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Greenwich Hospital Redevelopment

Noise & Vibration Impact Assessment

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1 INTRODUCTION

Acoustic Logic has been engaged to undertake an assessment of potential noise and vibration impacts associated with the proposed redevelopment project at 97-115 River Rd, Greenwich.

This Noise and Vibration Impact Assessment is submitted to the Department of Planning, Industry and Environment (DPIE) in support of a State Significant Development Application (SSD-13619238) for the redevelopment of Greenwich Hospital into an integrated hospital and seniors living facility on land identified as 97-115 River Road, Greenwich (the site). The extent of the site is shown below.

The subject proposal is for the detailed design and construction of the facility following its concept approval under SSD-8699. Specifically, SSD-13619238 seeks approval for the following:

- Demolition of the existing hospital building and associated facilities at the site;
- Construction of a new hospital facility and integrated healthcare campus comprising of hospital, residential aged care, seniors housing, overnight respite, across:
  - A new main hospital building up to RL 80.0;
  - Two new seniors living buildings, Northern building up to RL 56.36, and Southern building up to RL 60.65;
  - A new 2-3 respite care building up to RL 56.9;
- Construction of associated site facilities and services, including pedestrian and vehicular access and basement parking;
- Site landscaping and infrastructure works; and
- Preservation of Pallister House which will continue to host dementia care and administrative functions.

In accordance with section 4.39 of the Environmental Planning & Assessment Act 1979 (EP&A Act), the Secretary's Environmental Assessment Requirements (SEARs) for SSD-13619238 were issued on 24 February, 2021. This report has been prepared to respond to the following SEARs:

SEAR	***Relevant section of report***
10. Noise and Vibration • Provide a noise and vibration impact assessment that: o addresses the conditions imposed under SSD-8699. o details the proposed construction hours and provide details of, and justification for, instances where it is expected that works would be carried out outside standard construction hours. o outlines measures to minimise and mitigate the potential noise impacts on nearby sensitive receivers. o considers sources of external noise intrusion in proximity to the site (including, road rail and aviation operations) and identifies building performance requirements for the proposed development to achieve appropriate internal amenity standards. o demonstrates that the assessment has been prepared in accordance with polices and guidelines relevant to the context of the site and the nature of the proposed development. <u>*Relevant Policies and Guidelines:*</u> • NSW Noise Policy for Industry 2017 (NSW Environment Protection Authority (EPA). • Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009). • Assessing Vibration: A Technical Guideline 2006 (Department of Environment and Conservation, 2006).	See below for details Section 6.1 Section 5.4 Section 4 Section 5.1.1 Section 6.1.1 Section 6.2
13. Staging • Assess impacts of staging where it is proposed and detail how construction works, and operations would be managed to ensure public safety and amenity on and surrounding the site	Sections 6-11

In reference to the above SEAR 10, this report has been updated to address the NSW Department of Planning, Industry and Environment Development Consent (*ref: SSD-8699, dated 10th November 2020)*.

Specifically, the following Conditions have been addressed:

Building Design

B4. h) relocation of the carpark entry under the seniors living away from the adjacent properties to the west unless it can be demonstrated that noise impacts from the operation on the carpark entry/exit would not result in adverse noise impacts.

The above Condition has been addressed in Section 6.2.1 of this report through an assessment of the potential sleep disturbance impacts on the western residents due to the use of the western access road during the night-time period.

Noise and Vibration

B8. All future development applications for new built from must identify and provide a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation, and construction, and outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.

The above Condition has been addressed in Section 7 of this report through a detailed assessment of the predicted construction noise and vibration impacts on surrounding receivers. Additionally, management controls have been outlined to minimise the potential noise impacts during the demolition, excavation and construction stages.

B9. All future development applications for new built form must identify and provide a quantitative assessment of potential noise and vibration impacts on the identified sensitive receivers due to the operations of the hospital and occupation of the seniors living, particularly impacts from the carpark access located under the seniors living buildings orientated to the west.

The above Condition has been addressed in Section 6.2 of this report with an assessment of the allowable noise emission levels from site operation of mechanical plant equipment and carpark access via the western access road.

Additionally, this report will:

- Address relevant local council, State and Australian Standard noise and vibration criteria, applicable to the subject proposal.
- Conduct an external noise (traffic) impact assessment and recommend acoustic treatments to ensure that a reasonable level of amenity is achieved for future tenants.
- Identify potential noise generating sources associated with the subject proposal and determine relevant noise emission goals, ensuring that nearby developments are not adversely impacted by the subject proposal. Conduct an assessment of operational noise emissions (traffic increase and mechanical plant noise).
- Identify nearby noise and vibration sensitive receivers and conduct an assessment of potential noise and vibration impacts resulting from the proposed construction methodology.

Noise impacts will be addressed in accordance with the following standards and guidelines;

- *Lane Cove Council Development Control Plan (DCP) 2010.*
- *Australian and New Zealand Standard AS/NZS 2107:2016 "Acoustics - Recommended design sound levels and reverberation times for building interiors".*
- *NSW Environmental Protection Authority (EPA) Noise Policy for Industry (NPfI) 2017.*
- *NSW EPA Road Noise Policy.*
- *NSW EPA Interim Construction Noise Guideline (ICNG).*
- *German Standard DIN 4150-3 Structural Vibration: Effects of Vibration on Structures*
- *EPA document Assessing Vibration: A technical guideline*
- *NSW Department of Planning, Industry and Environment Development Consent – SSD-8699 dated 10th of November 2020.*

This report is based on the following architectural drawings provided by Bickerton Masters Architecture dated 8th of April 2022 Revision P20.

1.1 SITE SURROUNDS

The site is surrounded by residential properties. The surrounding nearest affected receivers are as follows;

- Residential properties along the western boundary of the site – 117, 117A & 117B River Road, Greenwich.
- Residential properties to the north of the site, across River Road – 102 to 120 River Road, Greenwich.
- Residential properties to the east of the site, across St Vincent's Road – 10 to 20 St Vincent's Road, Greenwich.
- Residential properties along the southern boundary of the site – 24 to 55 Gore Street, Greenwich.

Figures 1 below illustrates locations of unattended noise monitors, attended noise measurements, development site and surrounding sensitive land uses.

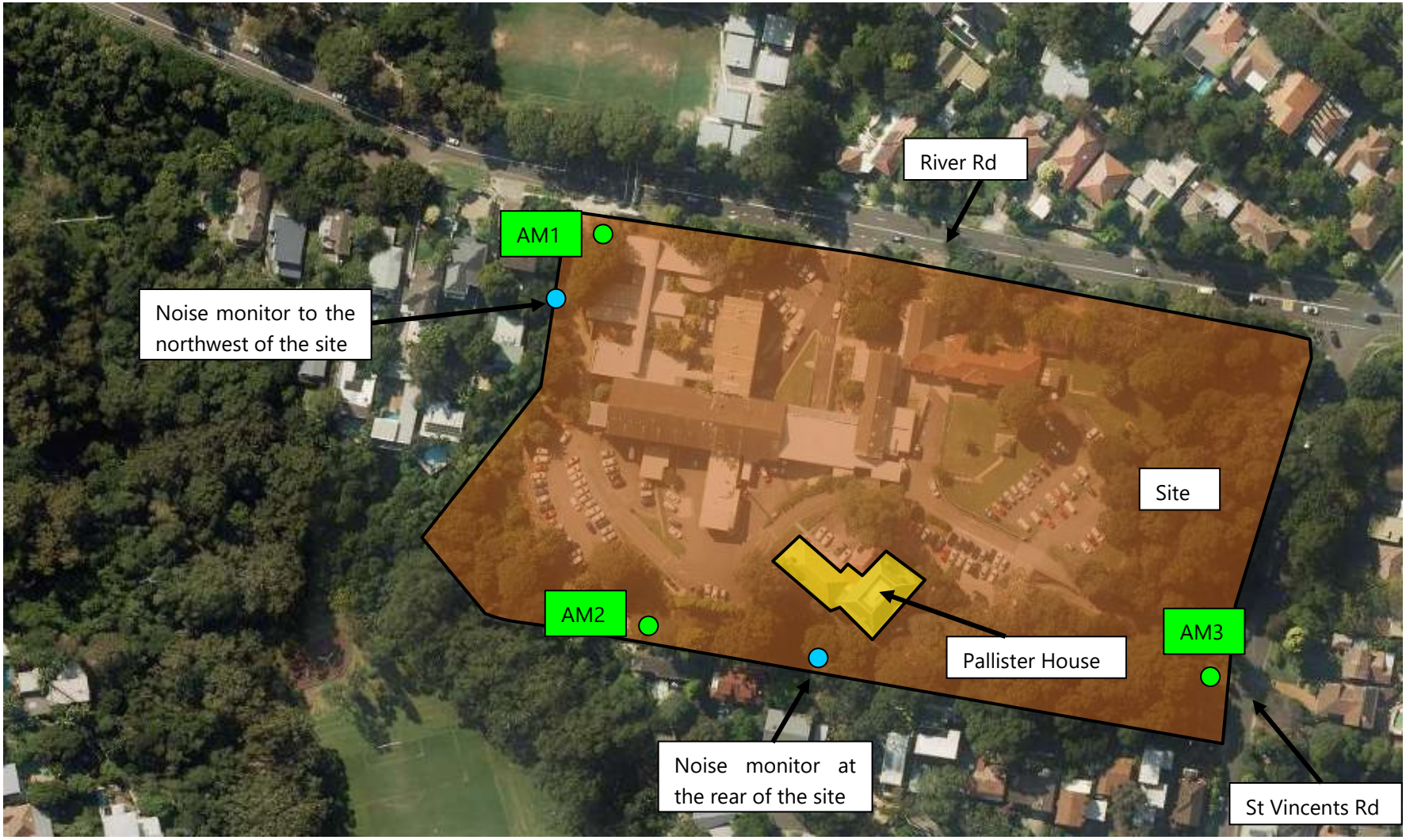


Figure 1 – Site Description (source: Google Maps)

- Subject Site
- Pallister House
- Unattended noise measurement location
- Attended noise measurement locations

2 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 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_{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.

L_{Max} levels represent is the loudest noise event during a measurement period.

3 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.

AL confirm that all monitoring/measurement procedures, measured noise levels and calculated rating background (RBL)/project amenity (ANL)/project intrusiveness levels, were conducted with reference to the requirements of the NSW EPA Noise Policy for Industry and Australian Standard 1055.2 "*Acoustics – Description and measurement of environmental noise*".

3.1 UNATTENDED NOISE MONITORING

Unattended noise monitoring was conducted between 30th July to 7th August 2018, 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. In addition, calibration certificates are provided in the Appendix.

Monitoring was conducted as follows;

- **Monitor 1** – Installed at the southern edge of the site, adjacent Gore Street residential property boundary. Noise levels measured by this logger are representative of ambient noise levels at the residential receivers to the south of the site, away from River Road. Refer to Appendix 1 for logging data.
- **Monitor 2** – Installed along the western boundary of the site, adjacent 117, 117A & 117B River Road, Greenwich residences. Noise levels measured by this logger are representative of ambient noise levels at the residential receivers located near the west of the site and along River Road. Refer to Appendix 2 for logging data.

3.1.1 Monitoring Results

Measured noise levels are detailed below. Daily background noise levels from the two locations are shown in Appendix 4.

Table 1 – Measured Noise Levels

Monitor	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-10pm)**	**Night (10pm-7am)**
Monitor 1 – Rear of the site (southern boundary)	44	40	35	50	45
Monitor 2 – 30m from River Rd (North-western boundary)	48	43	36	58	52

3.1.2 Meteorological conditions during Monitoring Period

Section A4 of the NSW EPA NPfI 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.

- Rain was recorded only once during the monitoring period, on 6th August between 10:30am and 11am. Noise levels measured during this interval for the two monitors, have been excluded.
- On review of the monitoring data, the measured L_{eq} and L_{90} noise levels during periods of high wind generally do not increase when compared to the L_{eq} and L_{90} noise levels measured during periods with little to no wind. This demonstrates that even though wind speeds measured at Observatory Hill exceed EPA guidelines, either:
    - The wind speed on site was significantly lower than at Observatory Hill, as the noise monitors are shielded by surrounding existing multi-storey properties in comparison to the weather station at Observatory Hill, which is on undeveloped land (adjacent to runways). and/or
    - The wind on site was not sufficiently consistent to increase background noise levels compared to calm periods.

Nevertheless, periods where adverse weather may have affected the noise monitoring data, these have been excluded from our assessment in determining the rating background noise levels.

3.2 ATTENDED NOISE MEASUREMENTS

Additionally, attended noise measurements were also conducted by this office, to supplement the unattended monitoring data. Noise measurements were conducted at 3 representative locations around the site, as illustrated in Figure 1. These measurements were conducted on the 7th August 2018, between 11:00pm and 12:00pm.

All attended measurements were conducted using a Norsonic type 140 Precision Sound Analyser. The analyser was set to measure in a fast response mode and calibrated before and after the measurements using a Norsonic Sound Calibrator type 1251. No significant drift was noted.

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

Table 2 – Attended Noise Measurements

Measurement Location (see Figure 1)	**Time of Day**	**Measured Noise Level**		**Description**
		Average/Traffic $L_{eq(1hr)}$	**Background $L_{eq(15min)}$**	
AM 1	Tuesday 7th August 2018 between 11:00am – 12:00pm	64dB(A)$L_{eq(1hr)}$	55dB(A)$L_{90(15mins)}$	Measured noise level primarily impacted by traffic noise along River Road.
AM2		56dB(A) $L_{eq(1hr)}$	50dB(A)$L_{90(15mins)}$	Measured noise level impacted by distant traffic noise and on-site vehicle movements. Mechanical noise the existing hospital audible during the measurement.
AM3		59dB(A) $L_{eq(1hr)}$	46dB(A)$L_{90(15mins)}$	Measured noise level primarily impacted by traffic noise along St Vincent's Road including cars entering / exiting hospital car park.

4 EXTERNAL NOISE IMPACT ASSESSMENT

Traffic noise from vehicle movements along River Road and St Vincent's Road will be the primary environmental noise sources with the potential to impact on the amenity of future residents.

4.1 TRAFFIC NOISE IMPACTS - ASSESSMENT CRITERIA

4.1.1 Lane Cove Council DCP

Lane Cove Council DCP states the following with respect to noise intrusion:

> *h) Internal habitable rooms of dwellings affected by high levels of external noise are to be designed to achieve internal noise levels of no greater than 50dBA.*

4.1.2 Australian and New Zealand AS/NZS 2107:2016 *"Recommended design sound levels and reverberation times for building interiors"*

AS2107-2016 *"Acoustics – Recommended design sound levels and reverberation times for building interiors"* recommends internal design criteria for occupiable spaces of difference types of development. The design noise levels are determined based on the occupancy type, function/activity of the space within the occupancy and proximity to environmental noise sources.

For residential buildings, the recommended internal design sound levels are based on the location of the proposed development to transportation. This is divided into three categories;

- Houses and apartments in inner city areas of entertainment districts or near major roads.
- Houses and apartments in suburban areas or near minor roads.
- Houses in rural areas with negligible transportation.

Internal design noise level criteria applicable for the subject development is detailed below;

Table 3 – AS2107:2016 Recommended Internal Design Noise Levels

Type of Occupancy	Space	Time	Internal Traffic Noise Criteria
Houses and apartments in suburban areas or near minor roads	Sleeping Areas (Bedroom)	Night-time (10pm – 7am)	35 dB(A)$L_{eq\ (1\ hour)}$ –
	Living or any other Habitable Areas	24 hours a day	40 dB(A)$L_{eq\ (15\ hour)}$
Hospital	Meeting rooms, interview rooms, enclosed offices	When in use	40 dB(A) $L_{eq\ (1\ hour)}$
	General offices	When in use	45
	Patient Bays	24 hours a day	40
	Toilets	24 hours a day	55
	Admin\Reception areas	24 hours a day	50
	Corridors, lobbies, and waiting areas	24 hours a day	50

4.2 RECOMMENDED TREATMENTS

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 Rw 27 to 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.
- Lightweight façade elements – Standard constructions which will include steel studs, top hats, acoustic insulation and plasterboard or Fibre Cement (FC) sheet linings. The extent of insulation and internal sheet linings will need to be determined by an Acoustic Consultant.
- Proposed masonry external wall construction is acoustically acceptable and will not require any additional treatments.
- If concrete slab is proposed as roofing, this is acoustically acceptable and will not require any additional treatments. All opening or penetrations in ceilings must be acoustically sealed. If lightweight elements are proposed, these specific cases will need to be reviewed to address any necessary acoustic treatment.

4.3 VENTIALTION REQUIREMENTS

4.3.1 Seniors Living Buildings

To comply with AS2107 acoustic requirements, external windows and doors for rooms of the Seniors Livings Buildings located to the northwest of the site facing River Road (northern façade) must be closed. An alternate outside air source may be required in accordance with AS 1668.2. Any mechanical ventilation system that is installed should be acoustically designed such that the acoustic performance of the recommended constructions is not reduced by any duct or pipe penetrating the wall/ceiling/roof. Noise emitted to the property boundaries by any ventilation system shall comply with Council requirements.

4.3.2 Hospital

Similarly, spaces within the hospital on the River Road façade may require alternative outside air sources. Ventilation requirements for the hospital components will require to be investigated when architectural design is finalised.

5 NOISE EMISSION ASSESSMENT

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

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

5.1 ASSESSMENT CRITERIA

5.1.1 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.

