# ST DOMINIC'S COLLEGE BLOCK E

## Development Application Noise Impact Assessment

**Prepared for:**

St Dominics College c/o PMDL
17/124 Walker St,
North Sydney
NSW 2060

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# BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with St Dominics College c/o PMDL (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

# DOCUMENT CONTROL

| Reference | Date | Prepared | Checked | Authorised |
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| 610.18509.00000-R01-v0.1 | 13 February 2019 | Attila Szabo | Alex Campbell | Alex Campbell |
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## APPENDICES

# 1 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been engaged by St Dominics College c/- PMDL Architecture & Design to provide acoustic consultancy services for the new Block E building within St Dominics College. The proposed Block E building is along the Copeland Street boundary.

The building would have previously been approved under a Complying Development Certificate (CDC) however recent changes to the education SEPP has meant the proposal does not meet the setback and tree removal requirements and is therefore being submitted as a Development Application to Penrith City Council. The development will be carried out under the general provisions of the SEPP Education 2017 instrument, any other relevant documents and guidelines, and any requirements as outlined by Penrith City Council.

This report sets out the minimum required acoustic performance specifications for the development as well as providing an environmental noise impact assessment. It presents noise criteria and design goals, as well as noise mitigation and design recommendations including:

- Design criteria for acoustic performance of the building
- Details of the façade and other external building element requirements
- Details for internal walls and floors
- Building services noise control requirements.

Project acoustic performance requirements are listed in **Section 4**. Recommended constructions to achieve these requirements are listed from **Section 6** onwards.

This report is based on SLR's understanding of the proposed project, application of the relevant state guidelines and professional experience within the acoustic field. Therefore, this report shall not be relied upon as providing any warranties or guarantees.

A glossary of acoustic terminology used throughout this report is included as **Appendix A**.

# 2 Background Information

## 2.1 Information Sources

This assessment was based on the following documentation provided by PMDL:

- 2794 Acoustic Consultants Briefing, provided by PMDL, dated 7/11/2018
- PMDL coordination drawing set, Issue P1, provided 15/01/2019
- Noise data collected on site through the use of two noise loggers and a Type 1 hand held sound level meter
- Services Return Brief Report prepared by JHA Consultants dated 18/01/2019

## 2.2 Reference Documents

The acoustic assessment is also based on the following reference documents:

- The Penrith Development Control Plan (2014)
- State Environmental Planning Policy (Educational Establishments and Child Care Facilities), issued 2017 by the NSW Government
- NSW Noise Policy for Industry (NSW NPI), issued in October 2017 by the NSW Environment Protection Authority (NSW EPA)
- Guideline for Educational Facilities Version 2.0, issued January 2018 by the Association of Australasian Acoustical Consultants (AAAC)
- NSW Road Noise Policy (NSW RNP), issued March 2011 and published by the Department of Environment, Climate Change and Water NSW, now part of the NSW EPA
- Development Near Rail Corridors and Busy Roads – Interim Guideline (DNRCBR-IG), by the NSW Department of Planning which is now part of the NSW Department of Planning & Environment (issued December 2008)
- Department of Environment and Climate Change (DECC) Interim Construction Noise Guidelines, issued July 2009.

# 3 Project Overview

## 3.1 Proposed Block E development

PMDL has prepared a schematic design for the new Block E building consisting of a double volume multipurpose space, General Learning Areas (GLA), a change room and WC facilities, a covered outdoor area facing the playing field, a lower level carpark which is accessed via an existing carpark, On-Site Detention (OSD tanks and store rooms.

The location of the proposed Block E is to the south of the College's playing fields and its closest boundary is Copeland St. The site terrain slopes towards the boundary. Existing trees will need to be removed and replaced with suitable and appropriate landscaping.

The proposal also provides a new lift and a new pedestrian walkway connecting the upper level of the adjacent building so access to all levels is possible.

The proposal will comprise the following activities:

- Construction of the Block E building and associated landscaping.

## 3.2 Site Description

The existing St Dominic's College premises are located at 54 Gascoigne St, Kingswood. Whilst the site is adjacent to residential areas to the north and west, there are no common boundaries. The site is bounded by the following streets:

- Phillip Street to the east
- Gascoigne Street to the north

- Copeland Street to the south
- Parker Street to the west

The proposed Block E building will be located along Copeland Street towards the centre of the site.

