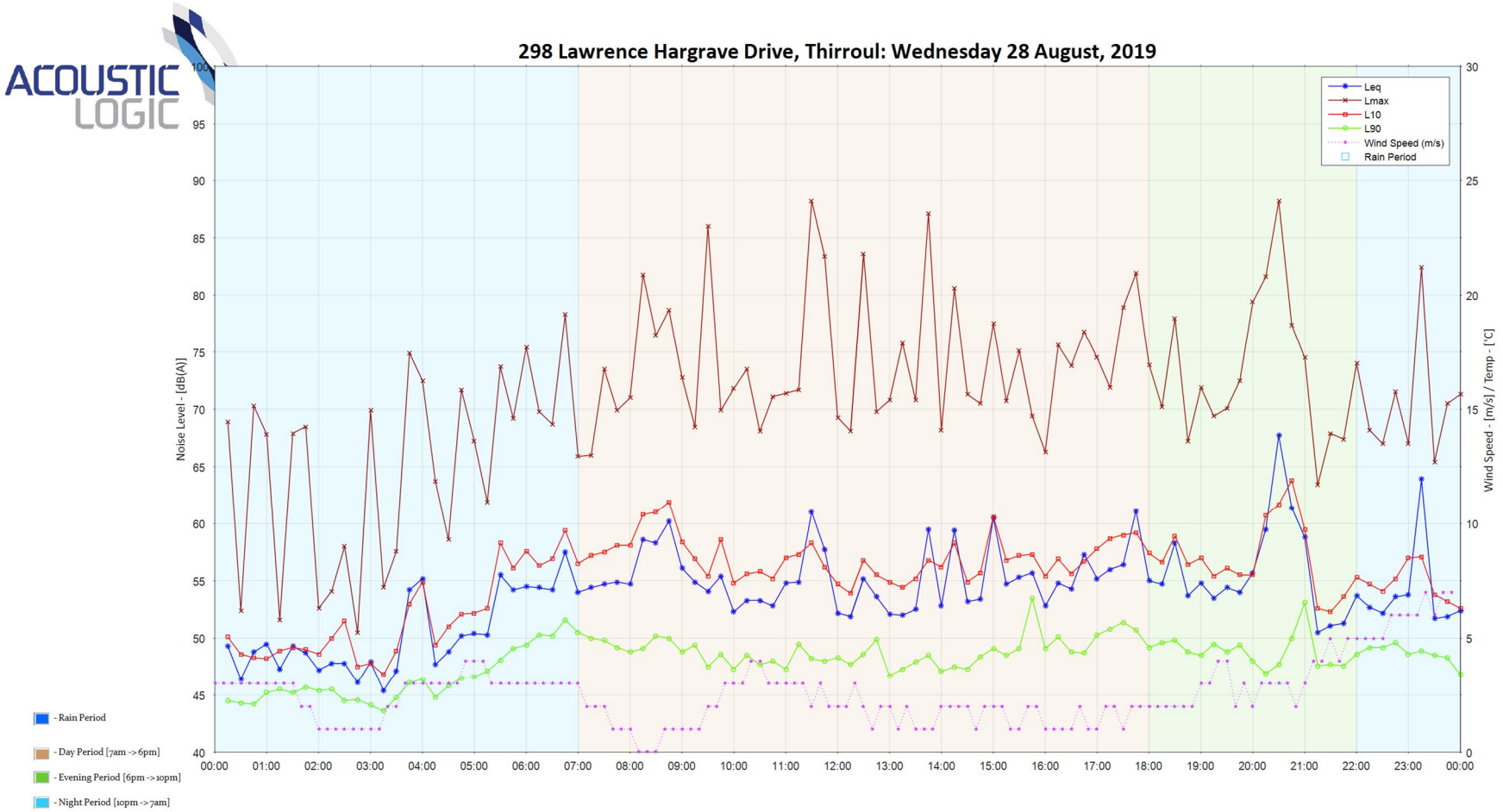

298 Lawrence Hargrave Drive, Thirroul: Friday 23 August, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

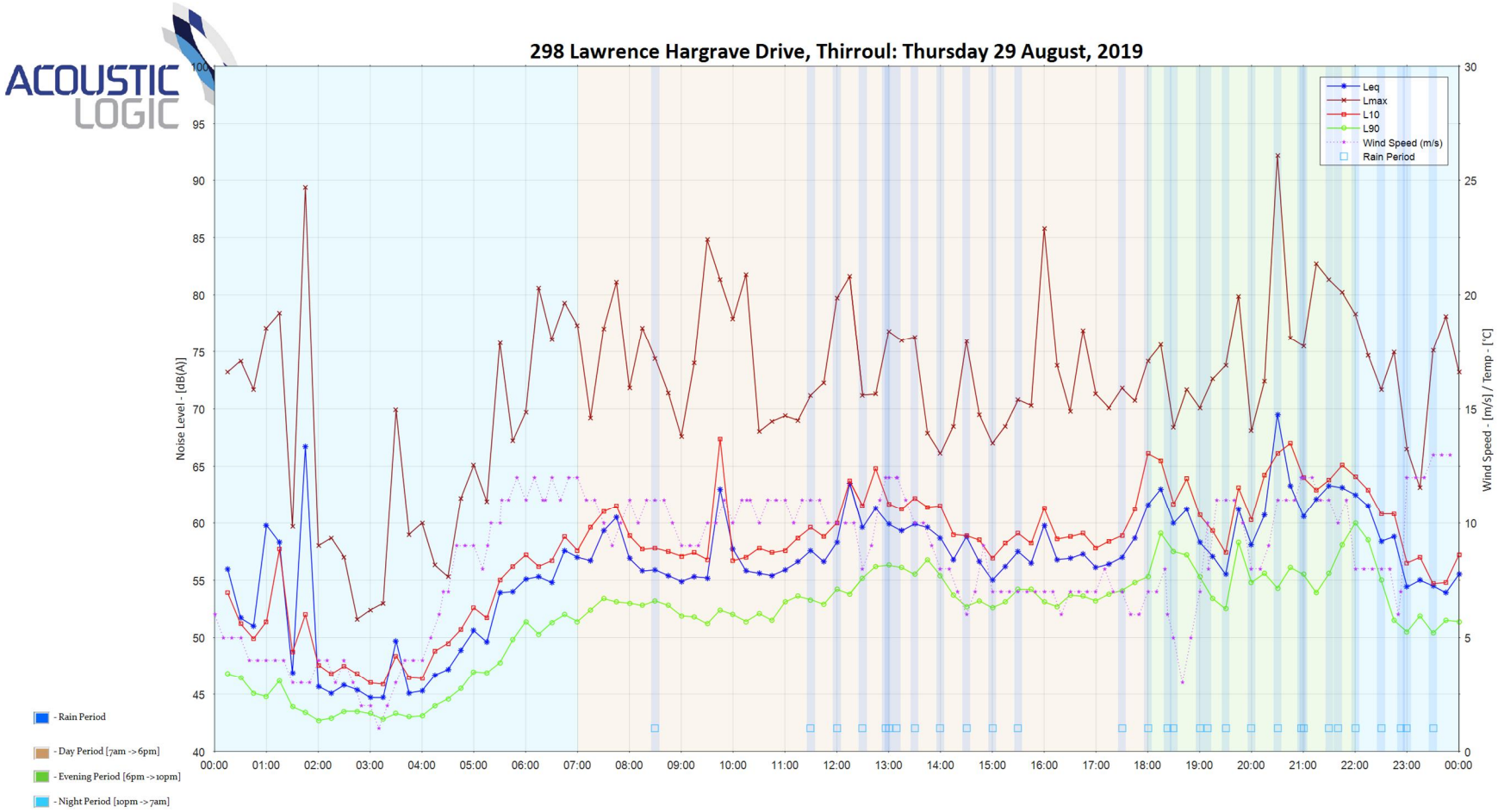

298 Lawrence Hargrave Drive, Thirroul: Saturday 24 August, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

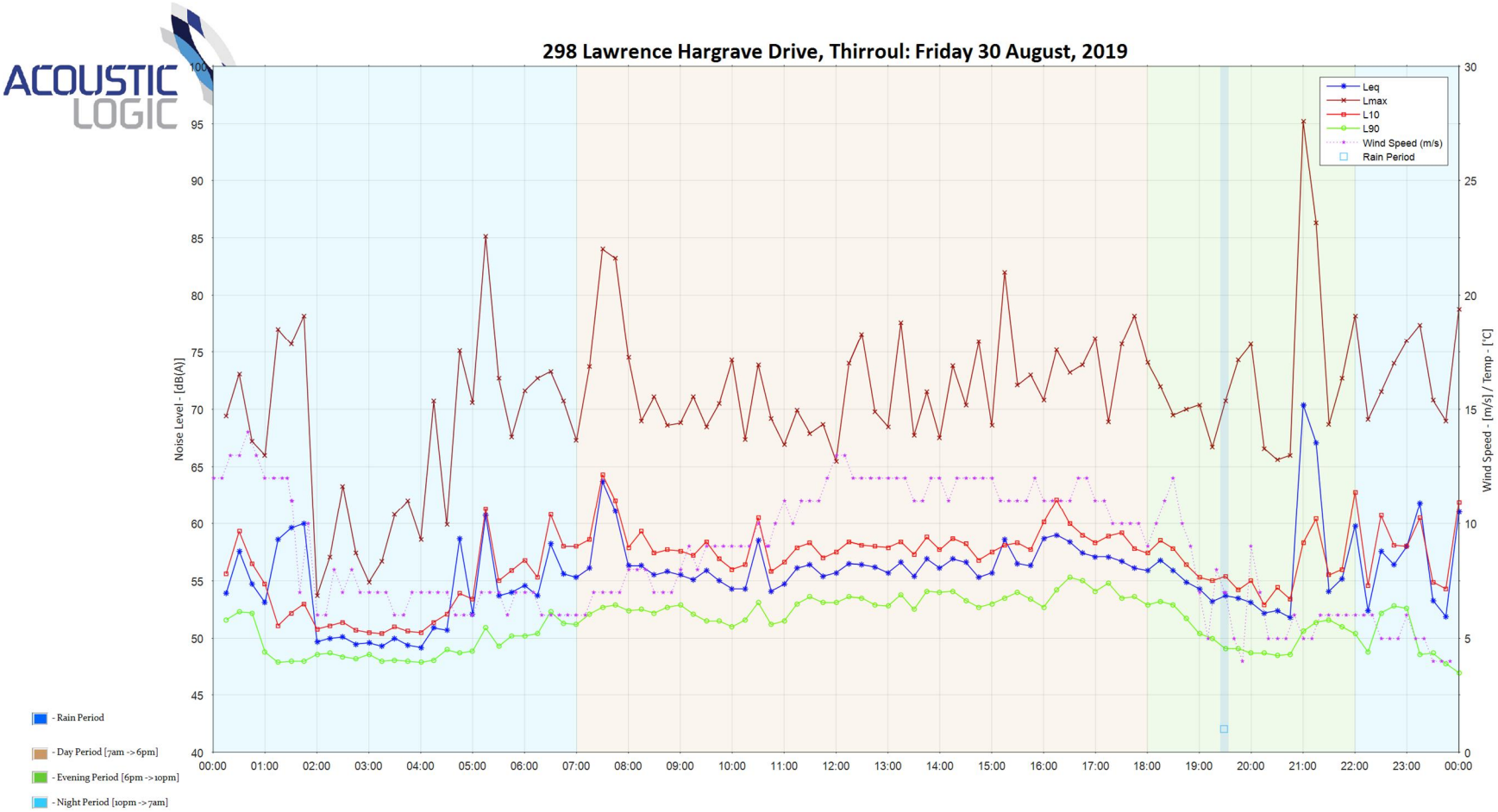

298 Lawrence Hargrave Drive, Thirroul: Sunday 25 August, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

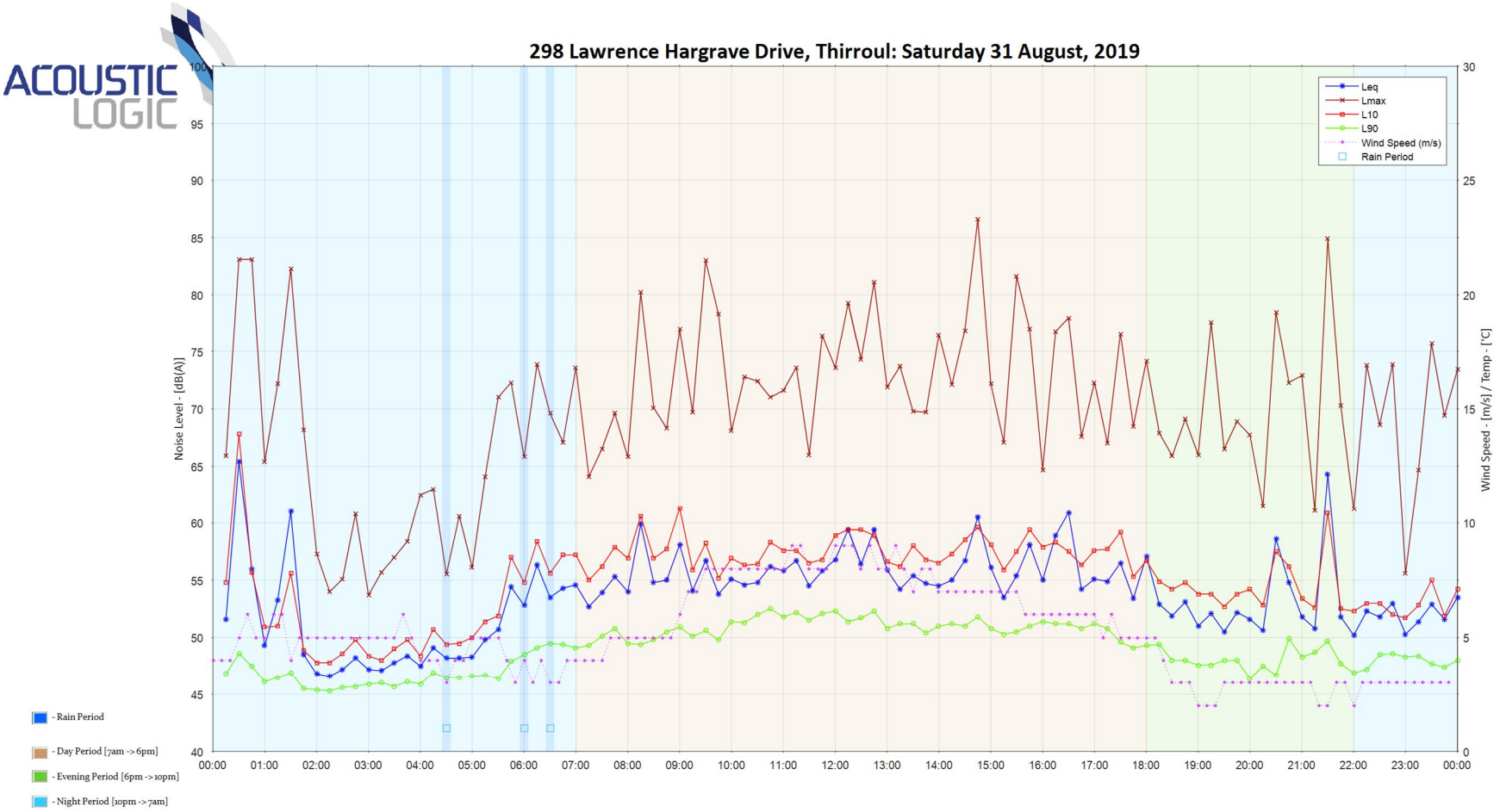