5.1.1.1 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 4 – 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 north and northwest (River Rd)	Day Time (7am - 6pm)	48	53
	Evening (6pm - 10pm)	43	48
	Night (10pm - 7am)	36	41
Residential Receivers to the east (across St Vincent's Rd)	Day Time (7am - 6pm)	44	49
	Evening (6pm - 10pm)	40	45
	Night (10pm - 7am)	35	40
Residential Receivers to the south	Day Time (7am - 6pm)	44	49
	Evening (6pm - 10pm)	40	45
	Night (10pm - 7am)	35	40

5.1.1.2 NSW EPA NPfI - Project Amenity Goals

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 EPA's NPfI sets out acceptable noise levels for various localities. The recommended noise amenity area is based upon the measured background noise levels at the sensitive receiver. Based on the measured background noise levels detailed in Section 3.1.1, the Noise Policy for Industry suggests the adoption of the 'urban' categorisation.

The NPI requires project amenity noise levels to be calculated in the following manner:

$L_{Aeq,15min}$ = *Recommended Amenity Noise Level – 5 dB(A) + 3 dB(A)*

The amenity levels appropriate for the receivers surrounding the site are presented in the Table below.

Table 5 – NPfI Project Amenity Noise Levels

Type of Receiver	Time of day	Recommended Noise Level dB(A)$L_{eq(period)}$	Project Amenity Noise Level dB(A)$L_{eq(15\ minute)}$
Residential – urban	Day (7am - 6pm)	60	58
	Evening (6pm - 10pm)	50	48
	Night (10pm - 7am)	45	43
Commercial	When in use	65	63

The NSW EPA Noise Policy for Industry (2017) defines:

- Day as the period from 7 am to 6 pm Monday to Saturday and 8 am to 6 pm Sundays and Public Holidays.
- Evening as the period from 6 pm to 10 pm.
- Night as the period from 10 pm to 7 am Monday to Saturday and 10 pm to 8 am Sundays and Public Holidays.

5.1.2 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 6 – Criteria for Traffic Noise Generated by New Developments

Road Type	Time of day	Permissible Noise Generation
Local Roads (including St Vincent's Road)	Day (7am to 10pm)	55 dB(A)$L_{eq(1hr)}$
	Night (10pm to 7am)	50 dB(A)$L_{eq(1hr)}$
Sub-arterial Roads (including River Road)	Day (7am to 10pm)	60 dB(A)$L_{eq(15\ hour)}$
	Night (10pm to 7am)	55 dB(A)$L_{eq(9\ hour)}$

In addition to the assessment criteria above, the RNP in section 2.4 outlines that any increase in the total traffic noise level at a location due to a proposed project or traffic-generating development must also be considered. Any existing residences experiencing increases in total traffic noise level above the relative increase criteria detailed below, should also be considered for mitigation as described in Section 3.4 of the Policy.

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.

5.1.3 Sleep Arousal Criteria

Potential sleep arousal impacts should be considered for noise generated after 10pm. Sleep arousal is a function of both the noise level and the duration of the noise.

The Noise Policy for Industry recommends the following noise limits to mitigate sleeping disturbance:

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

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

a detailed maximum noise level even assessment should be undertaken.

The following sleep emergence noise objectives then apply.

Table 7 - Sleep Arousal Criteria for Residential Receivers

Receiver	Rating Background Noise Level (Night) dB(A)L_{90}	Emergence Level
Adjacent residences to the west	36	41 dB(A) $L_{eq,\ 15min}$; 52 dB(A) L_{Fmax}

If there are noise events that could exceed the emergence levels detailed in the table 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 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.*

5.2 SUMMARISED NOISE EMISSION CRITERIA

Table 8 – EPA NPI Project Noise Trigger Level (PNTL) (Worst-Affected - Western Residents)

Time Period	Assessment Background Noise Level dB(A)L_{90}	Project Amenity Criteria dB(A) $L_{eq(15min)}$	Intrusiveness Criteria dB(A) $L_{eq(15min)}$	Sleep Disturbance Emergence Level
Day	48	58	**53**	N/A
Evening	43	48	**48**	N/A
Night	36	43	**41**	**41 dB(A)$L_{eq, 15min}$; 52 dB(A) L_{Fmax}**

5.3 NOISE EMISSION ASSESSMENT

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

- Traffic noise emissions due to new internal roads and basement carpark entry.
- Noise created on public roads as a result of additional traffic generated by the subject proposal.
- Noise emissions from any external mechanical plant and equipment associated with the subject proposal.
- Sleep disturbance due to use of basement carpark entry.

5.3.1 Noise from cars on internal roads (cars entering/leaving the site and circulating on the site)

The NSW Department of Planning, Industry and Environment Development Consent (*Ref: SSD-8699 dated 10th of November 2020*) states the following in regard to potential noise and vibration impacts on surrounding receivers due to carpark access and new internal roads on site.

B4. h) relocation of the carpark entry under the seniors living away from the adjacent properties to the west unless it can be demonstrated that noise impacts from the operation on the carpark entry/exit would not result in adverse noise impacts.

To address the above Condition, noise generated by vehicles manoeuvring on the site is assessed to the sensitive receivers located to the west at 117, 117A and 117B River Rd, Greenwich. Specifically, this report addresses the potential sleep disturbance impacts on the above residents due to the use of the western access road during the night-time period.

We note that the western access road and carpark entry/exit is operational under the existing development. Thus, noise impacts from the western access road will be marginal in that no new sources are being introduced other than those associated with increased usage.

The previous Development Application Acoustic Assessment prepared for the site (*Ref: 20181032.1/1308A/R2/RL, dated 13th of August 2018*) detailed predicted noise levels that would exceed the sleep disturbance thresholds detailed in the NSW EPA Noise Policy for Industry (2017). However, when internal noise levels were considered, the likelihood of sleep disturbance within the western residences was considered acceptable based on the guidelines of the NSW EPA Road Noise Policy.

As part of this assessment, the predicted peak hour traffic volumes for proposed use of the driveway and carpark along the western boundary of the development have been reviewed and incorporated into the predicted noise emission calculations. These traffic volumes provided in the TTPA Traffic and Parking Assessment (*ref: 20352, dated April 2022, Revision C Draft),* have been detailed in the below section.

Noise emission predictions are made based on the following assumptions:

- The internal western access road leading to the basement carpark entry for the seniors living is located along the western boundary of the site approximately 10 – 15 m away from the façade of the worst affected residential receivers.
- The most sensitive residential receivers are identified as 117, 117A and 117B River Road, Greenwich. These two-storey properties reside adjacent to the internal road located along the western boundary of the site.
- There is an existing accessway in the same location to the proposed future western driveway.
- Based on Figure 6 of the TTPA traffic report the following peak hour trip volumes are predicted:
    - AM Peak Hour 8:00 am – 9:00 am: 68 vehicle movements
    - PM Peak Hour 5 pm – 6 pm: 76 vehicle movements
- It is assumed that the western access road and basement carpark of the senior living will be used during the night-time period (10 pm – 7 am) by staff members. However, the abovementioned Traffic and Parking Impact Assessment Report does not provide predicted traffic volumes during this period. As a conservative measure for assessing sleep disturbance, Acoustic Logic have assumed a worst-case scenario of 20 peak hour vehicle movements.
- Cars have an assumed sound power of 81dB(A) per car when driving on the site (10km/h).

Based on the above assumptions, the following vehicle noise emissions are predicted at the external façades of the residents of 117, 117A and 117B River Road, Greenwich.

Table 9 – Vehicle Noise Impact Assessment to Western Residential Receivers

Noise Source	Time of day	Predicted Noise Level	Compliance
Vehicles manoeuvring, driving to/from site on western boundary internal road	AM Peak	45 dB(A)$L_{eq(15min)}$	Achieves compliance with Project Intrusiveness Noise Objective ($\leq$ 53 dB(A)$L_{eq(15min)}$)
	PM Peak	46 dB(A)$L_{eq(15min)}$	Achieves compliance with Project Intrusiveness Noise Objective ($\leq$ 53 dB(A)$L_{eq(15min)}$)
	Night (10 pm – 7 am)	41 dB(A)$L_{eq(15min)}$ 52 dB(A)L_{Fmax}	Achieves compliance with Sleep Arousal Noise Trigger Levels ($\leq$ 41 dB(A)$L_{eq(15min)}$ $\leq$ 52 dB(A)L_{Fmax})

We note that whilst the traffic report does not provide an expected level of traffic generation during the evening period, based on predicted noise levels for the AM/PM peaks traffic along the western driveway would comply with the evening PNTL in any case.

5.3.2 Noise Generated by Additional Traffic on Public Roads

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

Access/egress to the site will be via River Road and St Vincent's Road. Predictions of noise generation are based on the following:

- An assumed sound power level of a car driving on a public road (approx. 60km/h) of 94dB(A).
- Increase in traffic volume due to the proposed development is per Section 5 of the TTPA Traffic and Parking Assessment (*ref: 20352, dated April 2022, Revision C Draft).*

Noise emissions are predicted at the building's façades of the River Road and St Vincent's Road residences and compared against the acoustic criteria set out in section 5.1.2.

Predicted noise levels are as follows:

Table 10 – Noise Generated by Additional Public Road Traffic – Noise Impact Assessment

Receiver Location	Predicted Change in Traffic Noise Level	Comment
River Road residences (building façades)	<2 dB(A)$L_{eq(1hr)}$	Less than 2dB(A) allowable increase as detailed in the EPA Road Noise Policy Section 3.4
St Vincent's Road residences (building façades)	<2 dB(A)$L_{eq(1hr)}$	

Note: These predicted noise levels are conservative and based on a worst one-hour peak. If traffic generation is averaged over the course of the day (as is consistent for EPA guidelines for developments on arterial roads), the predicted noise level will be approximately 2dB(A) lower than the level predicted above.

Noise as a result of additional traffic generation is compliant with the EPA Road Noise Policy.

5.3.3 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:

- Located in hospital building:
    - Cooling towers.
    - Fan Coil Units and fans.
    - Chillers.
    - Emergency Backup Power Diesel Generator
- Located in the Seniors Living
    - Condensing Units
    - Carpark Supply and Exhuast Fans

5.3.3.1 Hospital Building Plant/Centralised Plant

With respect to the above, we note:

- Cooling Towers:
    - In the event the selected cooling tower sound power level (SWL) exceeds 90dB(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 EPA 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 70% would be expected at night-time.
        - Acoustic attenuator behind the intake louvre or selection of acoustic louvres for enclosures/plantrooms. Alternatively, dedicated air intake and discharge attenuators may be required.
- Chillers (assumed sound power of 102dB(A)).
    - Chillers must be located in a plantroom. This plantroom must be of masonry construction and should not have any external ventilation opening/louvre.
    - If light-weight external wall and roof construction is proposed for the plantroom, these areas 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. The external and internal element may also be required to be separated by a large single stud (150mm) or double stud system with acoustic insulation.
    - Typical vibration isolation would consist of 25mm static deflection springs sitting on a concrete plinth isolated from the structural slab using 20mm rubber acoustic underlay.

- Plant room (Fans and AHU's)
    - Case radiated noise from FCU's and fans located within the plantroom are typically quieter than other plant noise sources (compared to chillers, pumps, generators etc).
    - FCU's and fans will be acoustically reviewed when selections are confirmed to determine whether internal lining or attenuators are required to the supply/exhaust and intake/return air ductwork.
    - Major fans (typically with a sound power over 90(A) – such as carpark exhaust and supply fans, garbage room exhaust 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.
- Emergency Backup Power Diesel Generators
    - 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).
    - Given the proximity of surrounding sensitive receivers, the generator will need to be enclosed in plantroom, with additional treatment to any louvres for intake/discharge.
    - The plantroom will typically need to be of masonry construction with insulated walls and soffit (internally).
    - Acoustic treatment to air intake and discharge openings to the plant room typically require acoustic attenuators in the order of 2400mm long, 40% free area (Noise Control or equal).
- 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.
        - Construction of solid acoustic screens to act as barriers.
        - Lining of plantroom with absorptive treatments.
        - Small acoustic attenuators behind louvres.
- 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).

5.3.3.2 Seniors Living Buildings Plant

- Condensers (Seniors Living Buildings):
    - If condenser units for these dwellings are centralised, the units should be located on the roof top, basement or plant room (with acoustically treated ventilation openings.
    - In the event that units have individual condensers, we recommend that these units have a sound pressure level of no more than 55dB(A) at 1m distance, and be located at least 7 metres from any residential property boundary.

5.4 RECOMMENDATIONS

5.4.1 Mechanical Plant Noise Emissions

It is recommended that a detailed acoustic review of mechanical design and equipment selections is undertaken at CC stage, when plant selections and locations are finalised. This assessment shall provide recommendations and management controls to ensure compliance with the project noise emission trigger levels detailed in Section 5.1

This office 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 5.1.

6 CONSTRUCTION NOISE AND VIBRATION IMPACTS

6.1 NOISE AFFECTED MANAGEMENT LEVELS

Noise associated of construction activities on the site will be assessed in accordance with the NSW EPA Interim Construction Noise Guideline.

6.1.1 EPA Interim Construction Noise Guidelines

The "quantitative" assessment procedure, as outlined in the Interim Construction Noise Guideline (ICNG) will be used. The quantitative assessment method requires: Determination of noise generation goals (based on ambient noise monitoring); Prediction of operational noise levels at nearby development; and if necessary, recommendation of noise controls strategies in the event that compliance with noise emission goals is not possible.

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 affected" level at a nearby residence, the proponent should take reasonable/feasible work practices to ensure compliance with the "noise affected level". For residential properties, the "noise affected" level occurs when construction noise exceeds ambient levels by more than 10dB(A)$L_{eq(15min)}$.
- "*Highly noise affected level"*. Where noise emissions are such that nearby properties are "highly noise affected", noise controls such as respite periods should be considered. For residential properties, the "highly noise affected" level occurs when construction noise exceeds 75dB(A)$L_{eq(15min)}$ at nearby residences.

Table 11 – Residential Receiver Noise Emission Goals

Receiver	"Noise Affected" Level - dB(A)$L_{eq(15min)}$	"Highly Noise Affected" Level - dB(A)$L_{eq(15min)}$
Residential Receivers to the north and northwest (River Rd)	58	75
Residential Receivers to the east (across St Vincents Rd)	54	
Residential Receivers to the south	54	

Section 4.1.2 and 4.1.3 of this guideline also nominates management levels for other sensitive land uses (other than residences). Noise affected management levels relevant to this assessment is detailed below;

Table 12 – Noise Emission Goal – Non-Residential Properties

Land Use	Management Level
Commercial premises (offices, retail outlets)	External noise level 70 dB(A)$L_{eq(15mins)}$

6.2 VIBRATION CRITERIA

Vibration associated with demolition and excavation activities on the site will be assessed in conjunction with the following guidelines:

For human exposure to vibration - Department of Environment and Conservation NSW "Assessing Vibration: A Technical Guideline" (Feb 2006) is based on the guidelines contained in BS 6472:1992 *Guide to Evaluate Human Exposure to Vibration in Buildings (1Hz to 80Hz)* for low probability of adverse comment.

For structural damage vibration - German Standard DIN 4150-3 *Structural Vibration: Effects of Vibration on Structures.*

6.2.1 Assessing Amenity (Human Comfort Guidelines)

Vibration goals for the amenity of nearby land users are those recommended by the EPA document *Assessing Vibration: A technical guideline.* These levels are presented below:

Table 13 – Vibration Goals

		RMS acceleration (m/s^2)		RMS velocity (mm/s)		Peak velocity (mm/s)	
Place	**Time**	**Preferred**	**Maximum**	**Preferred**	**Maximum**	**Preferred**	**Maximum**
Continuous Vibration							
Residences	Daytime	0.01	0.02	0.2	0.4	0.28	0.56
Offices	Day or night-time	0.02	0.04	0.4	0.8	0.56	1.1
Workshops		0.04	0.08	0.8	1.6	1.1	2.2
Impulsive Vibration							
Residences	Daytime	0.3	0.6	6.0	12.0	8.6	17.0
Offices	Day or night-time	0.64	1.28	13	26	18	36
Workshops		0.64	1.23	13	26	18	36

Note 1: Continuous vibration relates to vibration that continues uninterrupted for a defined period (usually throughout the daytime or night-time), e.g. continuous construction or maintenance activity. (DECC, 2006).

Note 2: Impulsive vibration relate to vibration that builds up rapidly to a peak followed by a damped decay and that may or may not involve several cycles of vibration (depending on frequency and damping), with up to three occurrences in an assessment period, e.g. occasional loading and unloading, or dropping of heavy equipment. (DECC, 2006).

6.2.2 Structure Borne Vibration (Damage Criteria)

German Standard DIN 4150-3 (1999-02) provides vibration velocity guideline levels for use in evaluating the effects of vibration on structures. The criteria presented in DIN 4150-3 (1999-02) are presented in Table 1.

It is noted that the peak velocity is the absolute value of the maximum of any of the three orthogonal component particle velocities as measured at the foundation, and the maximum levels measured in the x- and y-horizontal directions in the plane of the floor of the uppermost storey.

Table 14 – DIN 4150-3 (1999-02) Safe Limits for Building Vibration

TYPE OF STRUCTURE		PEAK PARTICLE VELOCITY (mms^{-1})			
		At Foundation at a Frequency of			Plane of Floor of Uppermost Storey
		< 10Hz	10Hz to 50Hz	50Hz to 100Hz	All Frequencies
1	Buildings used in commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

In this case, the houses adjoining the site would be considered a type 2 structure.

7 ACTIVITIES TO BE CONDUCTED AND THE ASSOCIATED NOISE SOURCES

Noise impact will be determined from primary processes and equipment. The sound power levels of these activities are presented below. These equipment items have been selected for this assessment based on the construction staging plans and proposed works.

Table 15 – Sound Power Levels of the Proposed Equipment

EQUIPMENT /PROCESS	SOUND POWER LEVEL dB(A)
Excavator with Rock Breaker Attachment	120
Hand Held Jackhammer	115*
Angle Grinder / Tile Cutter	114*
General Trucks	108
Piling Rig	108
Excavator with Bucket Attachment	105
Shotcrete	105
Bobcat	105
Concrete Pump	105
Cement Mixing Truck	105
Tower Crane	104
Man & Material Hoist	96
Powered Hand Tools	95*

*** - includes 5 dB(A) addition for characteristics of noise source.**

The noise levels presented in the above table are derived from the following sources, namely:

- On site measurements;
- Table A1 of Australian Standard 2436-2010, and
- Data held by this office from other similar studies.