The Block E site is bounded by commercial/industrial receivers across Copeland and Phillip Streets, and single-storey residential dwellings across Gascoigne Street to the North.

The most sensitive receivers include:

- Residential receivers located along Gascoigne Street approximately 160 m to the North of the proposed Block E building (refer to marker R1)
- Commercial receiver is an Office building that belongs to the Penrith Council site 30 m to the south (refer to marker C1)
- A Community Centre building which also holds religious worship (refer to marker R2) approximately 70 m to the south-east.

These receivers are displayed in **Figure 1**

It has been noted through site observations that ambient levels are relatively quiet and similar on all sides of the proposed Block E building. Receivers on all sides are subject to similar ambient conditions.

## Figure 1 Site Overview

## 3.3 Acoustic Concerns

A pre-DA meeting was held in June 2016, during which specific requirements were set by Penrith City Council as stated below:

- *An Acoustic Report is required to be submitted to demonstrate that the proposed development will not impact sensitive receivers. This report is to be prepared by a suitably qualified acoustic consultant, and is to address:*
    - *The 'NSW Industrial Noise Policy' in terms of assessing the noise impacts associated with development, including all noise generating activities such as the use of the school facilities, any outdoor spaces, new carpark, and plant and equipment (including PA systems).*
    - *The 'Interim Construction Noise Guideline' in assessing the impacts associated with the construction phase of the development.*
    - *Should mitigation measures be necessary, recommendations should be included to this effect and they need to be shown on any site plans. It is also important to note that conditions of consent may be recommended in line with the recommendations of the acoustic assessment as necessary (such as restricting use of certain spaces).*

Note the above three points have been addressed in **Sections 7** and **8**.

The acoustic issues relating to the development are as follows:

- Noise intrusion from vehicle movements on Copeland Street, Gascoigne Street, Phillip Street, and Parker Street into the development
- Noise emissions from mechanical plant and from the development use to the surrounding receivers
- Noise emissions from use of the Theatre space
- Construction noise impacts to surrounding residential, commercial, and other sensitive properties.

# 4 Existing Noise Environment

## 4.1 Ambient Noise Survey

In order to characterise the existing acoustical environment of the area, unattended noise monitoring was conducted between the dates of 30th November and 14th December 2018 at the logging locations shown in **Figure 2**.

Due to logger failure at Location 1 (along Copeland St), a second deployment period between January 31st and February 11th was conducted.

## Figure 2 On site noise measurement location map


Additionally, 15-minute attended noise measurements were conducted at the locations indicated in **Figure 2** to determine the character of the existing acoustic environment of the local area. Instrumentation for the noise survey included the following:

## Table 1 Noise Monitoring Equipment List

| Equipment | Location |
|---|---|
| ARL EL316 Environmental Noise Logger (S/N 16-207-041)[1] | Location 1 Unattended |
| ARL EL316 Environmental Noise Logger (S/N 16-207-041) | Location 1 Unattended (Second Deployment) |
| ARL EL316 Environmental Noise Logger (S/N 16-301-473) | Location 2 Unattended |
| Brüel & Kjær 2270 (S/N 3008204) Sound Level Meter | Location 1 and Location 2 Attended |
| Brüel & Kjær Calibrator (S/N 2115053) | - |

Note 1: Logger failed during monitoring period

Calibration of the logging devices was checked prior and after the measurements. There was no detectable drift in calibration. All equipment carried appropriate and current manufacturer calibration certificates.

Logger locations were selected with consideration to the noise sources which may influence readings, security issues for noise monitoring equipment and accessibility from residents and landowners. Positions were selected to capture a representative sample of the ambient noise character of the site in order to establish the noise emission criteria.

The measured data has been filtered to remove data affected by adverse weather conditions following reference to the weather reports recorded at the Bureau of Meteorology (BOM) Penrith Lakes weather station.

Daily graphs representing the measured noise data are attached in **Appendix B**. The graphs represent each 24-hour period by incorporating the $L_{A10}$, $L_{A90}$, $L_{Aeq}$ and $L_{Amax}$ noise levels for the corresponding 15-minute periods.

### 4.1.1 Unattended Noise Monitoring

To assess the acoustical implications of the development on the levels of noise received at nearby potentially sensitive receivers, the measured data at the noise logging position was processed in accordance with the Environmental Protection Authority's (EPA) NSW *Noise Policy for Industry* (NPfI).