298 Lawrence Hargrave Drive, Thirroul: Monday 26 August, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

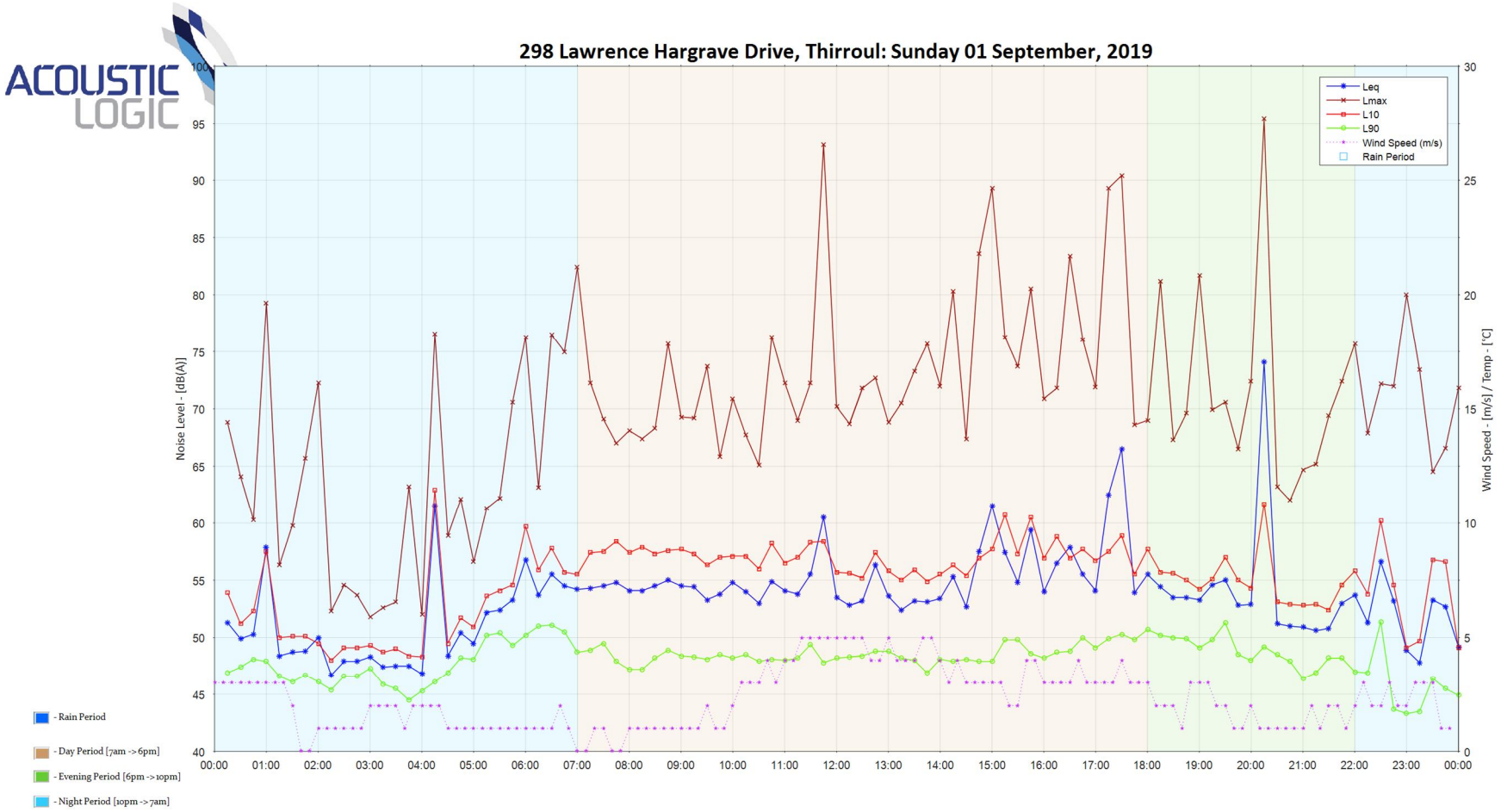

298 Lawrence Hargrave Drive, Thirroul: Tuesday 27 August, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

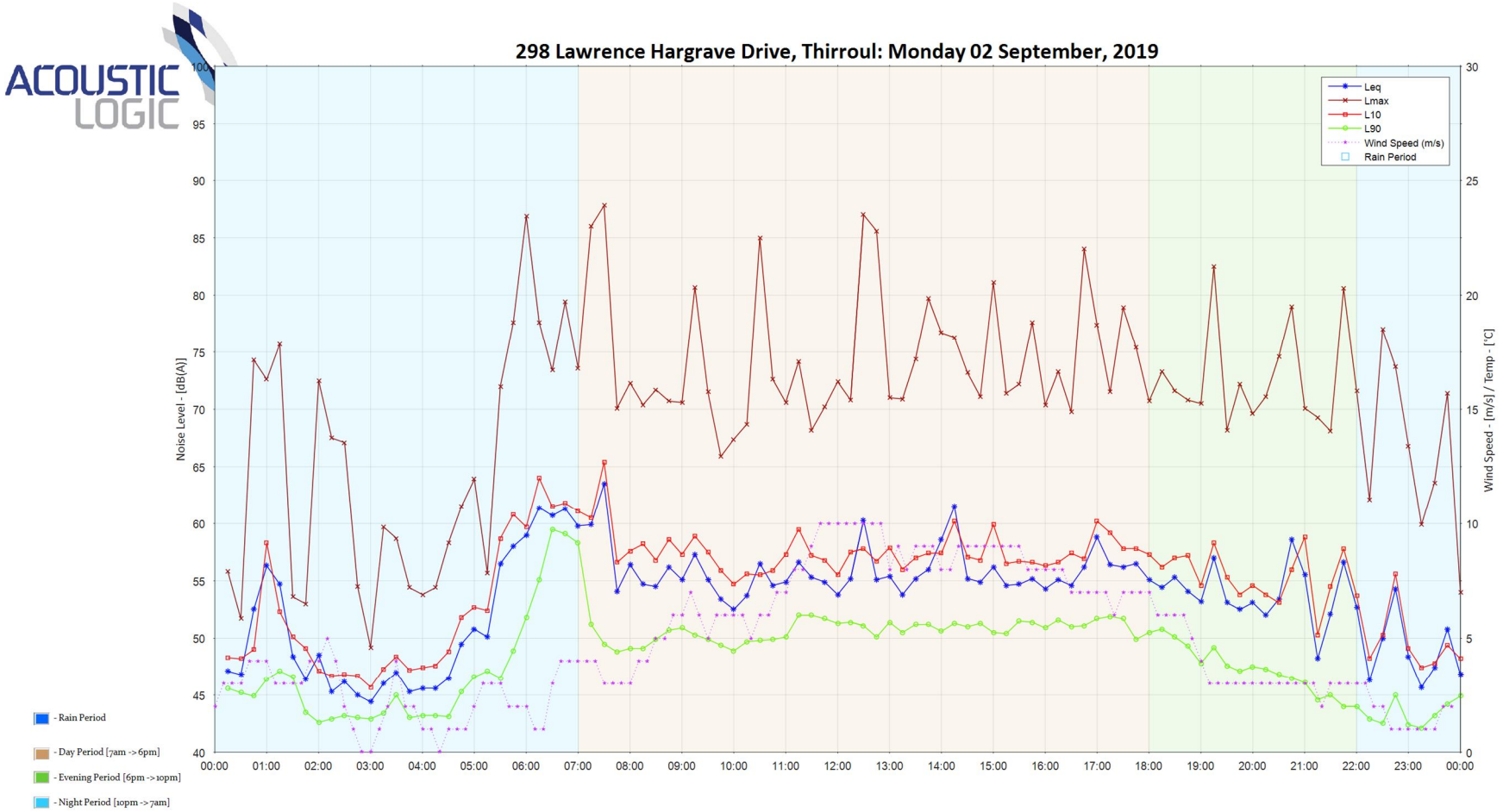

298 Lawrence Hargrave Drive, Thirroul: Wednesday 28 August, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

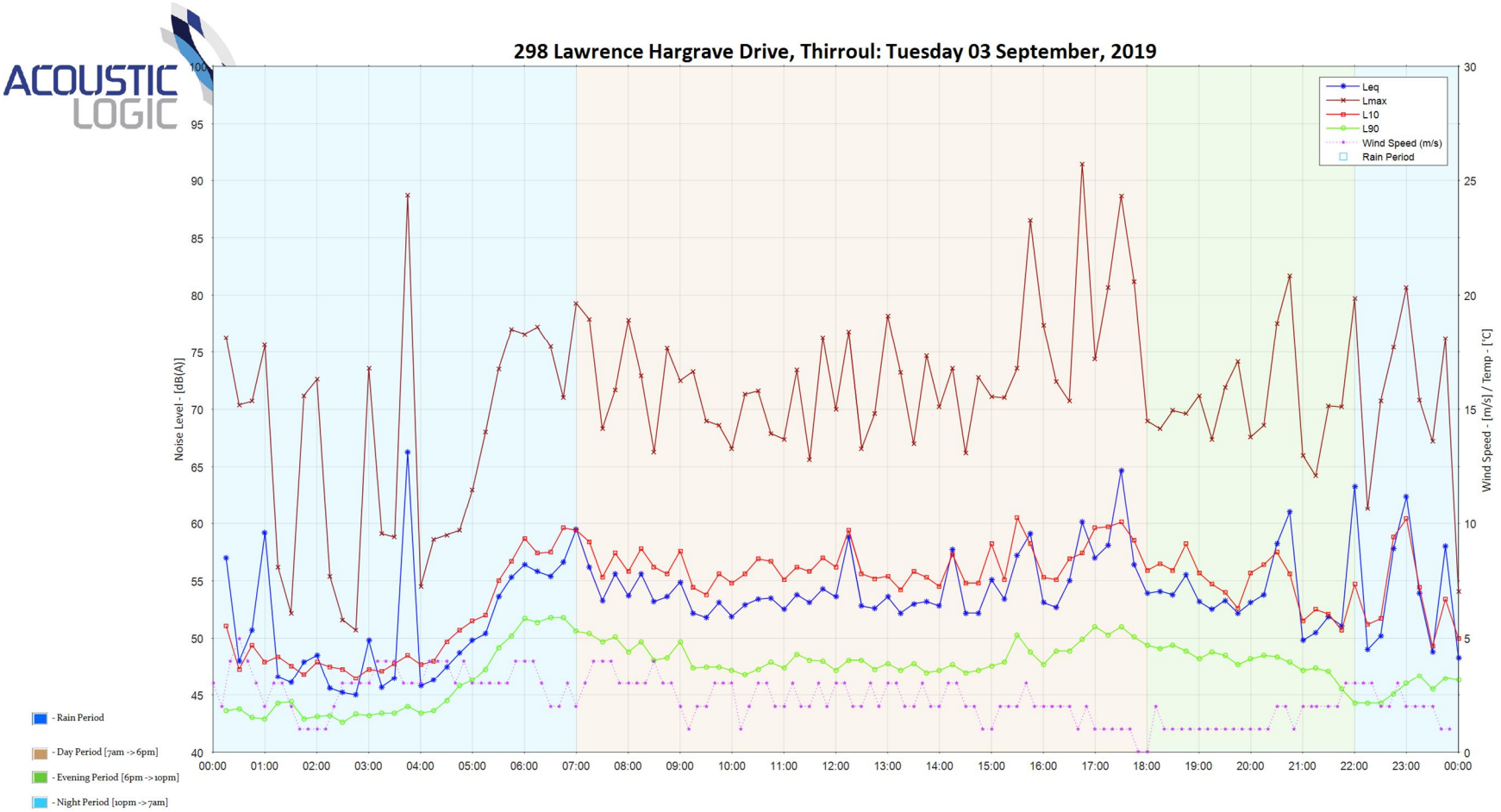

298 Lawrence Hargrave Drive, Thirroul: Thursday 29 August, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