7.1 NOISE ASSESSMENT

7.1.1 Methodology

Noise from the loudest typical construction activities for all stages of works have been predicted to the nearest most affected sensitive receivers.

Predictions take into account:

- The distance between the noise source and the receiver.
- The screening effect provided by any building structure or building shell, if applicable. In particular, noise from works proposed during the fit-out stages when the building shell will screen these activities from the surrounding sensitive receivers.

7.1.2 Recommended Hours of Work

As recommended in section 2.2 of the NSW EPA Interim Construction Noise Guideline (ICNG), the following hours of operation will be enforced for all construction activities and delivery of materials to and from the site;

- Monday to Friday – 7am to 6pm.
- Saturdays – 8.00am to 1pm.
- Sundays and Public Holidays – No works.

7.1.3 Predicted Noise Levels

See tables below for predicted noise levels for each receiver. Given the size of the site predicted noise levels will change significantly depending on where the noise source is located. As such, a noise level range has been presented, giving expected noise levels for activities 'farthest from' to 'nearest to' the receiver.

Table 16 – Predicted Noise Generation to Northern Residential Receivers (106-120 River Rd, Greenwich)

Activity	Predicted Noise Level dB(A)$L_{eq(15min)}$ *(External Areas)*	Noise Management Level dB(A)$L_{eq(15min)}$ *(External Areas)*	Comment
Excavator with Rock Breaker Attachment	70-80	≤ 58	The following construction activities can cause an intermittent exceedance of Noise Management Level. However, the predicted noise levels are only exceeding the 75dB(A) 'Highly Noise Affected Level' when working close to the northern boundary of the site. See Section 8 for mitigation measures.
Hand Held Jackhammer	70-80	≤ 58	
Angle Grinder / Tile Cutter	64-74	≤ 58	Causes an intermittent exceedance of Noise Management Level. However, the predicted noise levels are still less than 75dB(A) 'Highly Noise Affected Level'.
General Trucks	58-68	≤ 58	
Pilling Rig	58-68	≤ 58	
Excavator with Bucket Attachment	55-65	≤ 58	Causes an intermittent exceedance of Noise Management Level when working close to the northern boundary of the site.
Shotcrete	55-65	≤ 58	
Bobcat	55-65	≤ 58	
Concrete Pump	55-65	≤ 58	
Cement Mixing Truck	55-65	≤ 58	
Tower Crane	59-60*	≤ 58	Compliant
Man & Material Hoist	46-56	≤ 58	
Powered Hand Tools (Externally)	45-55	≤ 58	
Powered Hand Tools (Internally)	30-40	≤ 58	

*An exceedance of 1-2dB is imperceptible as per standard industry practice.

Table 17 – Predicted Noise Generation to Eastern Residential Receivers (10-20 St Vincents Rd, Greenwich)

Activity	Predicted Noise Level dB(A)$L_{eq(15min)}$ *(External Areas)*	Noise Management Level dB(A)$L_{eq(15min)}$ *(External Areas)*	Comment
Excavator with Rock Breaker Attachment	64-74	≤ 54	Causes an intermittent exceedance of Noise Management Level. However, the predicted noise levels are still less than 75dB(A) 'Highly Noise Affected Level'.
Hand Held Jackhammer	64-74	≤ 54	
Angle Grinder / Tile Cutter	58-68	≤ 54	
General Trucks	52-62	≤ 54	Causes an intermittent exceedance of Noise Management Level when working close to the eastern boundary of the site.
Pilling Rig	52-62	≤ 54	
Excavator with Bucket Attachment	49-59	≤ 54	
Shotcrete	49-59	≤ 54	
Bobcat	49-59	≤ 54	
Concrete Pump	49-59	≤ 54	
Cement Mixing Truck	49-59	≤ 54	
Tower Crane	48-52	≤ 54	Compliant
Man & Material Hoist	40-50	≤ 54	
Powered Hand Tools (Externally)	39-49	≤ 54	
Powered Hand Tools (Internally)	24-34	≤ 54	

Table 18 – Predicted Noise Generation to Southern Residential Receivers (24-55 Gore St, Greenwich)

Activity	Predicted Noise Level dB(A)$L_{eq(15min)}$ *(External Areas)*	Noise Management Level dB(A)$L_{eq(15min)}$ *(External Areas)*	Comment
Excavator with Rock Breaker Attachment	70-82	≤ 54	The following construction activities can cause an intermittent exceedance of Noise Management Level. However, the predicted noise levels are only exceeding the 75dB(A) 'Highly Noise Affected Level' when working close to the southern boundary of the site. See Section 8 for mitigation measures.
Hand Held Jackhammer	70-82	≤ 54	
Angle Grinder / Tile Cutter	64-76*	≤ 54	Causes an intermittent exceedance of Noise Management Level. However, the predicted noise levels are still less than 75dB(A) 'Highly Noise Affected Level'.
General Trucks	58-70	≤ 54	
Pilling Rig	58-70	≤ 54	
Excavator with Bucket Attachment	55-67	≤ 54	
Shotcrete	55-67	≤ 54	
Bobcat	55-67	≤ 54	
Concrete Pump	55-67	≤ 54	
Cement Mixing Truck	55-67	≤ 54	
Tower Crane	56-57	≤ 54	
Man & Material Hoist	46-58	≤ 54	Causes an intermittent exceedance of Noise Management Level when working close to the southern boundary of the site.
Powered Hand Tools (Externally)	45-57	≤ 54	
Powered Hand Tools (Internally)	30-42	≤ 54	Compliant

*An exceedance of 1-2dB is imperceptible as per standard industry practice.

Table 19 – Predicted Noise Generation to Western Residential Receivers (117, 117A and 117B River Rd, Greenwich)

Activity	Predicted Noise Level dB(A)$L_{eq(15min)}$ *(External Areas)*	Noise Management Level dB(A)$L_{eq(15min)}$ *(External Areas)*	Comment
Excavator with Rock Breaker Attachment	66-92	≤ 58	The following construction activities can cause an intermittent exceedance of Noise Management Level. However, the predicted noise levels are only exceeding the 75dB(A) 'Highly Noise Affected Level' when working close to the western boundary of the site. See Section 8 for mitigation measures.
Hand Held Jackhammer	66-92	≤ 58	
Angle Grinder / Tile Cutter	60-86	≤ 58	
General Trucks	54-80	≤ 58	
Pilling Rig	54-80	≤ 58	
Excavator with Bucket Attachment	51-77	≤ 58	
Shotcrete	51-77	≤ 58	
Bobcat	51-77	≤ 58	
Concrete Pump	51-77	≤ 58	
Cement Mixing Truck	51-77	≤ 58	
Tower Crane	54-64	≤ 58	Causes an intermittent exceedance of Noise Management Level. However, the predicted noise levels are still less than 75dB(A) 'Highly Noise Affected Level'.
Man & Material Hoist	42-68	≤ 58	Causes an intermittent exceedance of Noise Management Level when working close to the western boundary of the site.
Powered Hand Tools (Externally)	41-67	≤ 58	
Powered Hand Tools (Internally)	26-52	≤ 58	Compliant

8 NOISE AND VIBRATION RECOMMENDATIONS

8.1 NOISE

- Quiet work methods/technologies:
    - Materials handling/vehicles:
        - Trucks and bobcats to use a non-tonal reversing beacon (subject to OH&S requirements) to minimise potential disturbance of neighbours.
        - Avoid careless dropping of construction materials into empty trucks.
        - Trucks, trailers and concrete trucks (if feasible) should turn off their engines during idling to reduce noise impacts (unless truck ignition needs to remain on during concrete pumping).
- Complaint's handling - In the event of complaint, the procedures outlined in the following sections should be adopted.
- A detailed noise management plan should be developed by the main contractor that describes in detail the construction phases, programme, processes and equipment used, noise impact assessment and proposed mitigation and management.
- Consideration of alternative construction techniques for high noise generating equipment.
- Site Induction:
    - A copy of the Noise Management Plan is to be available to contractors. The location of the Noise Management Plan should be advised in any site induction.
    - Site induction should also detail the site contact is to be notified in the event of noise complaint.

8.2 VIBRATION

Where vibration intensive activities are undertaken close to a residential boundary, there is a potential for exceedances of the nominated vibration levels at residential locations. Where these works are required, it is recommended that sample short-term vibration measurements are taken to determine the likely impact. If an exceedance is found during these tests, it is recommended that vibration monitoring is implemented along the property boundary closest to the receiver during the extent of the activity.

9 GENERAL MITIGATION METHODS

9.1 SELECTION OF ALTERNATE APPLIANCE OR PROCESS

Where a particular activity or construction appliance is found to generate excessive noise levels, it may be possible to select an alternative approach or appliance. For example; the use of a hydraulic hammer on certain areas of the site may potentially generate high levels of noise. By carrying this activity by use of pneumatic hammers, bulldozers ripping and/or milling machines lower levels of noise will result.

Selection of alternative appliances have been explored for the demolition of the existing structure. Due to safety concerns, particularly in relation to slab and structural loading, large excavator mounted milling will not be feasible.

Pre-drilling, saw cutting and ripping may be incorporated in the excavation of the existing base slab. Whilst hammering may still be required, the substitution of drilling, sawing and ripping will reduce degree of hammering required.

9.2 ACOUSTIC BARRIER

Barriers or screens can be an effective means of reducing noise. Barriers can be located either at the source or receiver.

- The placement of barriers at the source is generally only effective for static plant (tower cranes). Equipment which is on the move or working in rough or undulating terrain cannot be effectively attenuated by placing barriers at the source.
- Barriers can also be placed between the source and the receiver however this will not beneficial in this instance due to receivers overlooking the site.

The degree of noise reduction provided by barriers is dependent on the amount by which line of sight can be blocked by the barrier. If the receiver is totally shielded from the noise source reductions of up to 15dB(A) can be effected. Where only partial obstruction of line of sight occurs, noise reductions of 5 to 8dB(A) may be achieved. Where no line of sight is obstructed by the barrier, generally no noise reduction will occur.

As barriers are used to provide shielding and do not act as an enclosure, the material they are constructed from should have a noise reduction performance that is approximately 10dB(A) greater than the maximum reduction provided by the barrier. In this case the use of a material such as 10mm or 15mm thick plywood (radiata plywood) would be acceptable for the barriers.

9.3 SILENCING DEVICES

Where construction process or appliances are noisy, the use of silencing devices may be possible. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts.

9.4 MATERIAL HANDLING

The installation of rubber matting over material handling areas can reduce the sound of impacts due to material being dropped by up to 20dB(A).

9.5 TREATMENT OF SPECIFIC EQUIPMENT

In certain cases, it may be possible to specially treat a piece of equipment to dramatically reduce the sound levels emitted.

9.6 ESTABLISHMENT OF SITE PRACTICES

This involves the formulation of work practices to reduce noise generation. It is recommended that all available and reasonable treatments and mitigation strategies presented in this report be adopted to minimise noise emissions from the excavation and construction activities on site.

9.7 NOISE MONITORING

Predicted noise levels indicate that noise emissions from a number of activities proposed on site will exceed the noise management at the surrounding sensitive receivers. On this basis, noise monitoring can be undertaken to determine the effectiveness of ameliorative measures which have been implemented.

Noise monitoring can be conducted during the demolition and excavation stages, to establish a benchmark of the potential highest levels of noise likely to be generated. We recommend monitoring for a weeklong period during each stage of works, to establish these benchmark levels.

Ongoing monitoring and reporting can be conducted if required, after this initial benchmark period. Continuous monitoring will typically include report generated fortnightly, with additional reports created if benchmark levels are exceeded. In events of exceedance in benchmark levels, site foreman will immediately stop work on site and contact acoustic consultant to determine if;

- Noisy plant/activity was recognised by site foreman – determine reason for exceedance and recommend ameliorative measures or alternate processes for the activity.
- Site attendance is required by acoustic consultant to determine noisy plant/activity and conduct attended measurements. Device further controls based on measured levels.

9.8 COMBINATION OF METHODS

It may be necessary that two or more control measures be implemented to minimise noise.

9.9 MAINTENANCE OF PLANT, EQUIPMENT AND MACHINERY

Construction Profile will ensure all plant, equipment and machinery are regularly serviced and maintained at optimum operating conditions, to ensure excessive noise emissions are not generated from faulty, overused or unmaintained machinery.

9.10 STAFF TRAINING AND REPORTING MECHANISM

All construction staff on site, as part of the site induction process, will be informed of the surrounding sensitive receivers on site and the site-specific recommendations to reduce noise impacts to these receivers (late starts, respite period, vehicle noise control etc. – refer section 10). Any complaints received by construction staff must be immediately reported to the site foreman, followed by completion of incident report form and steps detailed in the section below.

A copy of the recommendations detailed in this report (section 10) and dealing with complaints procedure (section below) will be posted at key areas around the site for easy reference by all staff.

10 CONTROL OF CONSTRUCTION NOISE AND VIBRATION

The execution of this work will facilitate the formulation of noise control strategies for this project.

The flow chart presented in Figure 2 illustrates the process that will be followed in assessing construction activities.

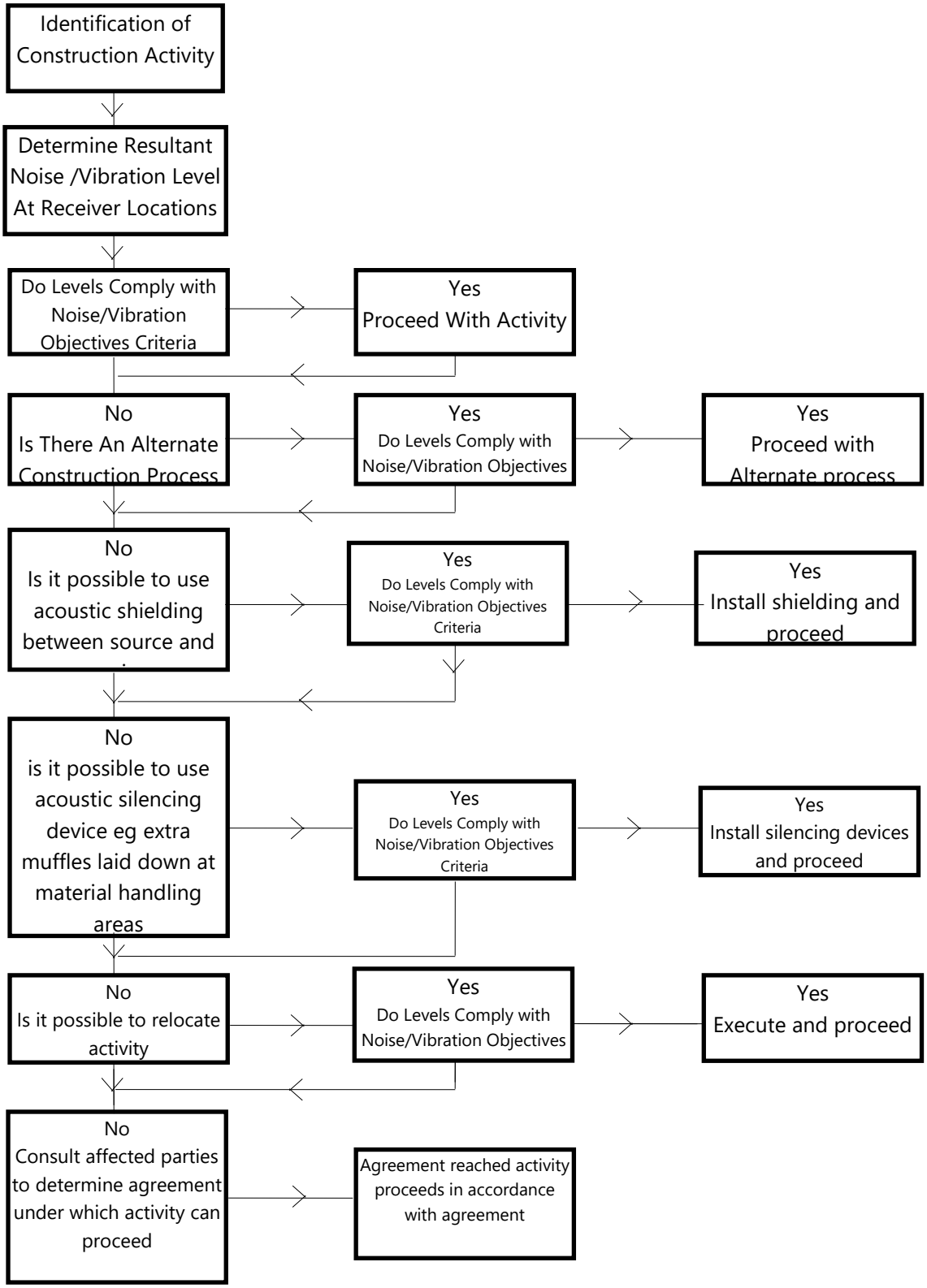


Figure 2 – Process Flowchart

11 COMMUNITY INTERACTION AND COMPLAINTS HANDLING

11.1 ESTABLISHMENT OF DIRECT COMMUNICATION WITH AFFECTED PARTIES

In order for any construction noise management programme to work effectively, continuous communication is required between all parties, which may be potentially impacted upon, the builder and the regulatory authority. This establishes a dynamic response process which allows for the adjustment of control methods and criteria for the benefit of all parties.

The objective in undertaking a consultation processes is to:

- Inform and educate the groups about the project and the noise controls being implemented;
- Increase understanding of all acoustic issues related to the project and options available;
- Identify group concerns generated by the project, so that they can be addressed; and
- Ensure that concerned individuals or groups are aware of and have access to a Constructions Complaints Register which will be used to address any construction noise related problems should they arise.