**Table 2** details the Rating Background Level (RBL) and $L_{Aeq}$ noise levels recorded during the daytime, evening and night-time periods. Data affected by adverse meteorological conditions and by spurious and uncharacteristic events has been excluded from the results, and were also excluded from the data used to determine the noise emission criteria.

**Table 2 Measured Ambient Noise Levels Corresponding to EPA NPfI Assessment Time Periods**

| Noise Monitoring Location | Period[1] | Measurement Parameter (dBA) | |
|---|---|---|---|
| | | $L_{A90}$ (RBL)[2] | $L_{Aeq}$ [3] |
| Location 1[4] - Copeland St | Daytime | 48 | 62 |
| | Evening | 42 | 61 |
| | Night-time | 37 | 56 |
| Location 2 - Gascoigne St | Daytime | 42 | 55 |
| | Evening | 41 | 54 |
| | Night-time | 35 | 49 |

Note 1: For Monday to Saturday, Daytime 7:00 am - 6:00 pm; Evening 6:00 pm - 10:00 pm; Night-time 10:00 pm - 7:00 am.
On Sundays and Public Holidays, Daytime 8:00 am - 6:00 pm; Evening 6:00 pm -10:00 pm; Night-time 10:00 pm - 8:00 am.

Note 2: The RBL noise level is representative of the "average minimum background sound level" (in the absence of the source under consideration), or simply the background level.

Note 3: The $L_{Aeq}$ is essentially the "average sound level". It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

Note 4: Data retrieved from second deployment period. Calibration drift greater than 1 dB was observed at this location. Measured noise levels are considered indicative, however given this is not on a residential boundary, these noise levels do not impact NPfI or ICNG assessment criteria.

### 4.1.2 Attended Noise Monitoring

Operator attended noise monitoring measurements provide a context and noise level characteristics for the unattended noise measurements. A summary of the attended measurements is tabulated in **Table 3**.

**Table 3 Operator Attended 15-minute Ambient Noise Survey**

| Location/ Description | Date/ Start time/ Weather | Primary Noise Descriptor (dB re 20 µPa) | | | Comments |
|---|---|---|---|---|---|
| | | $L_{AFmax}$ | $L_{AFmin}$ | $L_{Aeq}$ | |
| Location 1 | 30th November 2018, 10:31-10:46 & 10:47-11:02 | 79 | 42 | 62 | Valid measurement. No atypical events or noises. |
| Location 2 | 30th November 2018, 09:55-10:10 | 78 | 41 | 54 | Valid measurement. No atypical events or noises. |

## 4.2 Road Traffic Noise

In order to assess environmental noise impacts on the site, the data obtained from the noise logging has been processed in order to establish representative ambient noise levels during defined standard time periods. These time periods are defined in the EPA's *Road Noise Policy* (RNP). Results are presented in **Table 4**.

**Table 4 Measured $L_{Aeq}$ values during monitoring period**

| Logger Location | $L_{Aeq(15hour)}$ | $L_{Aeq(9hour)}$ |
|---|---|---|
| Logger 1 along Copeland Street | 62 | 56 |

The $L_{Aeq}$ descriptor represents the logarithmic average noise energy during the measurement period. The '15-hour' represents the daytime period between 7:00am to 10:00pm, and '9-hour' represents the night time period between 10:00pm to 7:00am.

# 5 Design Criteria

The most appropriate design guidance for the proposed development can be found in:

- Guideline for Educational Facilities by the Association of Australasian Acoustical Consultants (AAAC Education Guidelines version 2.0).
- Australian Standard AS2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors.
- State Environmental Planning Policy (Educational Establishments and Child Care Facilities) 2017.
- NSW Noise Policy for Industry (NPfI), 2017.
- Interim Construction Noise Guideline (ICNG) 2009 by the Department of Environment and Climate Change NSW.

## 5.1 Operational Noise Emissions (NSW *Noise Policy for Industry*)

The NSW EPA *Noise Policy for Industry* (NPfI) outlines the applicable procedure for assessing noise emissions from industrial noise sources (i.e. mechanical plant) through establishing project noise trigger levels at nearby noise-sensitive receivers.

The *Intrusiveness* noise level is based on the measured background noise levels. In accordance with the NPfI, the equivalent continuous noise level ($L_{Aeq}$) of the source should not exceed the measured Rating Background Level (RBL) by more than 5 dBA over any 15-minute period within any assessment period.