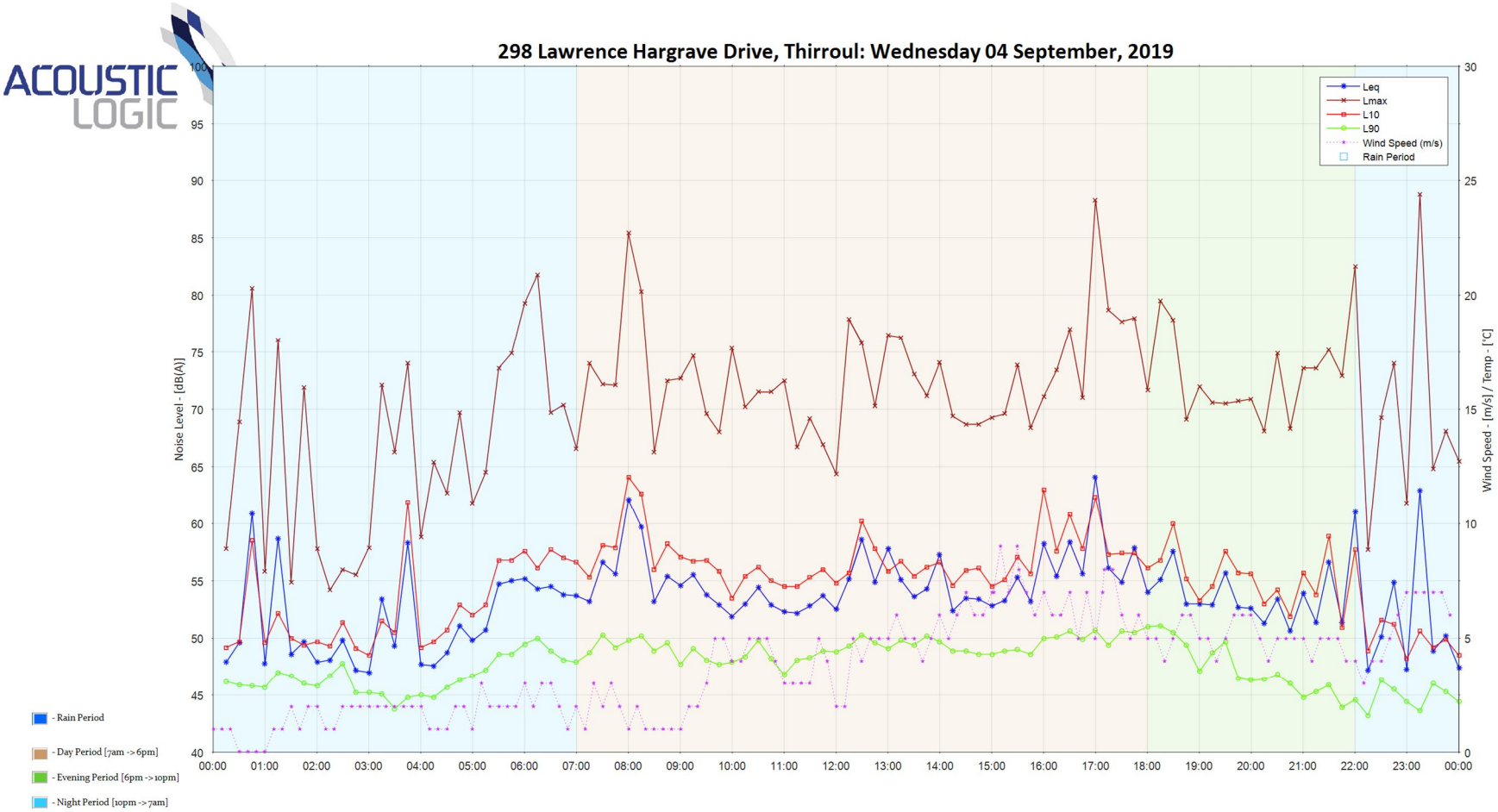

298 Lawrence Hargrave Drive, Thirroul: Friday 30 August, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

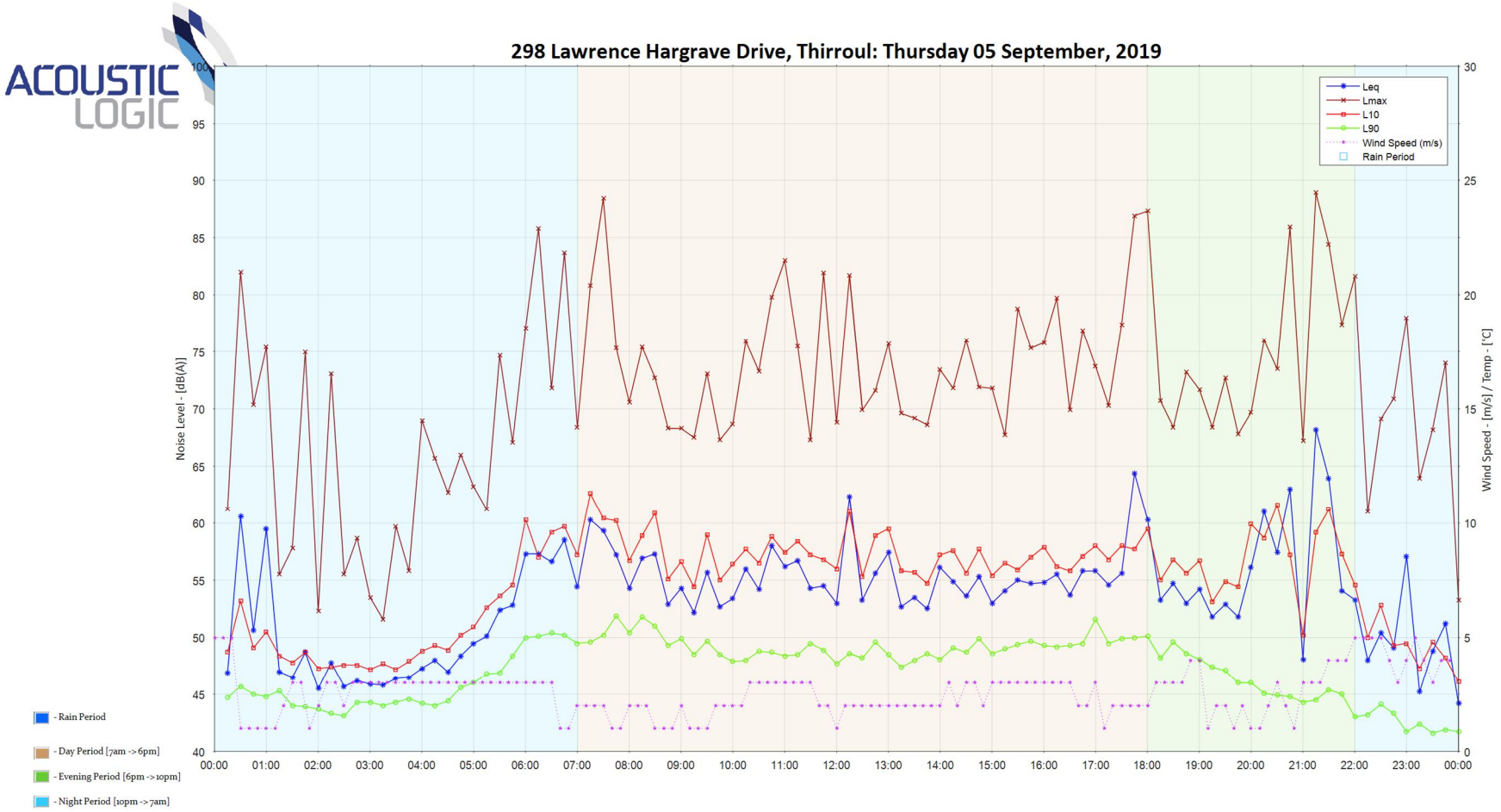

298 Lawrence Hargrave Drive, Thirroul: Saturday 31 August, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

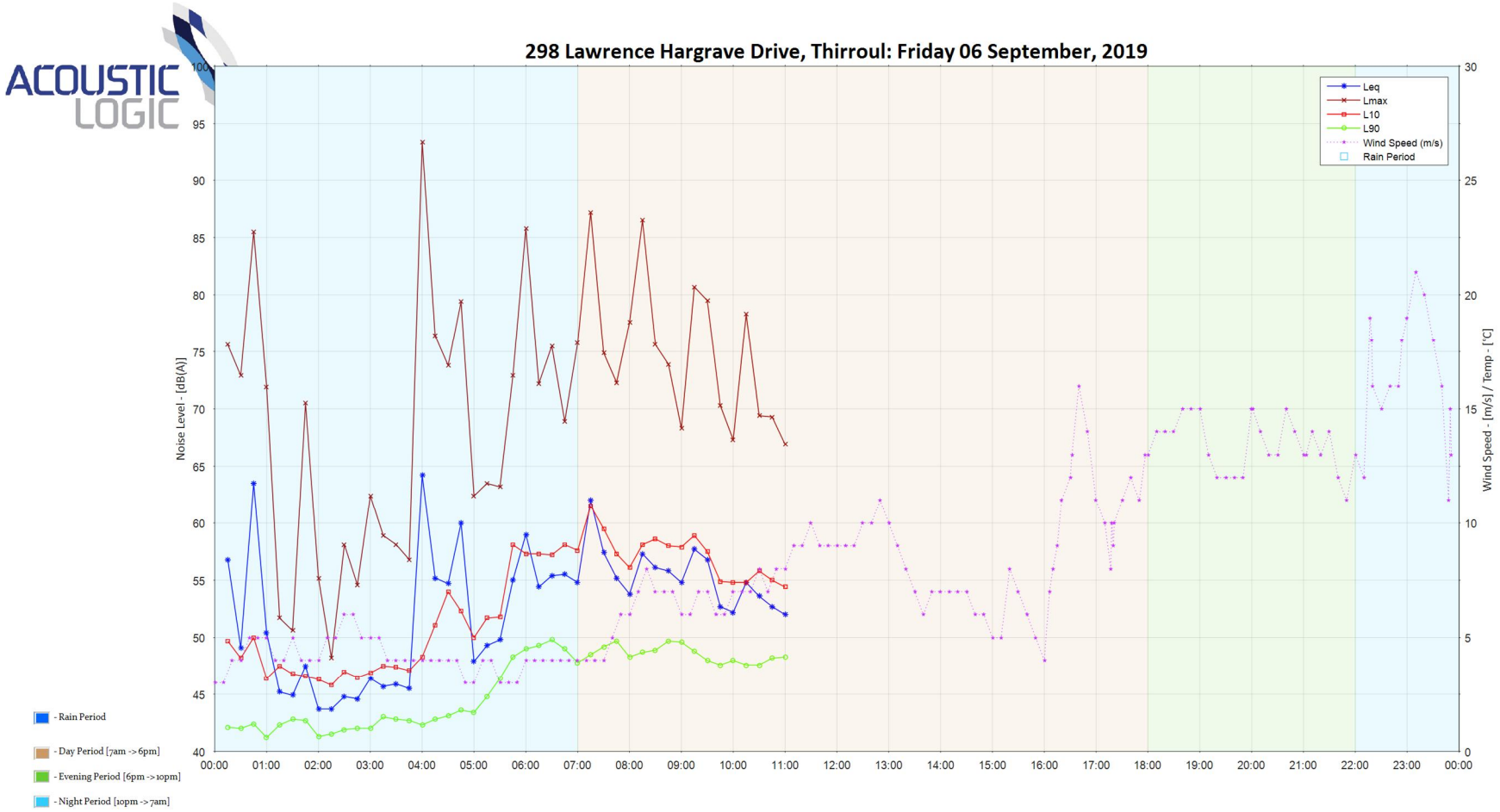

298 Lawrence Hargrave Drive, Thirroul: Sunday 01 September, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]