Community consultation is recommended prior to any works commencing on site, with letterbox notifications to all identified surrounding sensitive receivers (refer section 2). This will include a construction management plan detailing the proposed works on site and duration of each stage.

Part (f) of condition 34 requests strategies are developed with the community for managing high noise generating works. It should be noted community consultation has already been conducted prior to the bulk excavation works (which fall under a different application). Bulk excavation has now been completed, which is the loudest and most intrusive construction activity expected to occur on this site. We also note that no works assessed within this CNVMP are predicted to exceed the 'Highly Noise Affected' criteria of 75dB(A).

11.2 DEALING WITH COMPLAINTS

Should ongoing complaints of excessive noise or vibration criteria occur immediate measures shall be undertaken to investigate the complaint, the cause of the exceedances and identify the required changes to work practices. In the case of exceedances of the vibration limits all work potentially producing vibration shall cease until the exceedance is investigated.

The effectiveness of any changes shall be verified before continuing. Documentation and training of site staff shall occur to ensure the practices that produced the exceedances are not repeated.

If a noise complaint is received the complaint should be recorded on a Noise Complaint Form. The complaint form should list:

- The name and address of the complainant (if provided);
- The time and date the complaint was received;
- The nature of the complaint and the time and date the noise was heard;
- The name of the employee who received the complaint;
- Actions taken to investigate the complaint, and a summary of the results of the investigation;
- Required remedial action, if required;
- Validation of the remedial action; and
- Summary of feedback to the complainant.

A permanent register of complaints should be held. All complaints received should be fully investigated and reported to management. The complainant should also be notified of the results and actions arising from the investigation.

The investigation of a complaint shall involve where applicable;

- Noise measurements at the affected receiver;
- An investigation of the activities occurring at the time of the incident;
- Inspection of the activity to determine whether any undue noise is being emitted by equipment; and
- Whether work practices were being carried out either within established guidelines or outside these guidelines.

Where an item of plant is found to be emitting excessive noise, the cause is to be rectified as soon as possible. Where work practices within established guidelines are found to result in excessive noise being generated then the guidelines should be modified so as to reduce noise emissions to acceptable levels. Where guidelines are not being followed, the additional training and counselling of employees should be carried out.

Measurement or other methods shall validate the results of any corrective actions arising from a complaint where applicable.

11.3 REPORTING REQUIREMENTS

The following shall be kept on site:

1. A register of complaints received/communication with the local community shall be maintained and kept on site with information as detailed in this report.
2. Where noise/vibration complaints require noise/vibration monitoring, results from monitoring shall be retained on site at all times.
3. Any noise exceedances occurring including, the actions taken and results of follow up monitoring.
4. A report detailing complaints received and actions taken shall be presented to the construction liaison committee.

11.4 CONTINGENCY PLANS

Where non-compliances or noise complaints are raised the following methodology will be implemented.

1. Determine the offending plant/equipment/process.
2. Locate the plant/equipment/process further away from the affected receiver(s) if possible.
3. Implement additional acoustic treatment in the form of localised barriers, silencers etc where practical.
4. Selecting alternative equipment/processes where practical.

12 CONCLUSION

Potential noise and vibration impacts associated with the proposed redevelopment project located at 97-115 River Rd, Greenwich.

Noise impacts from existing environmental noise sources on future occupants of the development, have been assessed in accordance with the requirements of the following:

- *Lane Cove Council Development Control Plan (DCP) 2010.*
- *Australian and New Zealand Standard AS/NZS 2107:2016 "Acoustics - Recommended design sound levels and reverberation times for building interiors".*

Noise and vibration impacts associated with the operation of the proposed development have been assessed in accordance with the requirements of the following:

- *NSW Environmental Protection Authority (EPA) Noise Policy for Industry (NPfI) 2017.*
- *NSW EPA Road Noise Policy.*
- *NSW EPA Interim Construction Noise Guideline (ICNG).*
- *Australian Standard 2436-1981 "Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites".*
- *NSW Department of Planning, Industry and Environment Development Consent – SSD-8699 dated 10th of November 2020.*

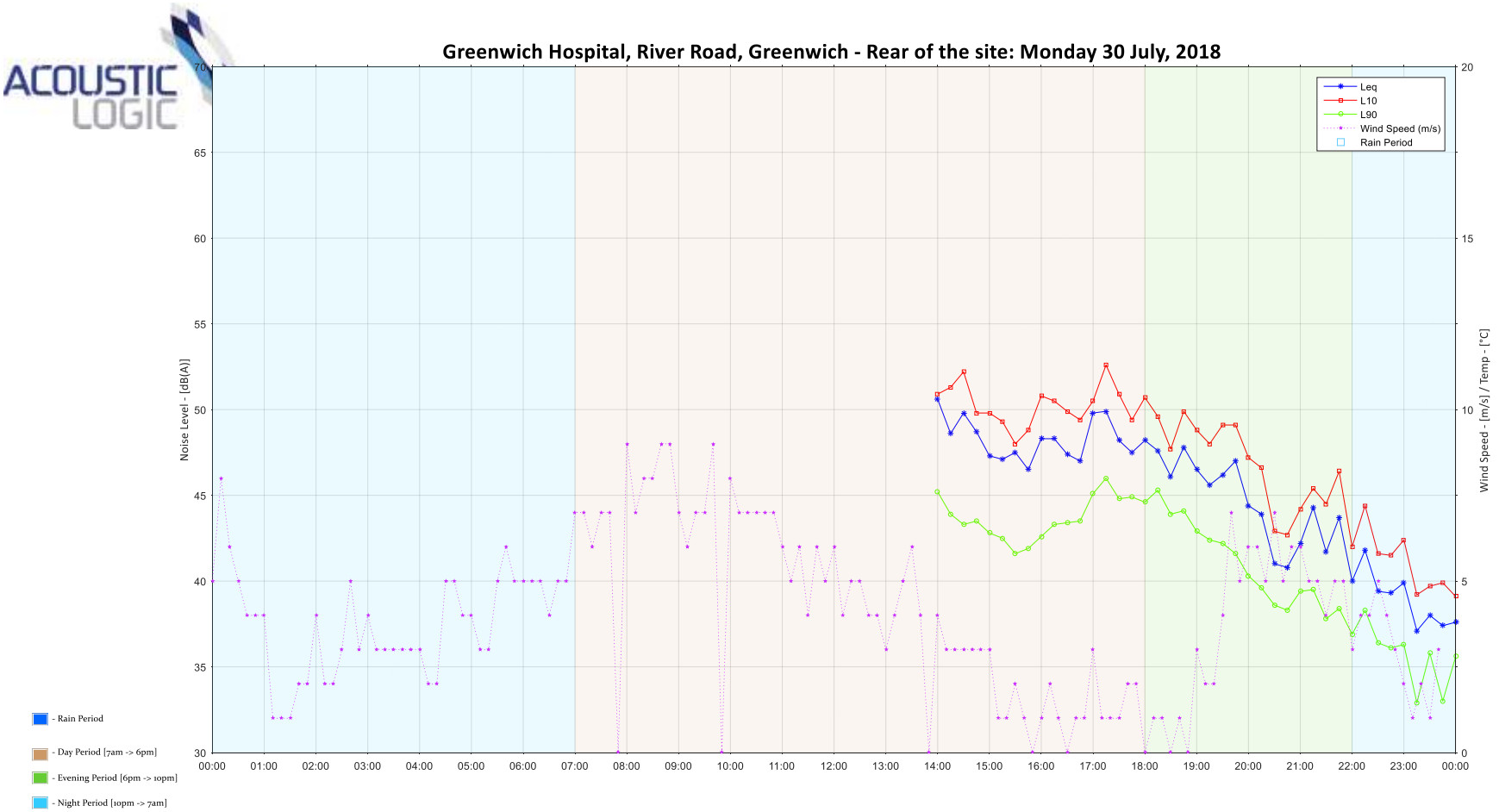
Provided that the recommendations in this report are implemented, noise intrusion and noise emissions associated with the proposed Greenwich Hospital Redevelopment will satisfy the requirements of the abovementioned regulations/documentation.

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

Yours faithfully,

Acoustic Logic Pty Ltd
Lillian Lockett

APPENDIX 1 – UNATTENDED NOISE MONITORING DATA- REAR OF THE SITE (SOUTH)