The *Amenity* noise level is based on land use and associated activities (and their sensitivity to noise emissions). The study has been classified as 'Urban residential' for the purpose of this assessment, corresponding to an area dominated by "urban hum" and near commercial / industrial districts.

The processed results of the unattended noise monitoring have been used to establish the project noise trigger levels in bold. These are controlled by a combination of project intrusiveness noise levels for daytime criteria and project amenity noise level which are more stringent than the project intrusiveness noise level for evening and night time periods (refer to **Table 5**).

**Table 5 Project Noise Trigger Level for Nearest Sensitive Receiver Adjacent to Proposed Project Site**

| Receiver | Time of Day | Recommended Amenity Noise Level (dBA) | Measured RBL LA90(15minute) (dBA) | Measured $L_{Aeq}$(period) Noise Level (dBA) | Project Noise Trigger Levels (dBA) | |
|---|---|---|---|---|---|---|
| | | | | | Intrusiveness $L_{Aeq}$(15minute) | Amenity $L_{Aeq}$(period) |
| Residential Location 1- 75 Gascoigne Street (160m to the north) | Day | 60 | 42 | 55 | **47** | 55 |
| | Evening | 50 | 41 | 54 | 46 | **45** |
| | Night | 45 | 35 | 49 | **40** | 40 |
| Commercial Location 1- 34 Copeland Street (35m to the south) | When in use | 65 | 48 | 62 | **53** | 60 |

Note 1: *Noise Policy for Industry (NPfI)* assessment periods – Daytime: 7:00 am to 6:00 pm Monday to Saturday, 8:00 am to 6:00 pm Sundays and Public Holidays; Evening: 6:00 pm to 10:00 pm; Night: 10:00 pm to 8:00 am Monday to Saturday, 10:00 pm to 8:00 am Sundays and Public Holidays.

The State Environmental Planning Policy (Educational Establishments and Child Care Facilities) 2017 has two clauses which relate to noise emissions (detailed at beginning of **Section 5.2**). It shall be noted that compliance with the NPfI requirements will ensure compliance with Schedule 2 Clause 6 as the requirements overlap.

## 5.2 State Environment Planning Policy (Education) 2017

The State Environmental Planning Policy (Educational Establishments and Child Care Facilities) 2017 has a general clause which relates to overall acoustic design:

- **Schedule 4 Principle 5**- *Amenity: Schools should provide pleasant and engaging spaces that are accessible for a wide range of educational, informal and community activities, while also considering the amenity of adjacent development and the local neighbourhood. Schools located near busy roads or near rail corridors should incorporate appropriate noise mitigation measures to ensure a high level of amenity for occupants. Schools should include appropriate, efficient, stage and age appropriate indoor and outdoor learning and play spaces, access to sunlight, natural ventilation, outlook, visual and acoustic privacy, storage and service areas.*
- **Schedule 2 Clause 6-** *Noise: A new building or (if the development is an alteration or addition to an existing building for the purpose of changing its use) an existing building that is to be used for the purpose of a school or school-based child care must be designed so as not to emit noise exceeding an LAeq of 5 dB(A) above background noise when measured at any lot boundary.*

Note that compliance with the NPfI requirements will ensure compliance with Schedule 2 Clause 6 defined above.

## 5.3 Penrith City Council

A pre-DA meeting was held in June 2016, during which specific requirements were set by Penrith City Council as stated below:

- *An Acoustic Report is required to be submitted to demonstrate that the proposed development will not impact sensitive receivers. This report is to be prepared by a suitably qualified acoustic consultant, and is to address:*
  - *The 'NSW Industrial Noise Policy' in terms of assessing the noise impacts associated with development, including all noise generating activities such as the use of the school facilities, any outdoor spaces, new carpark, and plant and equipment (including PA systems).*
  - *The 'Interim Construction Noise Guideline' in assessing the impacts associated with the construction phase of the development.*
  - *Should mitigation measures be necessary, recommendations should be included to this effect and they need to be shown on any site plans. It is also important to note that conditions of consent may be recommended in line with the recommendations of the acoustic assessment as necessary (such as restricting use of certain spaces).*

## 5.4 Internal ambient noise levels

Suitable internal noise levels for educational facilities are recommended in the AAAC *"Guideline for Educational Facilities"* are presented in **Table 6**.