298 Lawrence Hargrave Drive, Thirroul: Monday 02 September, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]


298 Lawrence Hargrave Drive, Thirroul: Tuesday 03 September, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

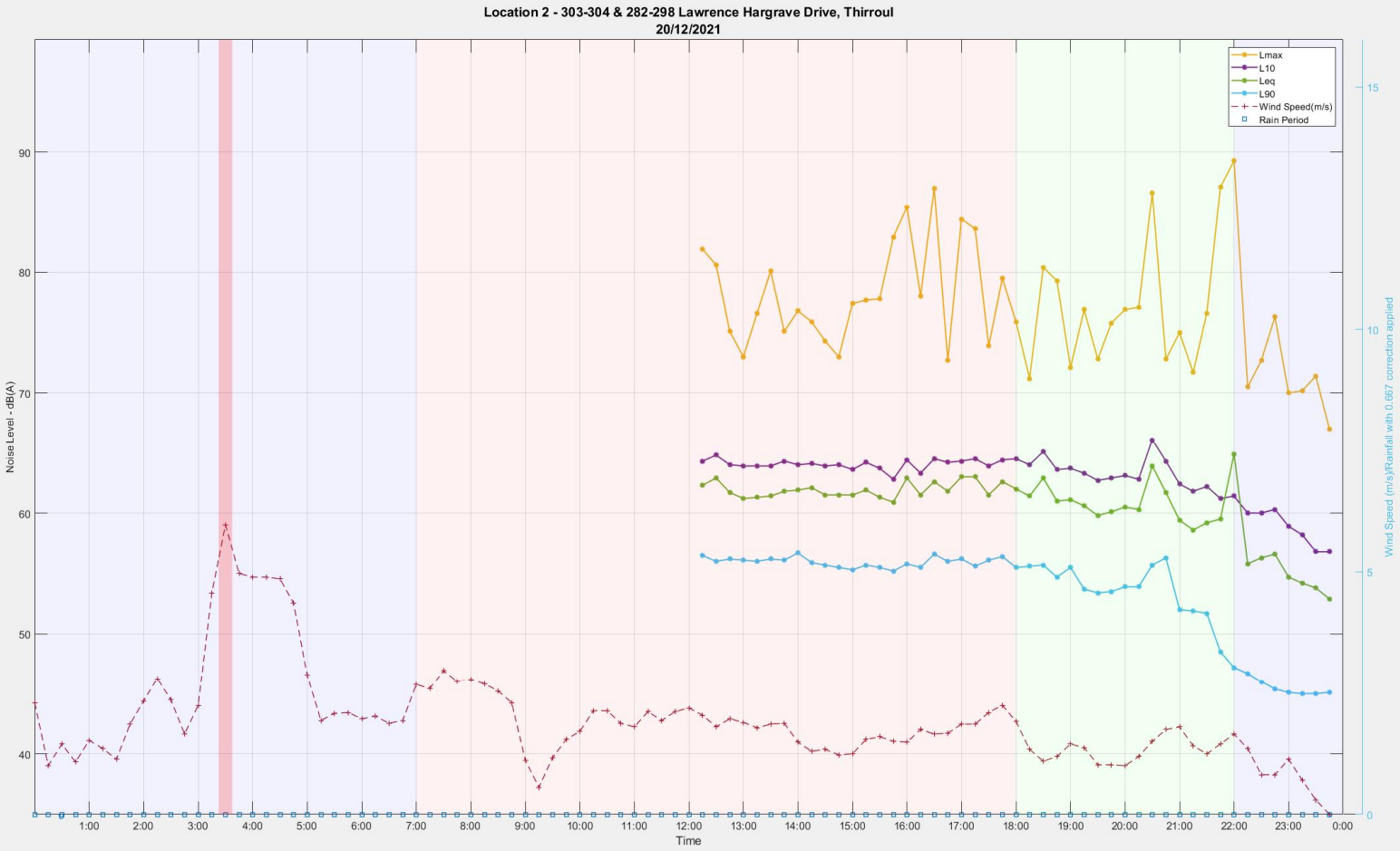

298 Lawrence Hargrave Drive, Thirroul: Wednesday 04 September, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

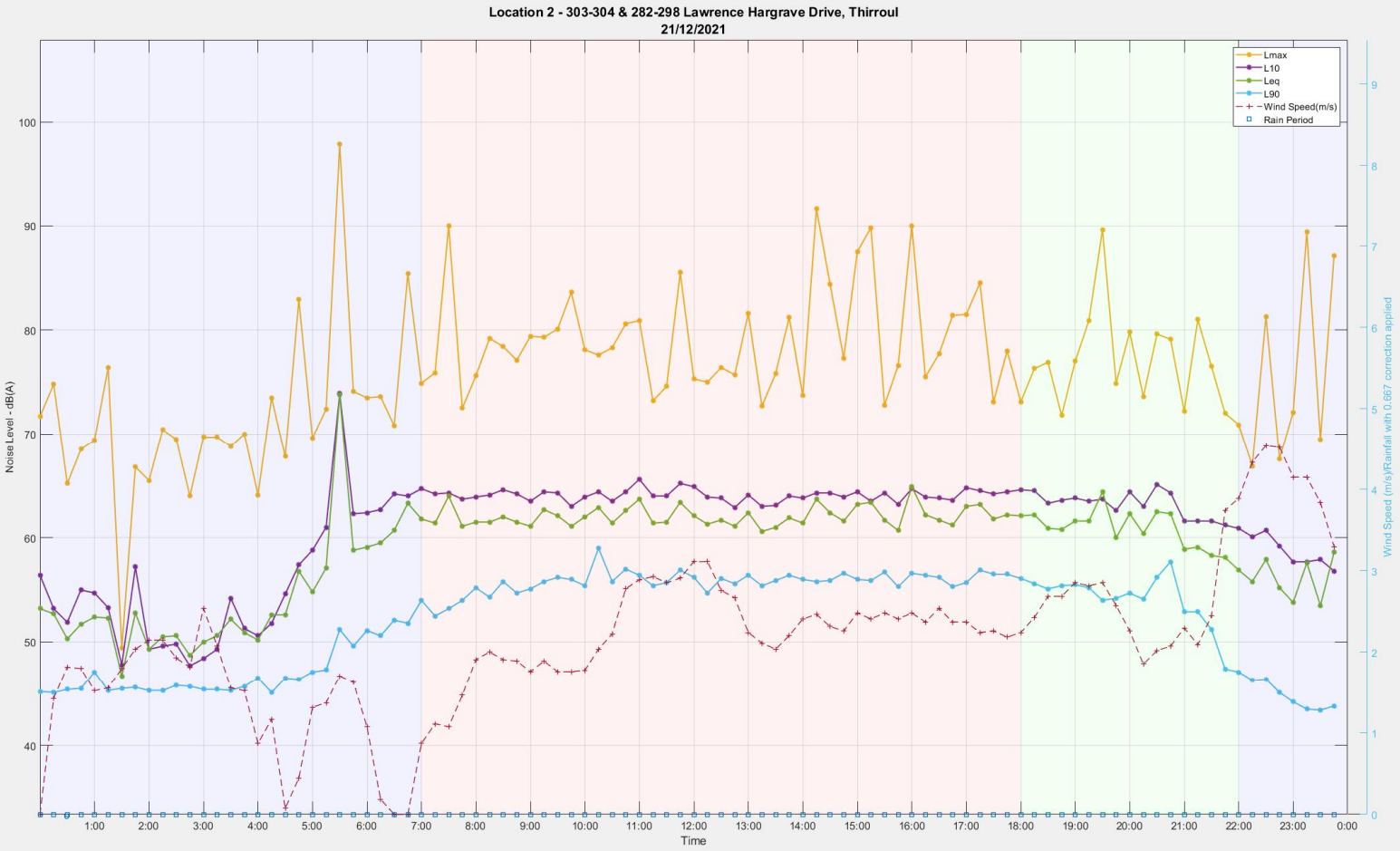

298 Lawrence Hargrave Drive, Thirroul: Thursday 05 September, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