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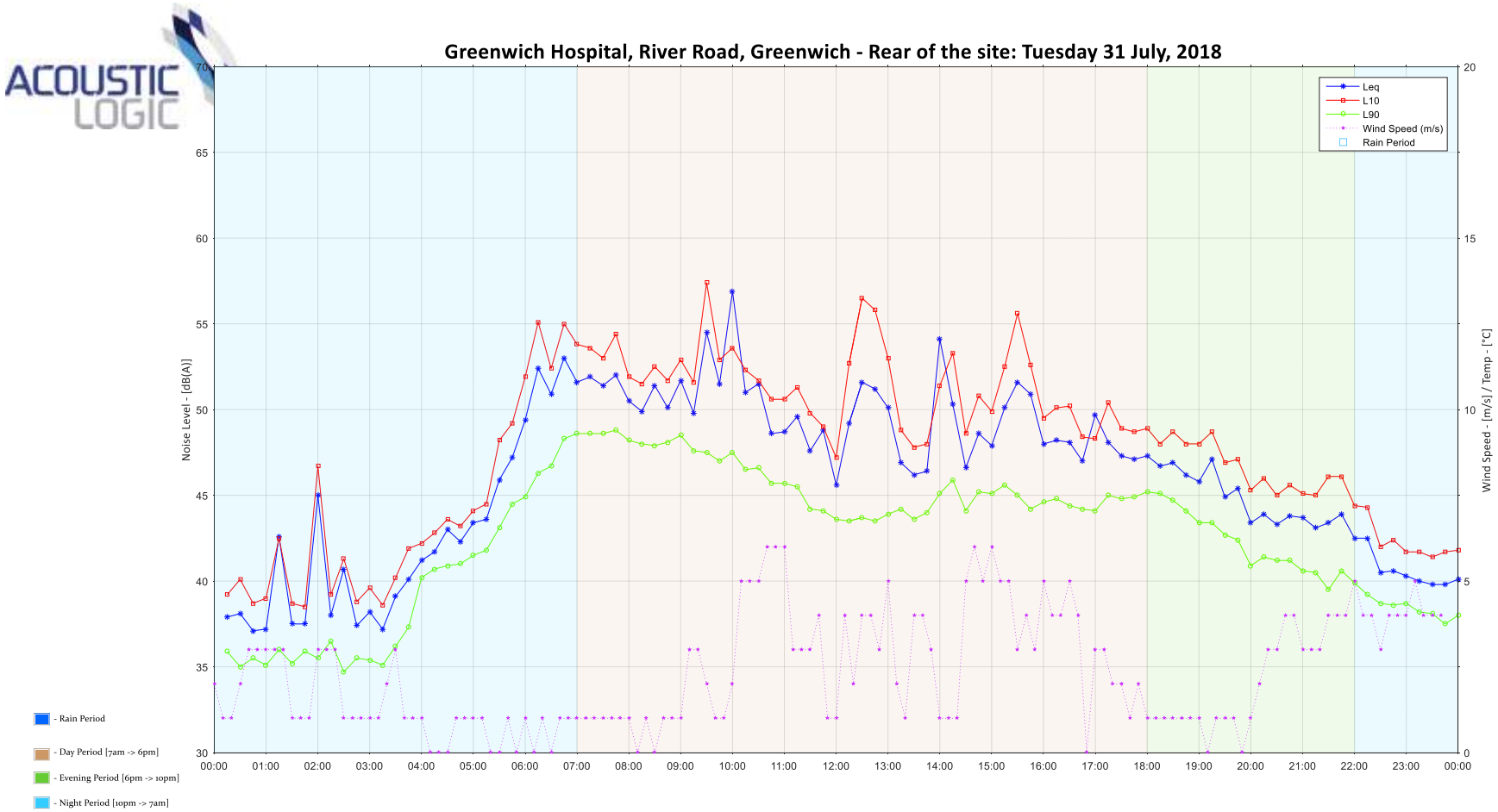
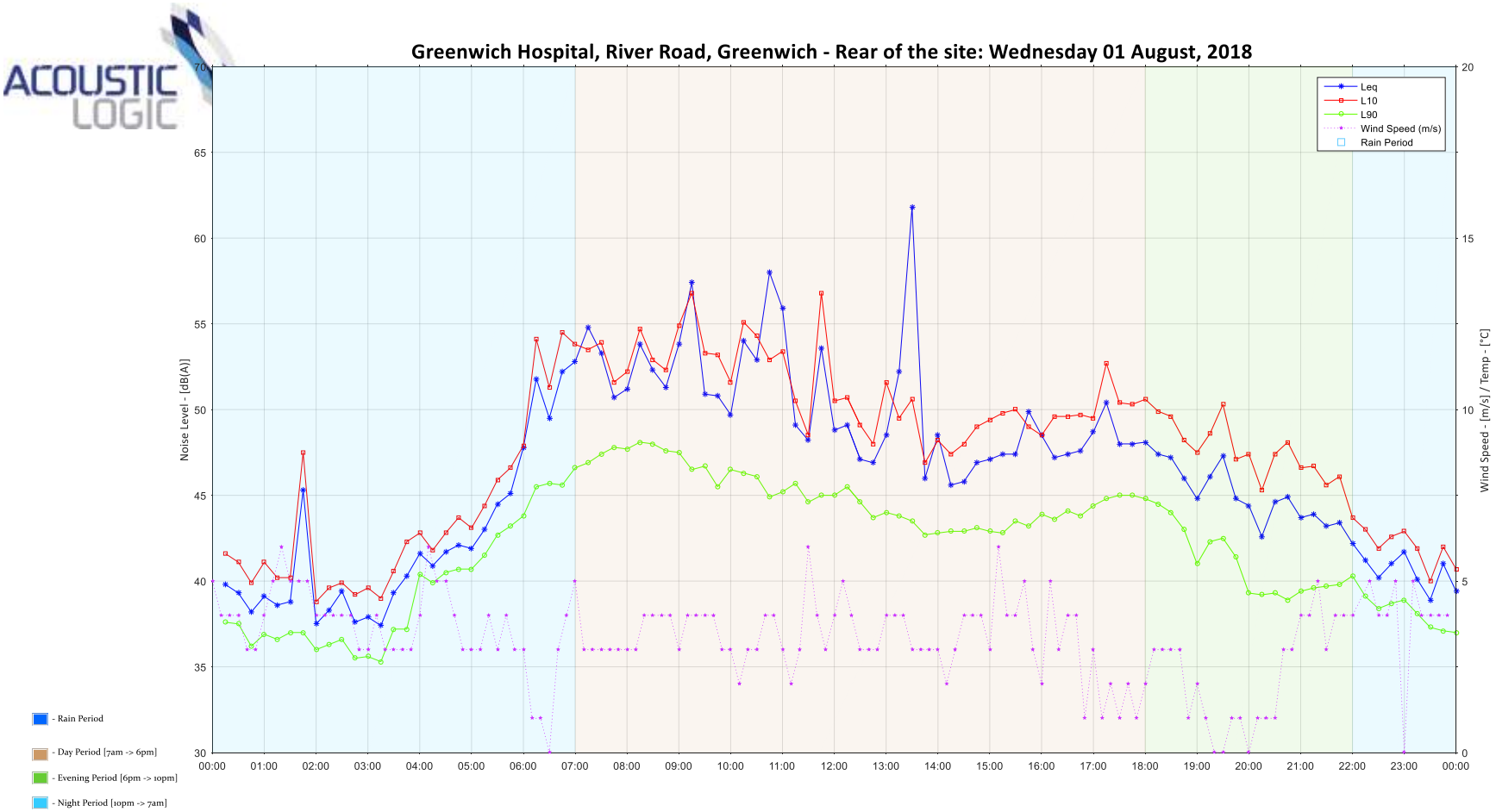
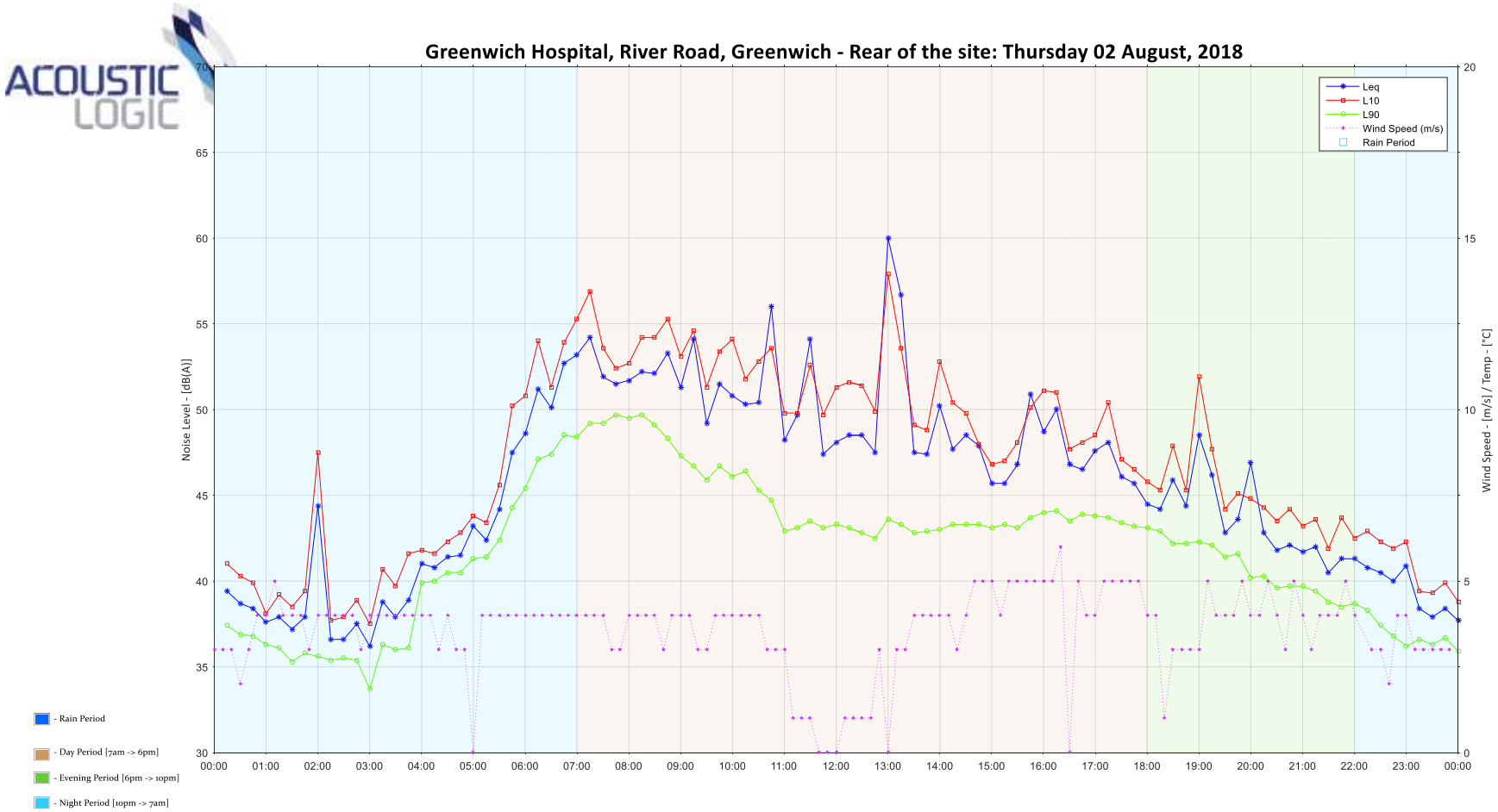
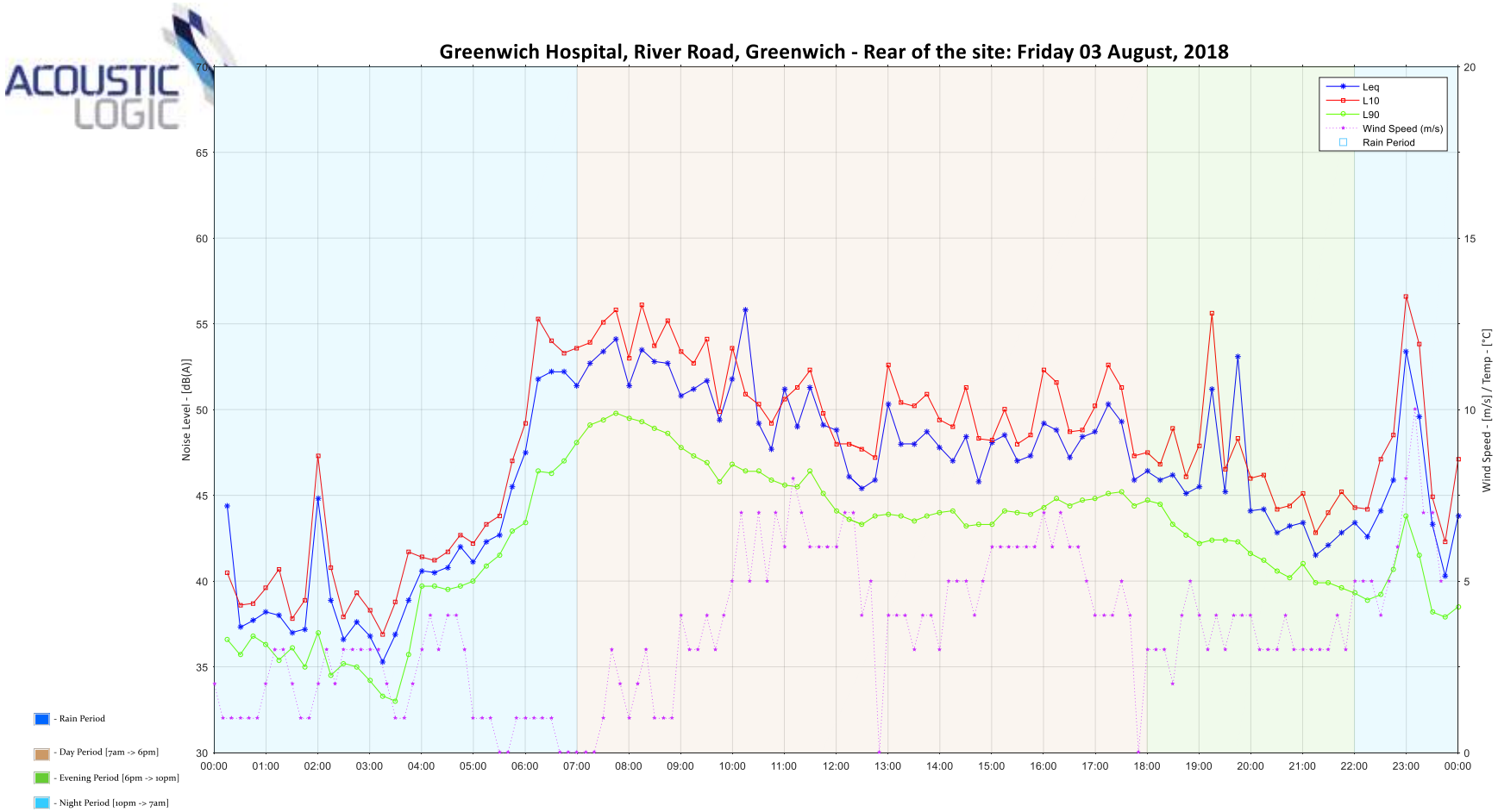
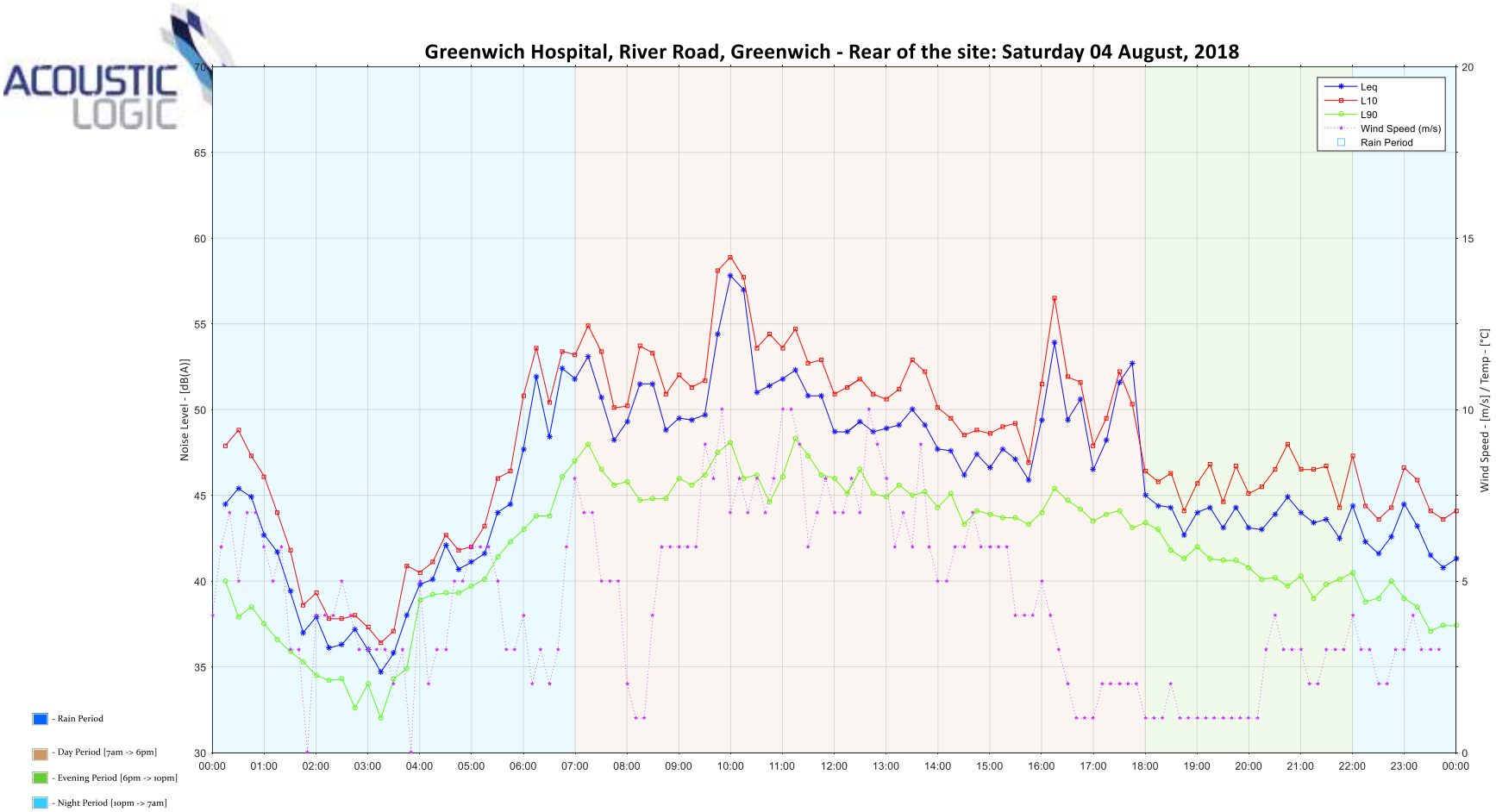
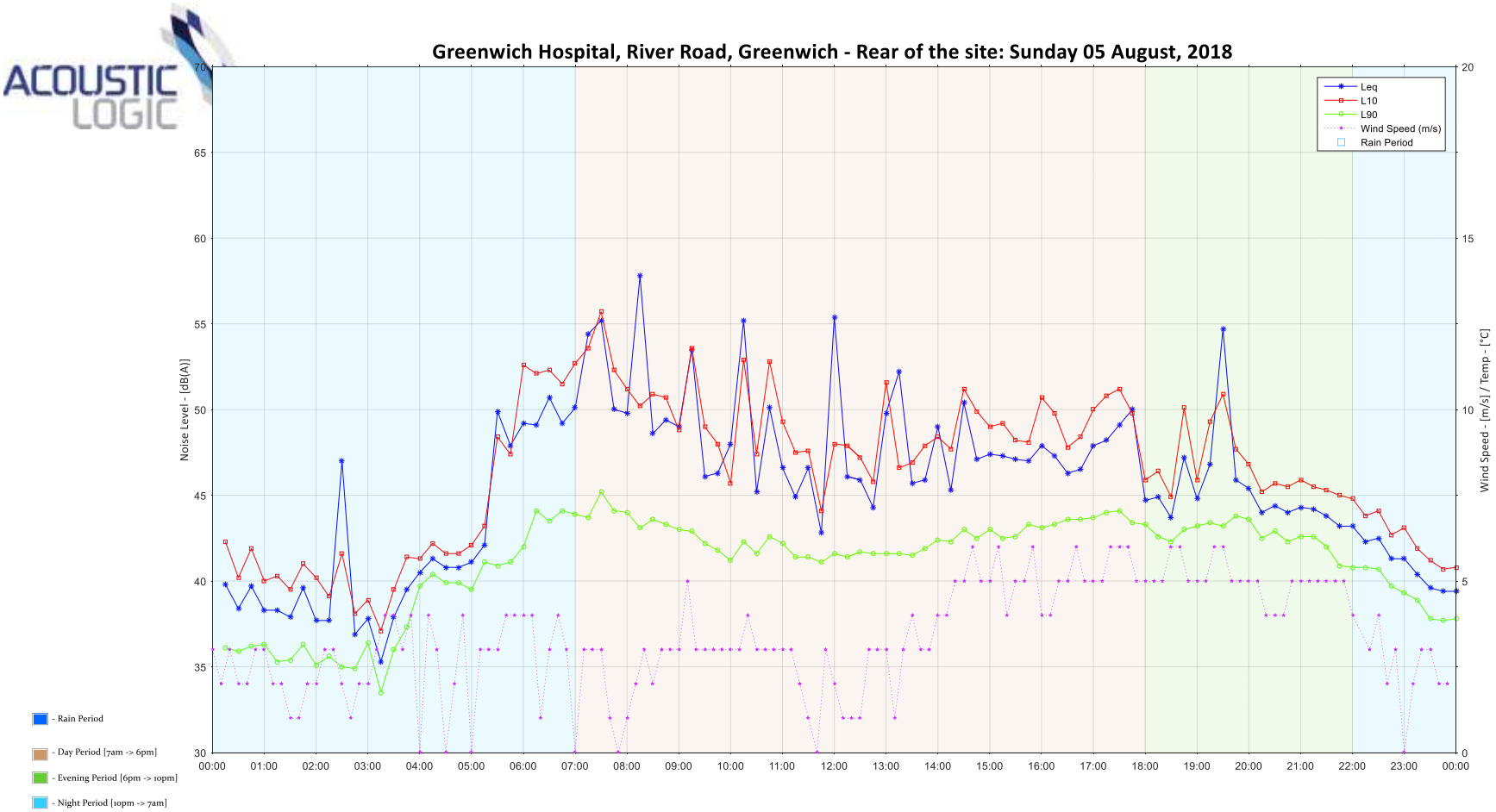

Greenwich Hospital, River Road, Greenwich - Rear of the site: Tuesday 31 July, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

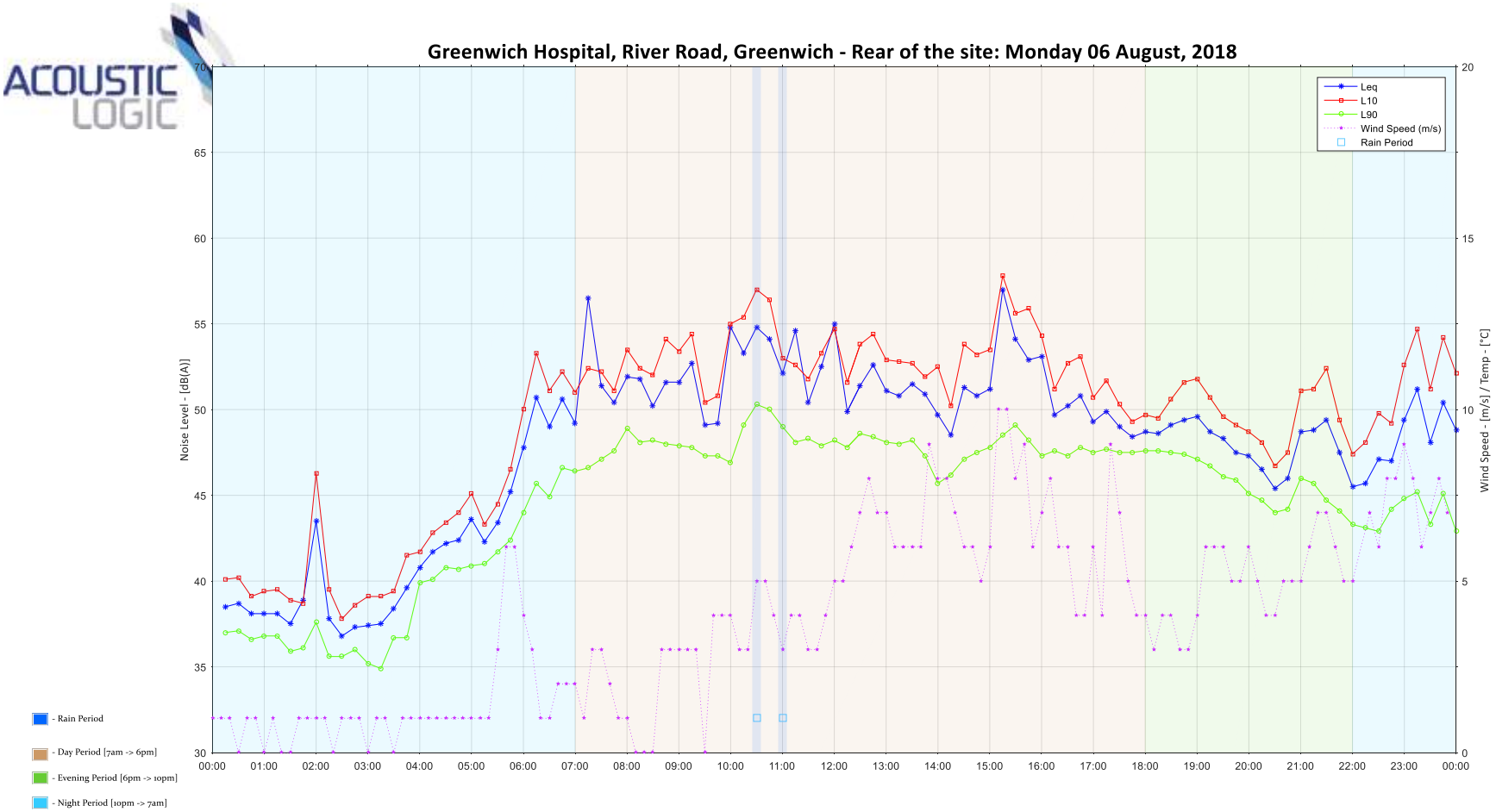

Greenwich Hospital, River Road, Greenwich - Rear of the site: Wednesday 01 August, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

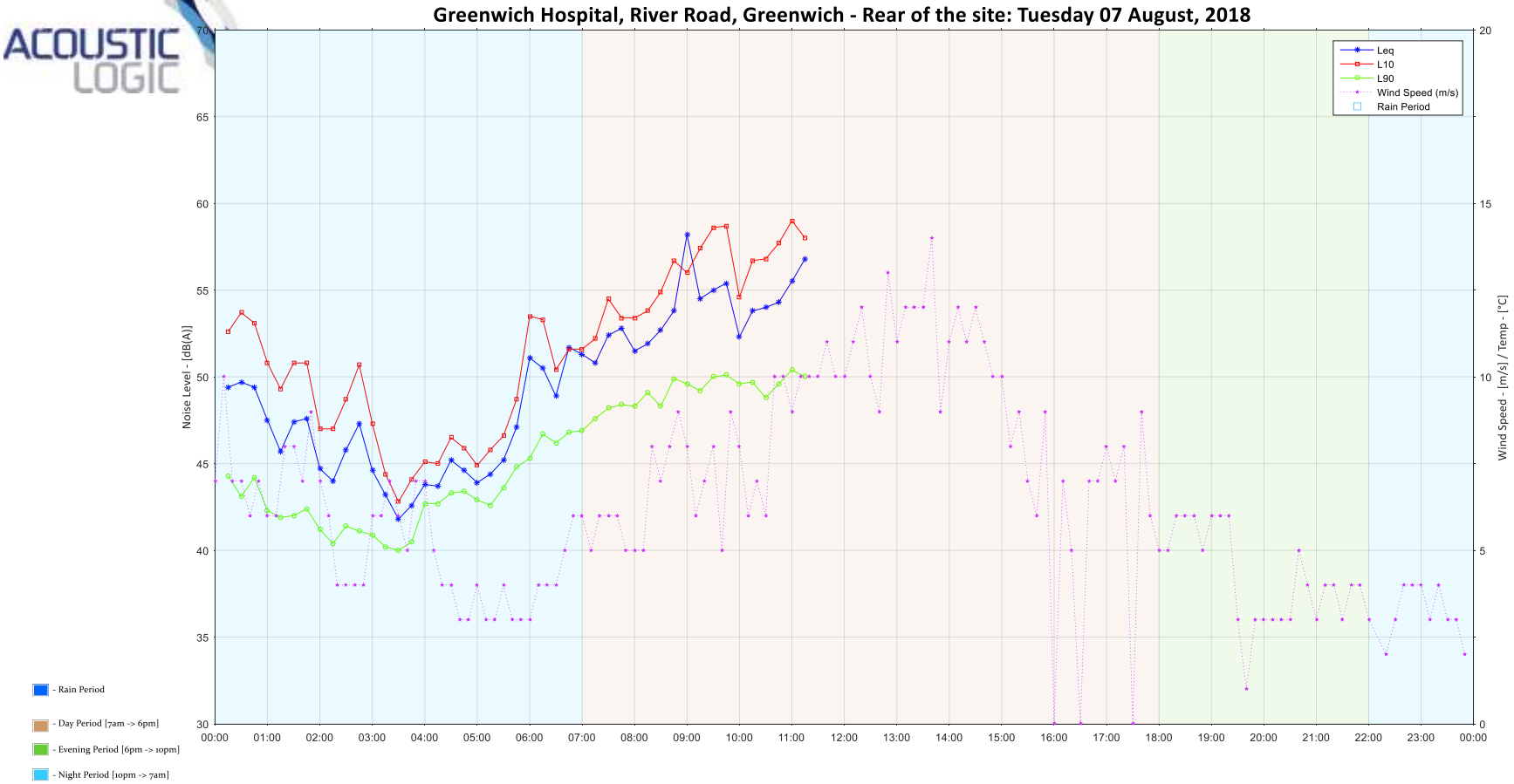

Greenwich Hospital, River Road, Greenwich - Rear of the site: Thursday 02 August, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]


Greenwich Hospital, River Road, Greenwich - Rear of the site: Friday 03 August, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

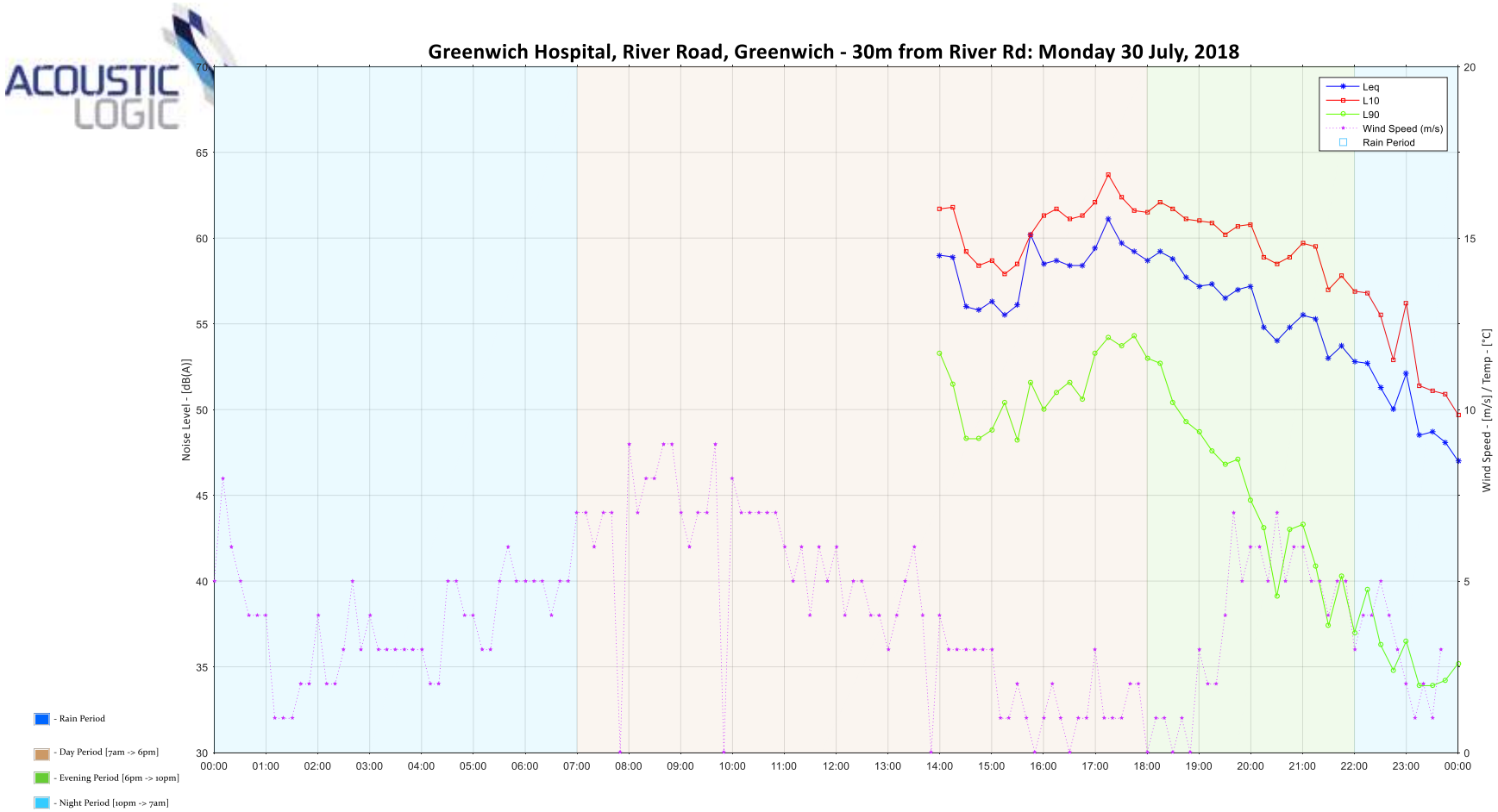

Greenwich Hospital, River Road, Greenwich - Rear of the site: Saturday 04 August, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

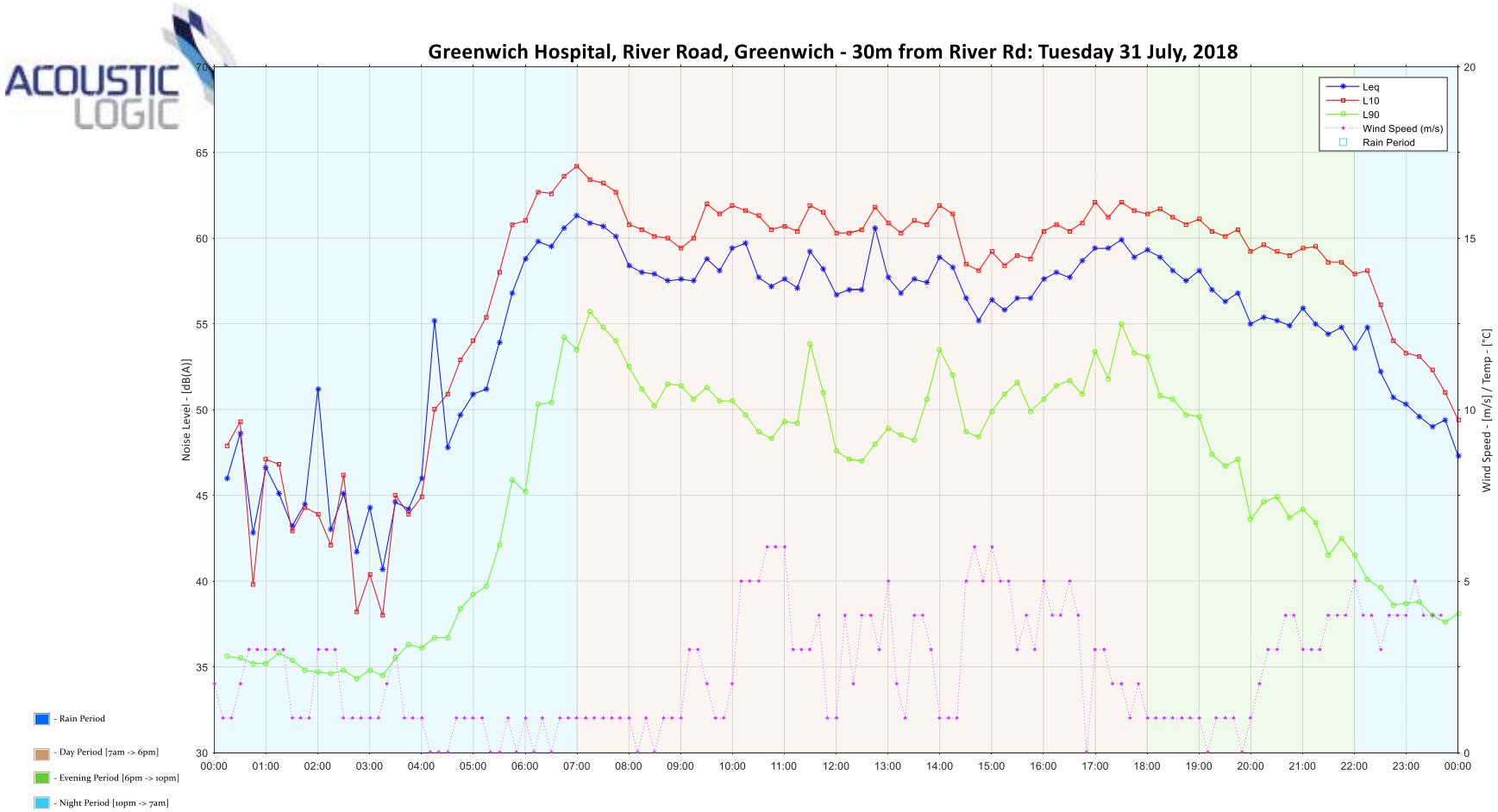

Greenwich Hospital, River Road, Greenwich - Rear of the site: Sunday 05 August, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

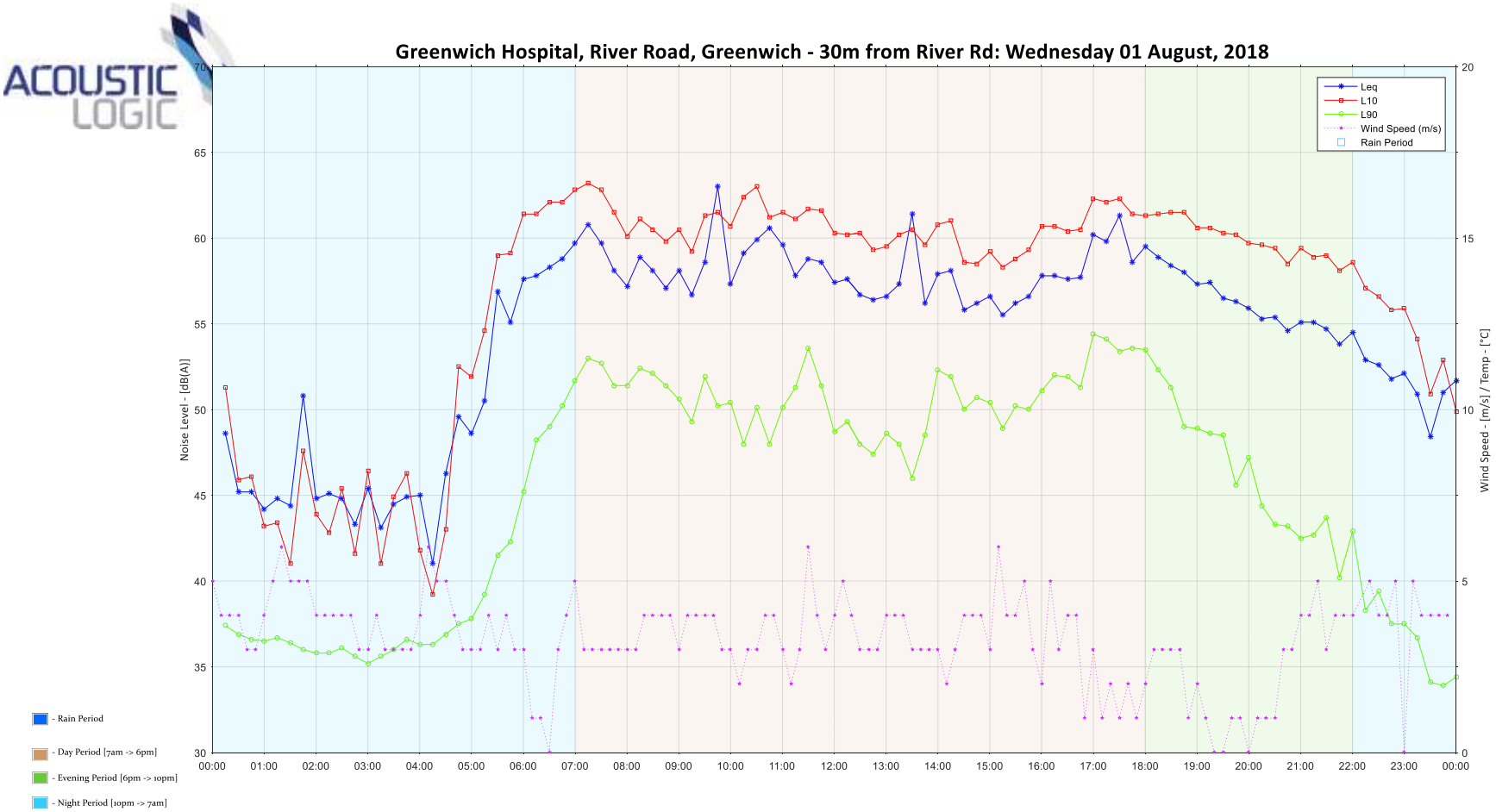

Greenwich Hospital, River Road, Greenwich - Rear of the site: Monday 06 August, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

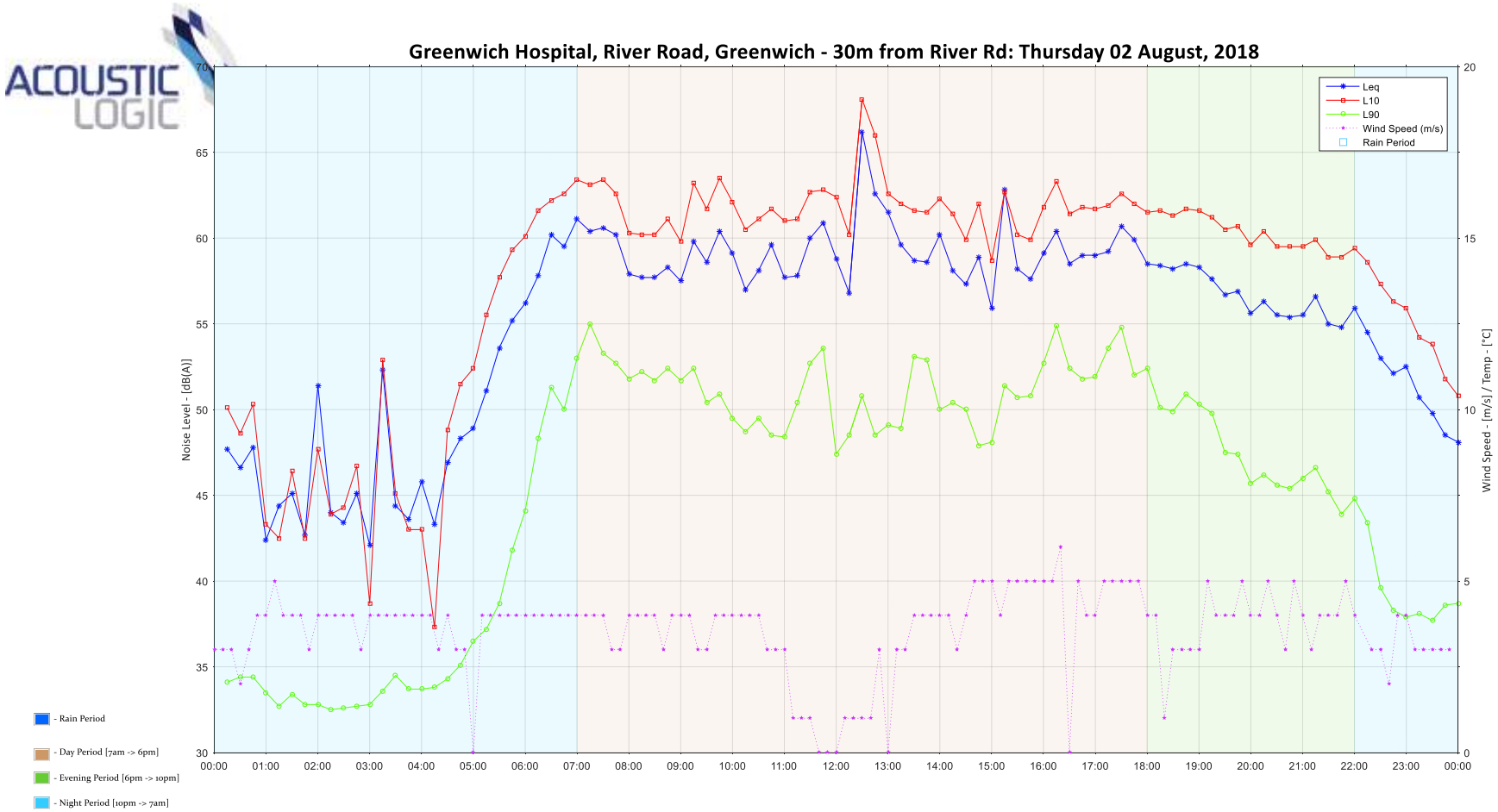

Greenwich Hospital, River Road, Greenwich - Rear of the site: Tuesday 07 August, 2018
Leq
L10
L90
Wind Speed (m/s)
Rain Period
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