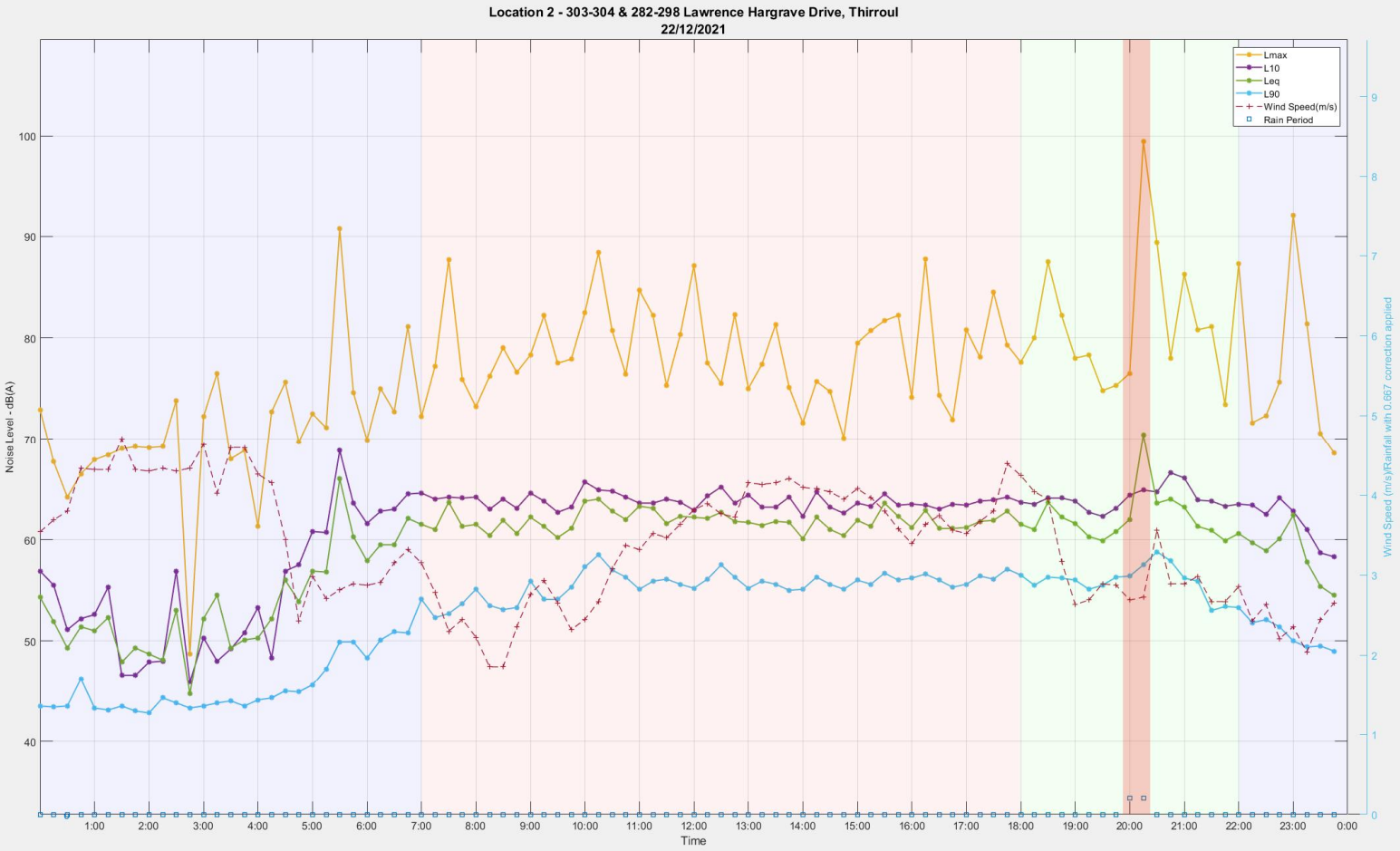

298 Lawrence Hargrave Drive, Thirroul: Friday 06 September, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

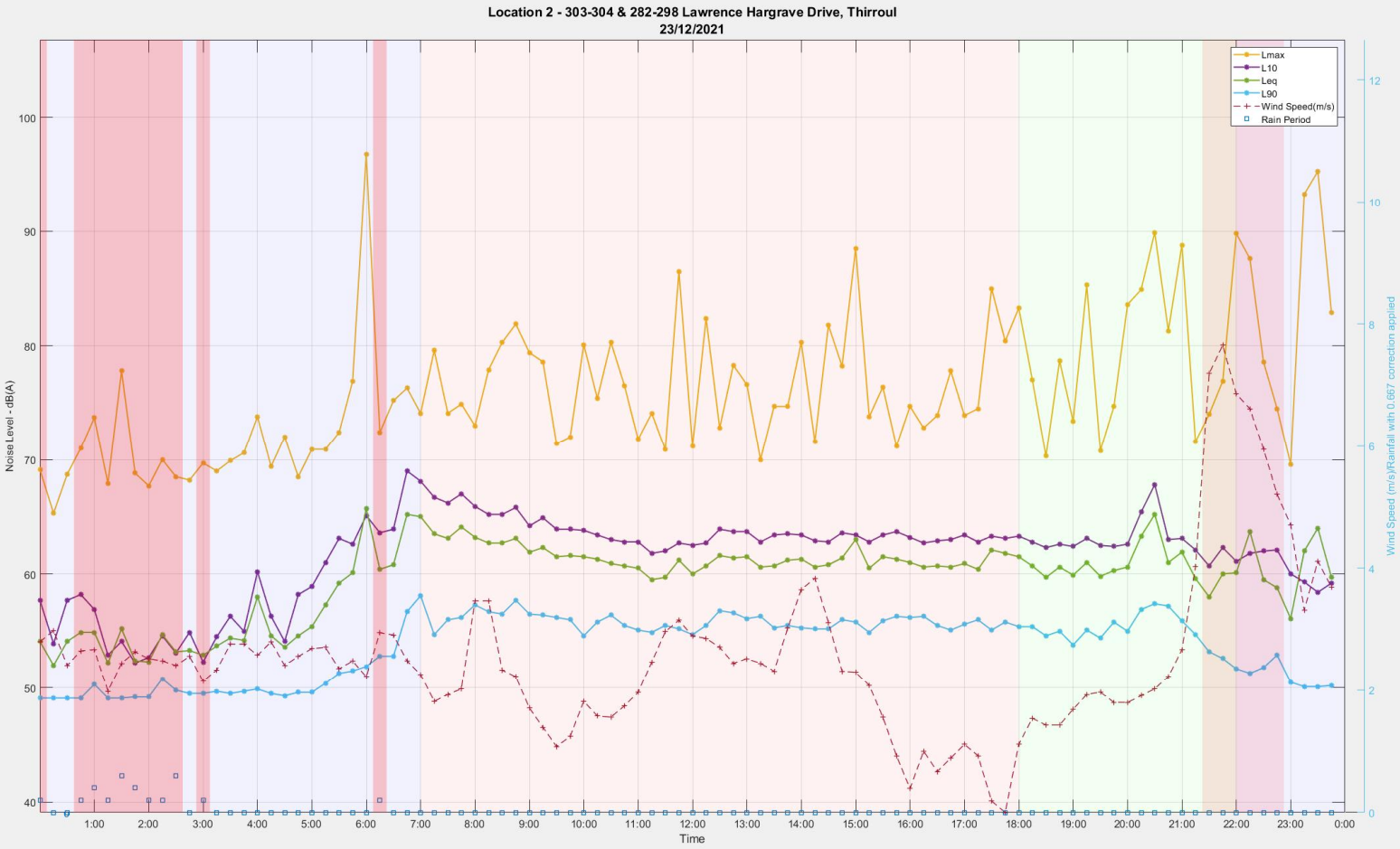
LOCATION 2

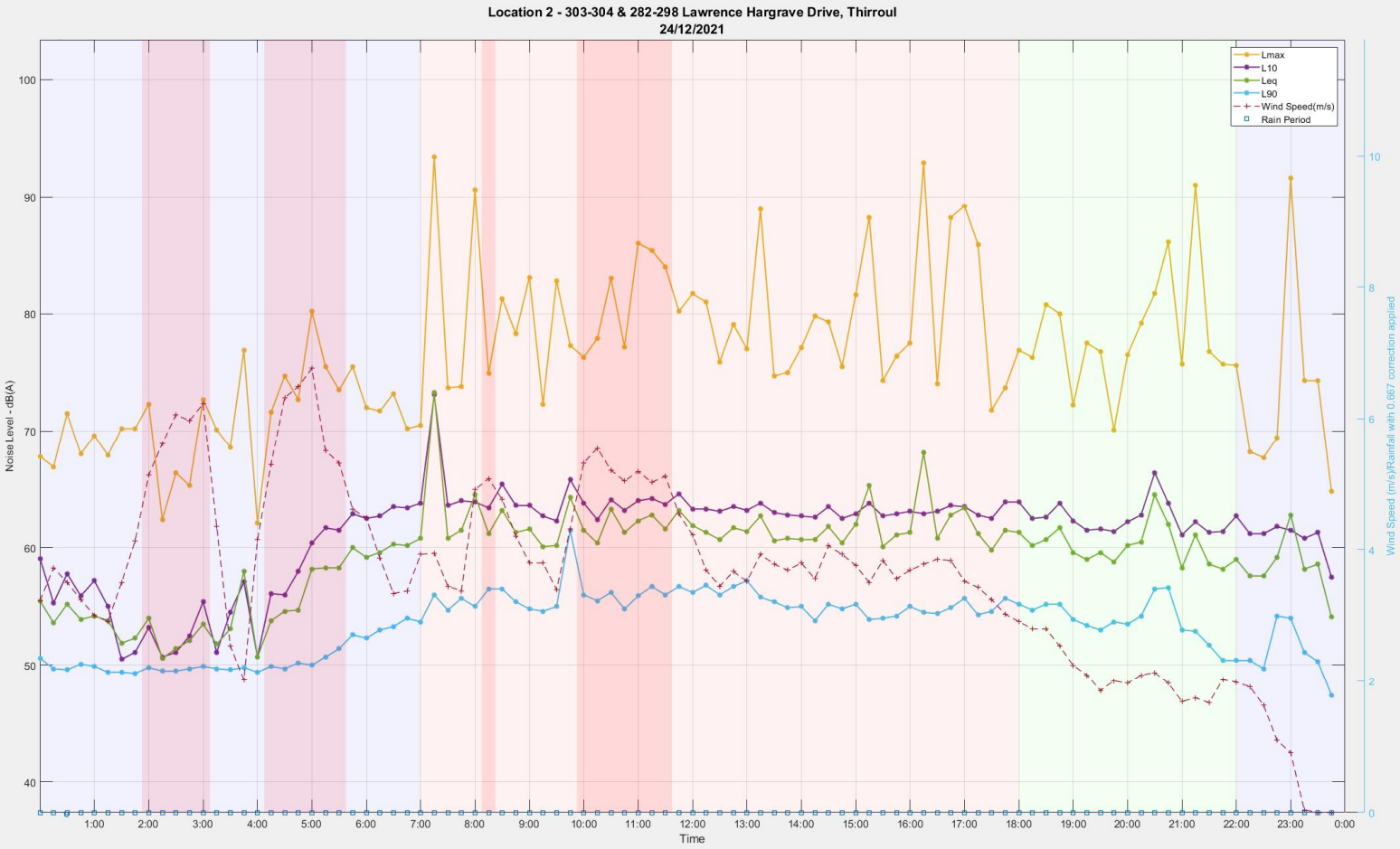
(Note : Wind speeds have been corrected by a factor of 0.667 for boundary layer reductions)

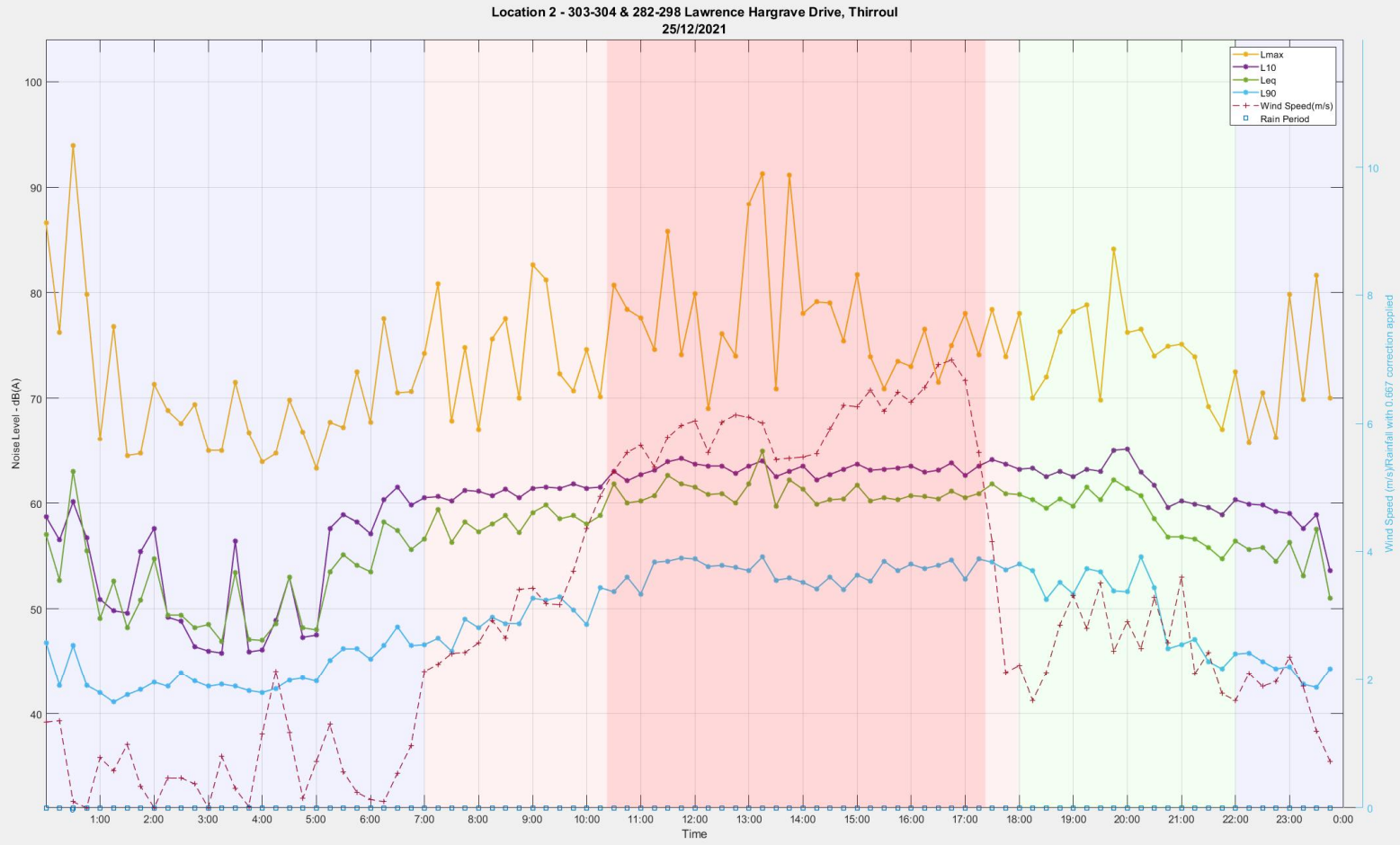

Location 2 - 303-304 & 282-298 Lawrence Hargrave Drive, Thirroul
20/12/2021
Lmax
L10
Leq
L90