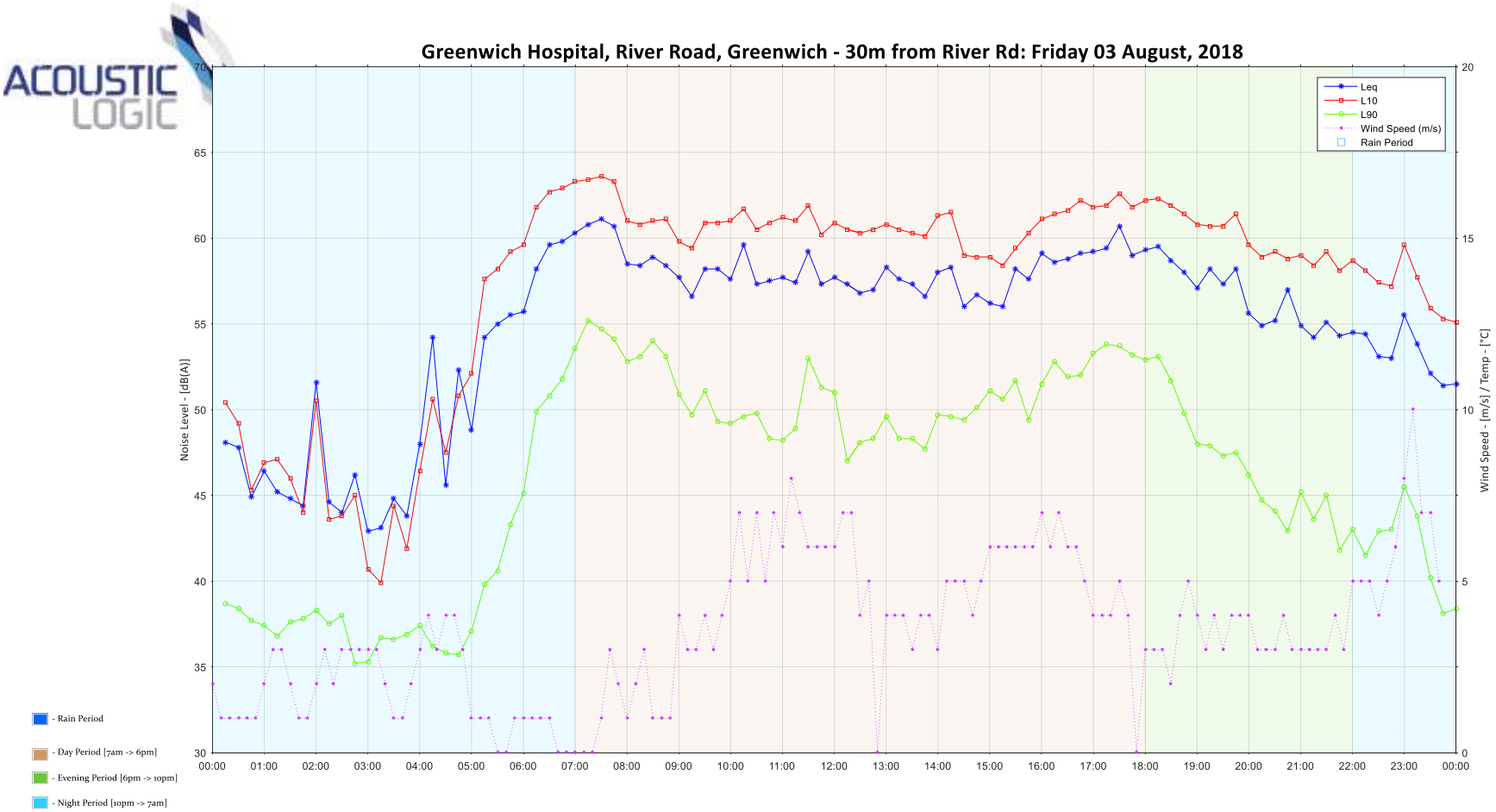
APPENDIX 2 – UNATTENDED NOISE MONITORING DATA - NORTHWESTERN BOUNDARY

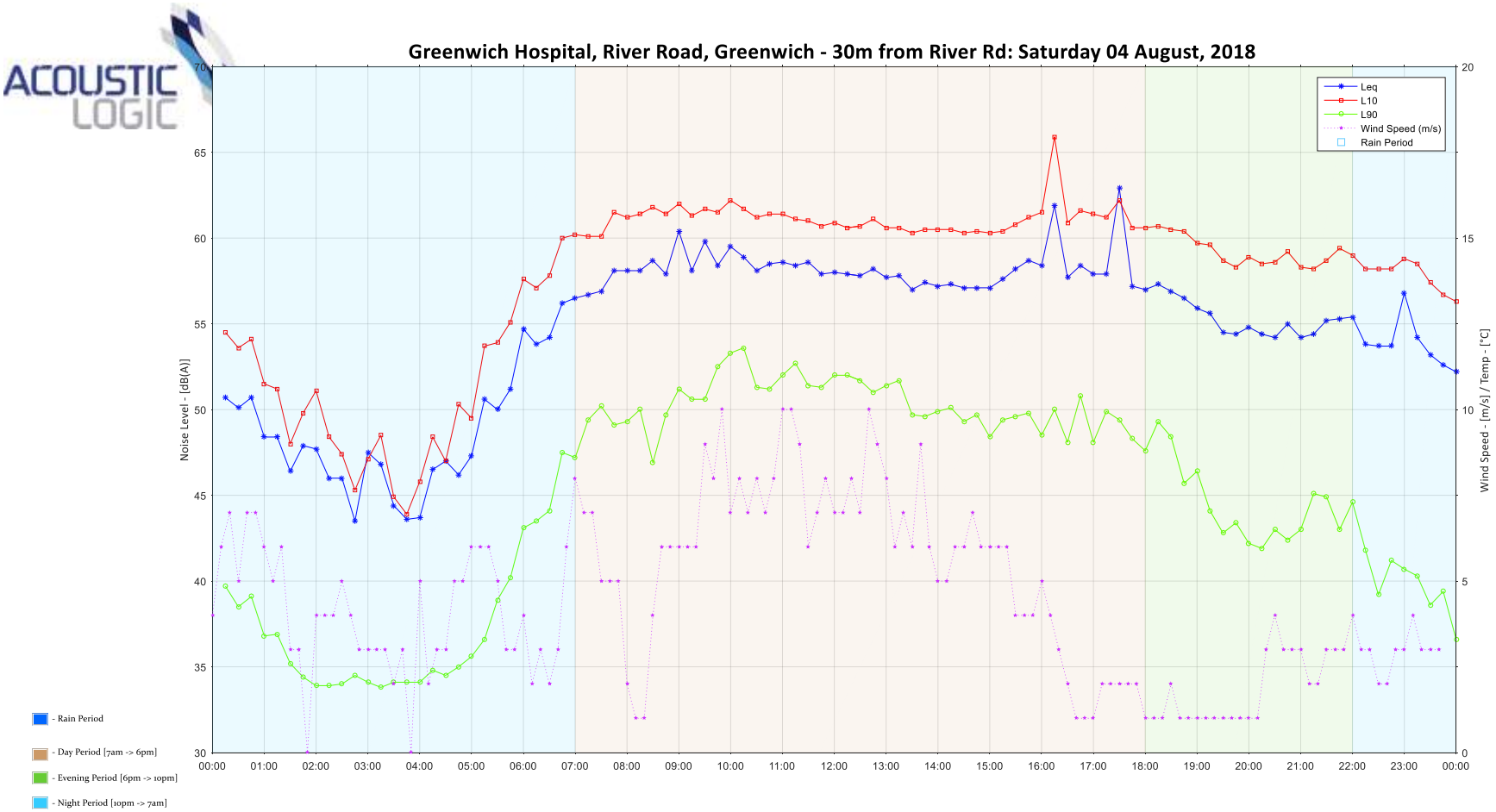

Greenwich Hospital, River Road, Greenwich - 30m from River Rd: Monday 30 July, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

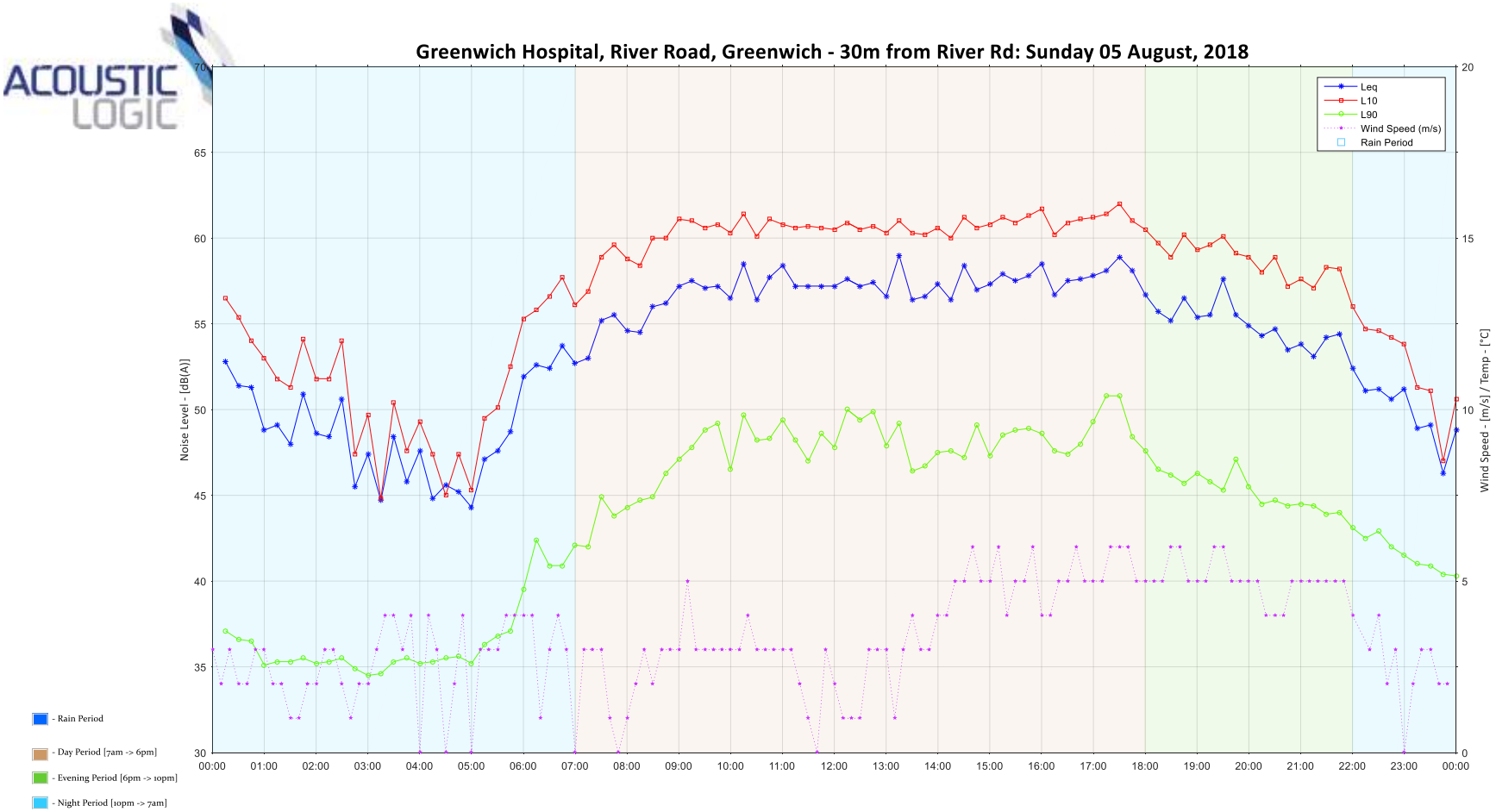

Greenwich Hospital, River Road, Greenwich - 30m from River Rd: Tuesday 31 July, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

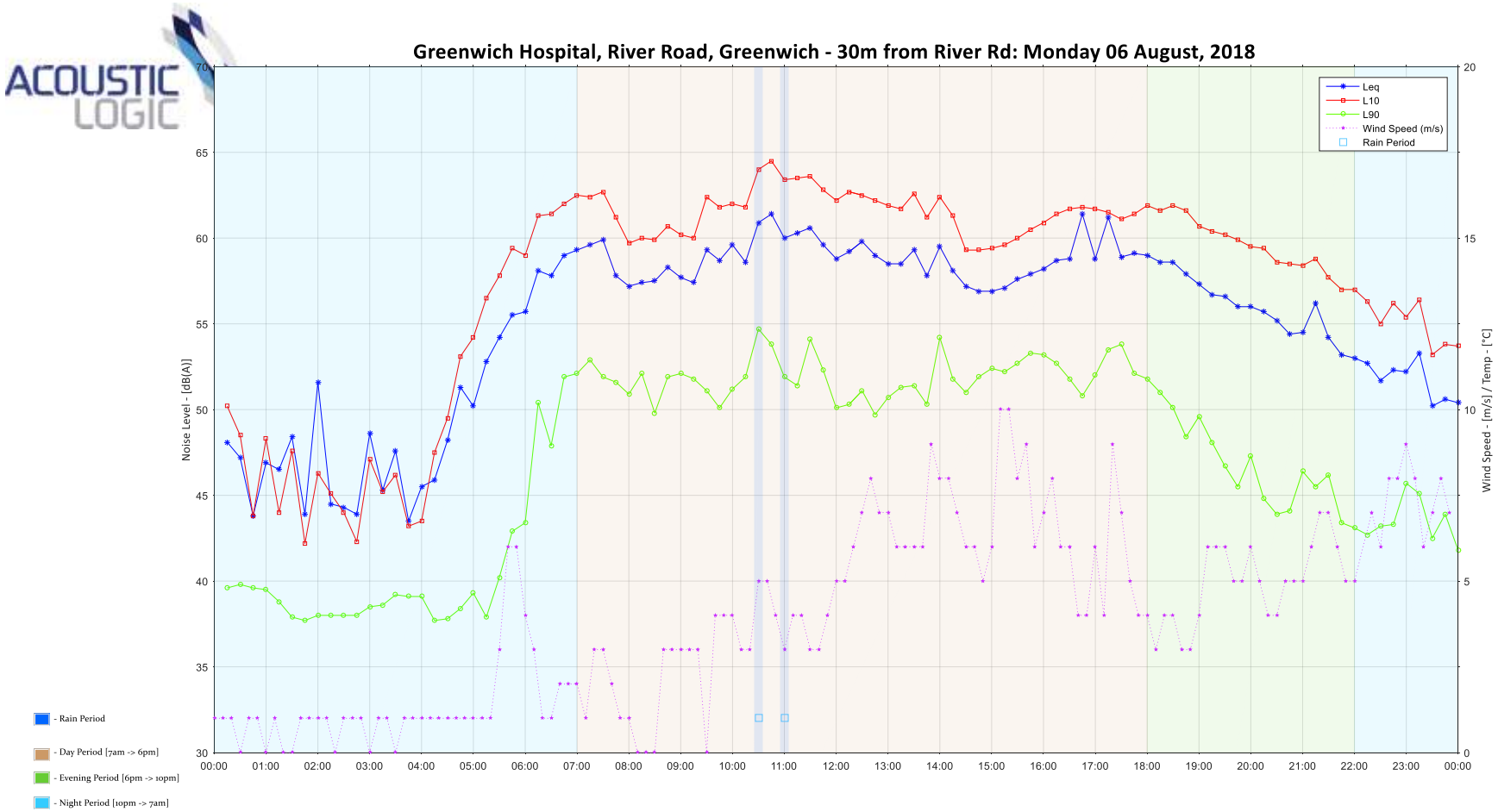

Greenwich Hospital, River Road, Greenwich - 30m from River Rd: Wednesday 01 August, 2018
Leq
L10
L90
Wind Speed (m/s)
Rain Period
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

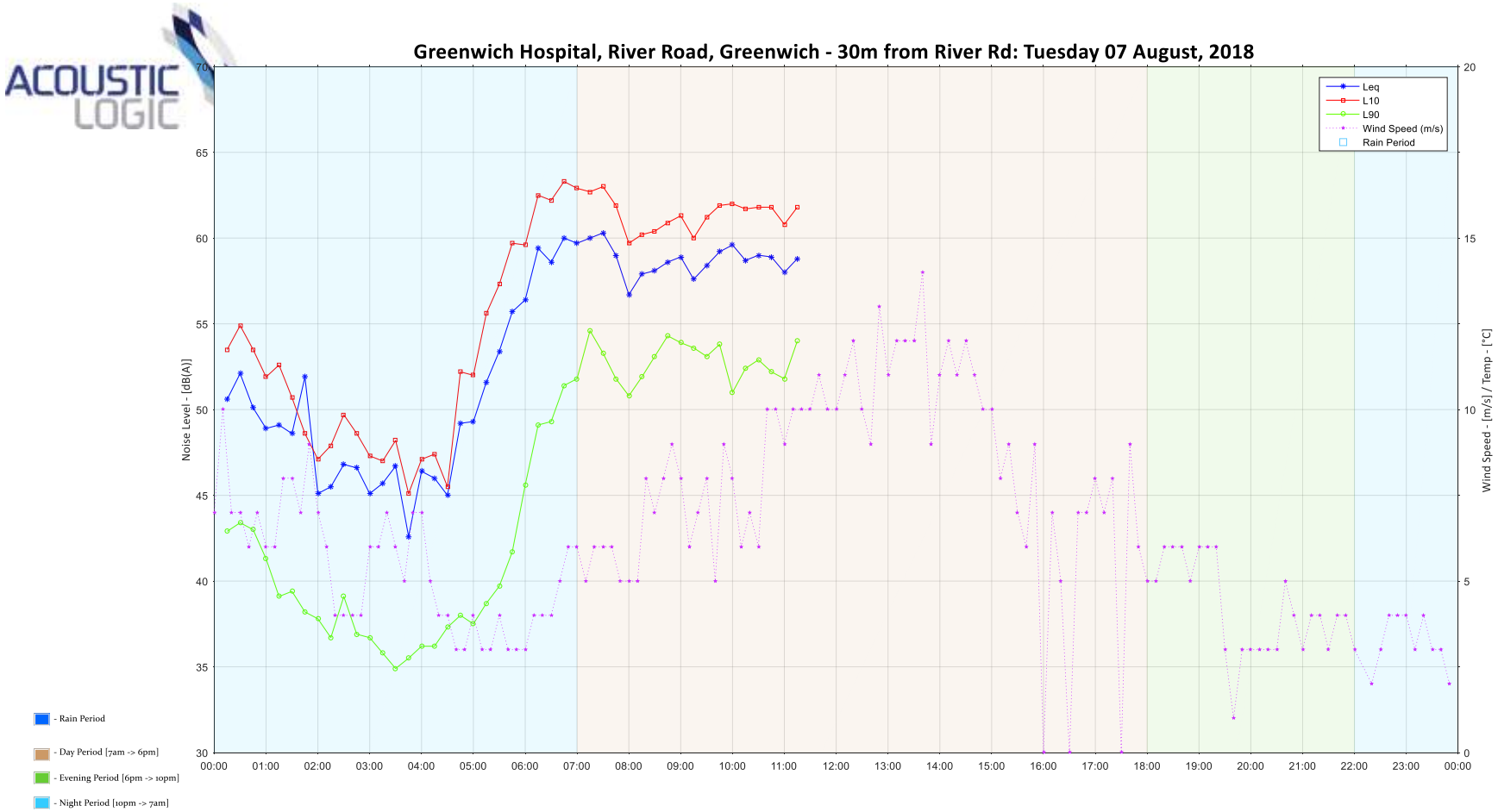

Greenwich Hospital, River Road, Greenwich - 30m from River Rd: Thursday 02 August, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]


Greenwich Hospital, River Road, Greenwich - 30m from River Rd: Friday 03 August, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

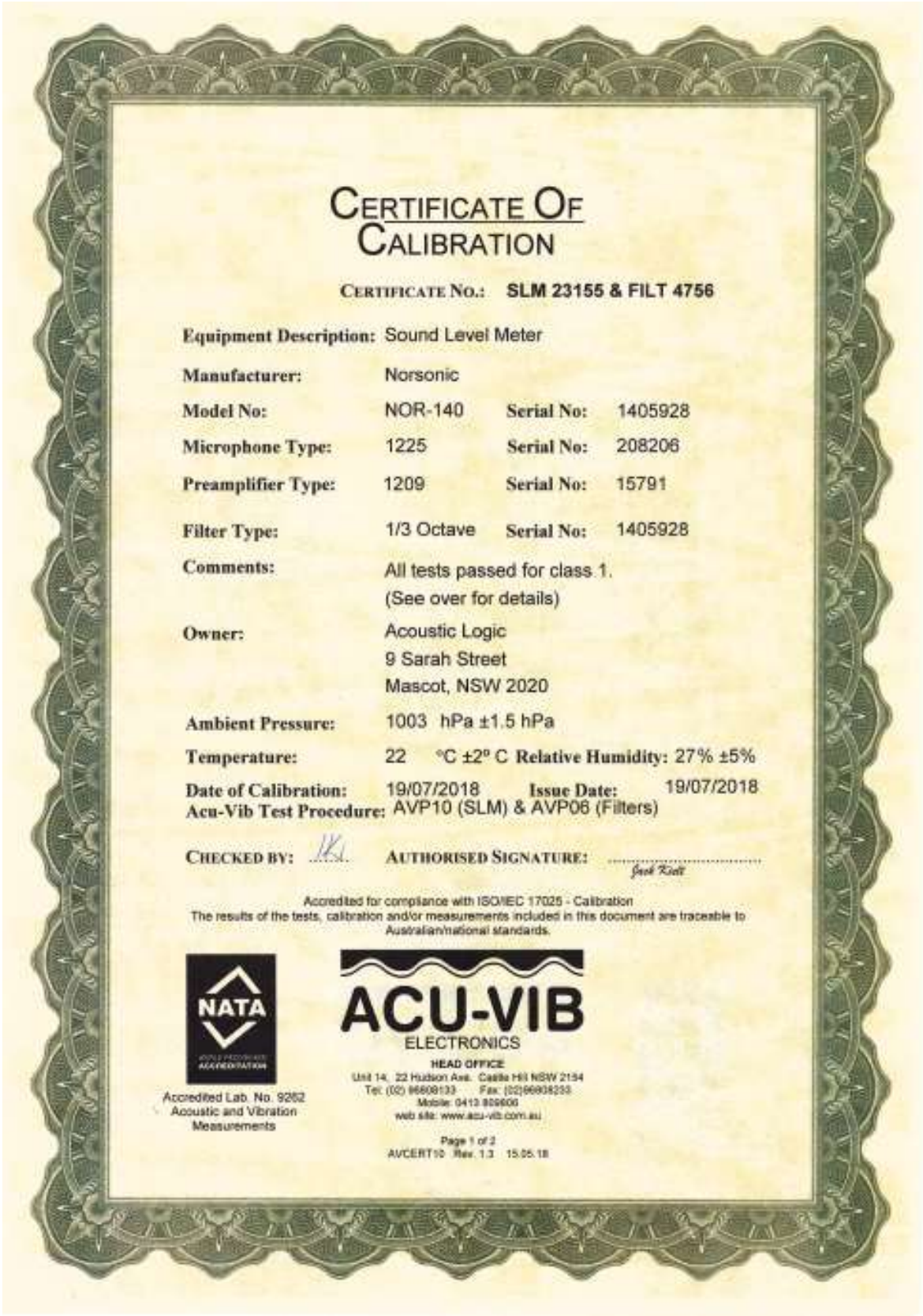

Greenwich Hospital, River Road, Greenwich - 30m from River Rd: Saturday 04 August, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]


Greenwich Hospital, River Road, Greenwich - 30m from River Rd: Sunday 05 August, 2018
Leq
L10
L90
Wind Speed (m/s)
Rain Period
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]


Greenwich Hospital, River Road, Greenwich - 30m from River Rd: Monday 06 August, 2018
Leq
L10
L90
Wind Speed (m/s)
Rain Period
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]


Greenwich Hospital, River Road, Greenwich - 30m from River Rd: Tuesday 07 August, 2018
Leq
L10
L90
Wind Speed (m/s)
Rain Period
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
- Rain Period
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

APPENDIX 3 – CALIBRATION CERTIFICATES



CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 23155 & FILT 4756

Equipment Description:	Sound Level Meter		
Manufacturer:	Norsonic		
Model No:	NOR-140	**Serial No:**	1405928
Microphone Type:	1225	**Serial No:**	208206
Preamplifier Type:	1209	**Serial No:**	15791
Filter Type:	1/3 Octave	**Serial No:**	1405928
Comments:	All tests passed for class 1. (See over for details)		
Owner:	Acoustic Logic 9 Sarah Street Mascot, NSW 2020		
Ambient Pressure:	1003 hPa ±1.5 hPa		
Temperature:	22 °C ±2° C	**Relative Humidity:**	27% ±5%
Date of Calibration:	19/07/2018	**Issue Date:**	19/07/2018
Acu-Vib Test Procedure:	AVP10 (SLM) & AVP06 (Filters)		

CHECKED BY: **AUTHORISED SIGNATURE:**

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

NATA
Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB ELECTRONICS
HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 96808133 Fax: (02)96808233
Mobile: 0413 809600
web site: www.acu-vib.com.au

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Norsonic 140 Sound Level Meter

Acoustic Research Labs Pty Ltd
Level 7 Building 2 423 Pennant Hills Rd
Pennant Hills NSW AUSTRALIA 2120
Ph: +61 2 9484 0800 A.B.N. 65 160 399 119
www.acousticresearch.com.au

Sound Level Meter
IEC 61672-3.2013
Calibration Certificate

Calibration Number C18142

Client Details	Acoustic Research Labs Pty Ltd Level 7, Bld 2, 423 Pennant Hills Road Pennant Hills NSW 2120
Equipment Tested/ Model Number :	Rion NL-42EX
Instrument Serial Number :	00184110
Microphone Serial Number :	173006
Pre-amplifier Serial Number :	74636

Pre-Test Atmospheric Conditions		**Post-Test Atmospheric Conditions**	
Ambient Temperature :	22°C	**Ambient Temperature :**	22.2°C
Relative Humidity :	53.6%	**Relative Humidity :**	55.8%
Barometric Pressure :	99.94kPa	**Barometric Pressure :**	99.92kPa

Calibration Technician :	Vicky Jaiswal	**Secondary Check:**	Riley Cooper
Calibration Date :	13 Mar 2018	**Report Issue Date :**	13 Mar 2018

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
12: Acoustical Sig. tests of a frequency weighting	*Pass*	17: Level linearity incl. the level range control	*Pass*
13: Electrical Sig. tests of frequency weightings	*Pass*	18: Toneburst response	*Pass*
14: Frequency and time weightings at 1 kHz	*Pass*	19: C Weighted Peak Sound Level	*Pass*
15: Long Term Stability	*Pass*	20: Overload Indication	*Pass*
16: Level linearity on the reference level range	*Pass*	21: High Level Stability	*Pass*

The sound level meter submitted for testing has successfully completed the class 2 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed.

However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2013 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013 and because the periodic tests of IEC 61672-3:2013 cover only a limited subset of the specifications in IEC 61672-1:2013.

Least Uncertainties of Measurement -

Acoustic Tests		Environmental Conditions	
31.5 Hz to 8kHz	*±0.15dB*	*Temperature*	*±0.07°C*
12.5kHz	*±0.21dB*	*Relative Humidity*	*±0.58%*
16kHz	*±0.29dB*	*Barometric Pressure*	*±0.017kPa*
Electrical Tests			
31.5 Hz to 20 kHz	*±0.12dB*		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

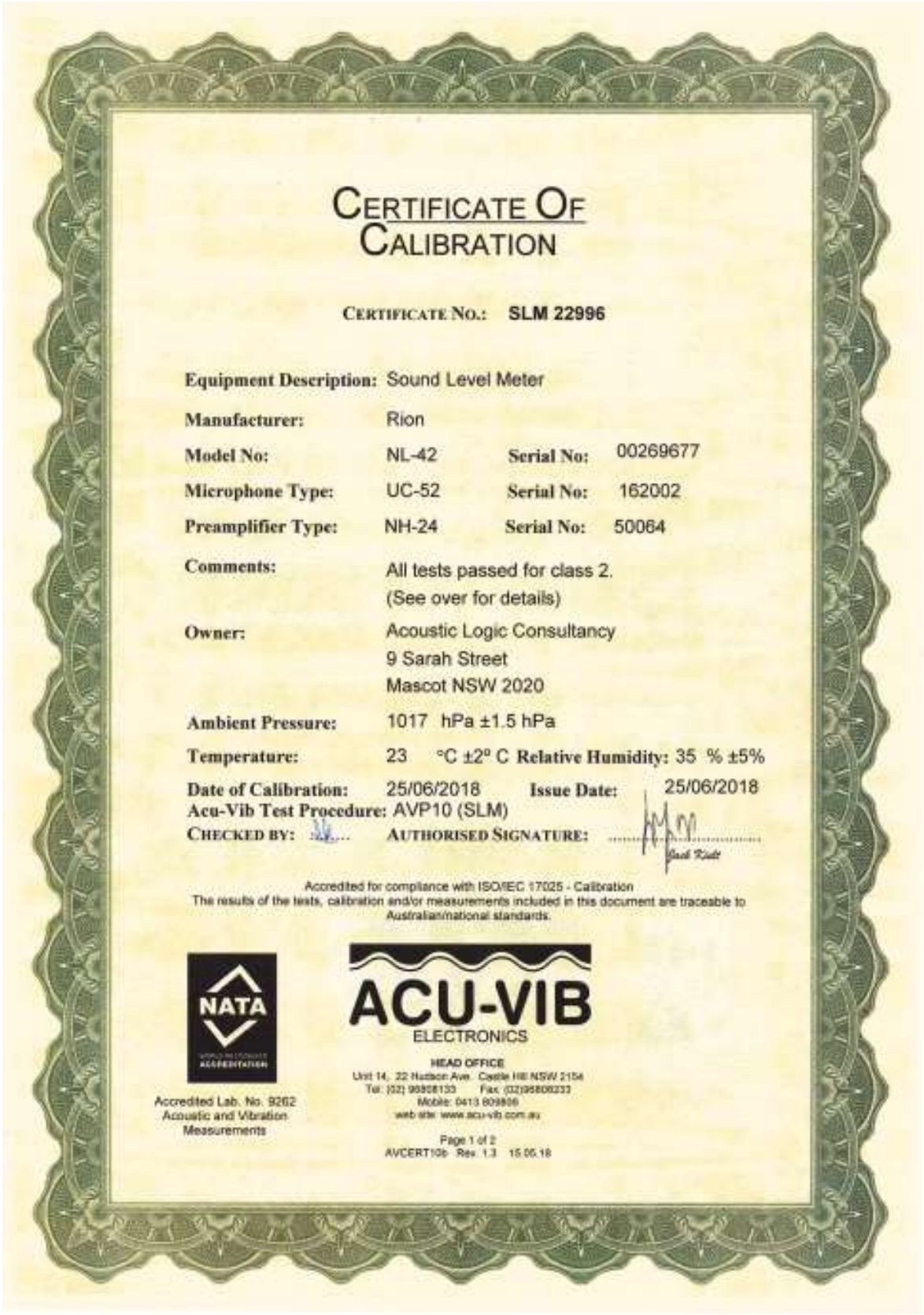
This calibration certificate is to be read in conjunction with the calibration test report.

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number 14172.
Accredited for compliance with ISO/IEC 17025 - calibration.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.

Rion NL-42EX – Noise Monitor



CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 22996

Equipment Description:	Sound Level Meter		
Manufacturer:	Rion		
Model No:	NL-42	**Serial No:**	00269677
Microphone Type:	UC-52	**Serial No:**	162002
Preamplifier Type:	NH-24	**Serial No:**	50064
Comments:	All tests passed for class 2. (See over for details)		
Owner:	Acoustic Logic Consultancy 9 Sarah Street Mascot NSW 2020		
Ambient Pressure:	1017 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	**Relative Humidity:**	35 % ±5%
Date of Calibration:	25/06/2018	**Issue Date:**	25/06/2018
Acu-Vib Test Procedure:	AVP10 (SLM)		
CHECKED BY:	...	**AUTHORISED SIGNATURE:**	.....

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

NATA
ACCREDITATION

Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS

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web site: www.acu-vib.com.au

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Rion NL-42EX – Noise Monitor

APPENDIX 4 -DAILY RATING BACKGROUND NOISE LEVELS

Table 20 – Unattended Noise Monitor – Rear of the site (south)

Date	Measured Rating Background Level (RBL) dB(A)L_{90}		
	Day (7am-6pm)	**Evening (6pm-10pm)**	**Night (10pm-7am Next Day)**
Monday 30 July 2018	-	38	35
Tuesday 31 July 2018	44	41	36
Wednesday 01 August 2018	43	39	36
Thursday 02 August 2018	43	39	35
Friday 03 August 2018	44	40	34
Saturday 04 August 2018	44	40	35
Sunday 05 August 2018	41	42	36
Monday 06 August 2018	47	44	41
Tuesday 07 August 2018	-	-	-
Median	**44**	**40**	**35**

Table 21 – Unattended Noise Monitor – Rear of the site (south)

Date	Measured Rating Background Level (RBL) dB(A)L_{90}		
	Day (7am-6pm)	**Evening (6pm-10pm)**	**Night (10pm-7am Next Day)**
Monday 30 July 2018	-	39	35
Tuesday 31 July 2018	48	43	36
Wednesday 01 August 2018	48	43	33
Thursday 02 August 2018	49	45	36
Friday 03 August 2018	48	43	34
Saturday 04 August 2018	48	42	35
Sunday 05 August 2018	45	44	38
Monday 06 August 2018	50	44	36
Tuesday 07 August 2018	-	-	-
Median	**48**	**43**	**36**