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rainfall with 0.667 correction applied
Time
90
80
70
60
50
40
15
10
5
0
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00


Location 2 - 303-304 & 282-298 Lawrence Hargrave Drive, Thirroul
21/12/2021
Lmax
L10
Leq
L90
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rainfall with 0.667 correction applied
Time
100
90
80
70
60
50
40
9
8
7
6
5
4
3
2
1
0
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00


Location 2 - 303-304 & 282-298 Lawrence Hargrave Drive, Thirroul
22/12/2021
Lmax
L10
Leq
L90
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rainfall with 0.667 correction applied
Time
100
90
80
70
60
50
40
9
8
7
6
5
4
3
2
1
0
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00


Location 2 - 303-304 & 282-298 Lawrence Hargrave Drive, Thirroul
23/12/2021
Lmax
L10
Leq
L90
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rainfall with 0.667 correction applied
Time
100
90
80
70
60
50
40
12
10
8
6
4
2
0
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00


Location 2 - 303-304 & 282-298 Lawrence Hargrave Drive, Thirroul
24/12/2021
Lmax
L10
Leq
L90
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rainfall with 0.667 correction applied
Time
100
90
80
70
60
50
40
10
8
6
4
2
0
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00


Location 2 - 303-304 & 282-298 Lawrence Hargrave Drive, Thirroul
25/12/2021
Lmax
L10
Leq
L90
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rainfall with 0.667 correction applied
Time
100
90
80
70
60
50
40
10
8
6
4
2
0
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00