**Table 6 AAAC Recommended Internal Noise Levels**

| Room | Design level range for internal ambient noise level, $L_{Aeq}$ (dB)[1] |
|---|---|
| Assembly halls up to 250 seats | 30 – 40 |
| Teaching spaces – Secondary schools | 35 – 40 |
| Corridors and lobby spaces | ≤ 50 |
| Toilets/change rooms/showers | ≤ 55 |
| Store rooms[2] | 50 – 60 |
| Plant rooms[2] | ≤ 60 |

Note 1: The recommended internal levels presented in the AAAC Guidelines derived from Australian/New Zealand Standard *"AS/NZS 2107:2016 Acoustics - Recommended design sound levels and reverberation times for building interiors"* and have been nominated for use in the noise intrusion assessment

Note 2: In cases where the AAAC Guideline does not include room types relevant to the proposed development, the recommended internal levels are derived directly from Australian/New Zealand Standard *"AS/NZS 2107:2016 Acoustics - Recommended design sound levels and reverberation times for building interiors"*

# 6 External Building Constructions

This section summarises the required performance of external building constructions (façade and roof) to control external noise ingress and egress within the criteria established in **Section 5.4**. External sound isolation is required such that noise from external road traffic and on-site external mechanical plant be controlled to acceptable levels within the occupied spaces of the building. Additionally, the external building constructions will be used to control noise break-out to surrounding noise sensitive receivers.

Road traffic noise intrusion through the building facades shall be controlled such that the design internal sound levels listed in AS 2107 can be achieved. As outlined in **Section 5.4**, the internal criteria will be specific to the room use. Based upon the road traffic noise levels listed and considering the internal targets above, the minimum recommended facade acoustic ratings are as follows.

**Table 7 Minimum required performance of façade elements**

| Element | Weighted Sound Reduction ($R_W+C_{tr}$), dB | Minimum sound reduction (R), at 1/1 Octave Band Centre Frequencies | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz |
| Solid façade | **33** | 16 | 20 | 37 | 51 | 58 | 65 | 53 |
| Glazing | **29** | 15 | 19 | 24 | 26 | 33 | 34 | 42 |
| Roof | **33** | 5 | 29 | 40 | 45 | 52 | 54 | 48 |

The listed $R_W+C_{tr}$ (weighted sound reduction index plus low frequency offset) performance ratings can be taken as preliminary and are subject to refinement. General construction examples to achieve the above $R_W+C_{tr}$ ratings are discussed below.

## 6.1 Walls

Solid external wall elements are to be designed to achieve a minimum acoustic performance of $R_W+C_{tr}$ 33 dB (theatre space not included). The external solid wall system proposed by PMDL Architects (detailed in **Table 8** below) meets the minimum acoustic requirements for external walls.

**Table 8 External Solid Wall Systems Proposed**

| Typical Weighted Sound Reduction Performance Target **($R_W+C_{tr}$), dB** | Proposed Wall System | Predicted Performance of System **($R_W+C_{tr}$), dB** |
|---|---|---|
| 33 | Colorbond Zenith steel cladding to external, 92mm steel stud, 75mm thick Glasswool insulation (minimum 14 kg/m$^3$ density), 2 layers of 10mm standard plasterboard (8.4 kg/m$^2$) | 33 |
| 33 | External brick, 64mm staggered steel stud with 20mm gap, 50mm thick Glasswool insulation (minimum 14 kg/m$^3$), 1 layer of 10mm standard plasterboard (8.4 kg/m$^2$) | 53 |

## 6.2 Doors

It should be noted that walls to outdoor circulation spaces on the northern façade of Level 2 have the same performance requirements as **Table 8** above. However, these facades will incorporate both hinged and sliding doors. The required acoustic performance for both hinged and sliding doors to ensure the performance of the overall facade is not significantly reduced are provided in **Table 9** below.

A reduced performance level will need to be accepted due to practical limitations regarding the door acoustic Rw rating achievable from both commercial grade solid core doors, and glazed sliding doors.

**Table 9 Recommended performance levels of partitions including doors facing circulation areas**

| Façade and Location | Element | Minimum Sound Insulation Performance Requirement (dB Rw) |
|---|---|---|
| Northern Level 2 façade to outdoor circulation area | Sliding Door | 30 |
| | Hinged Door | 30 |

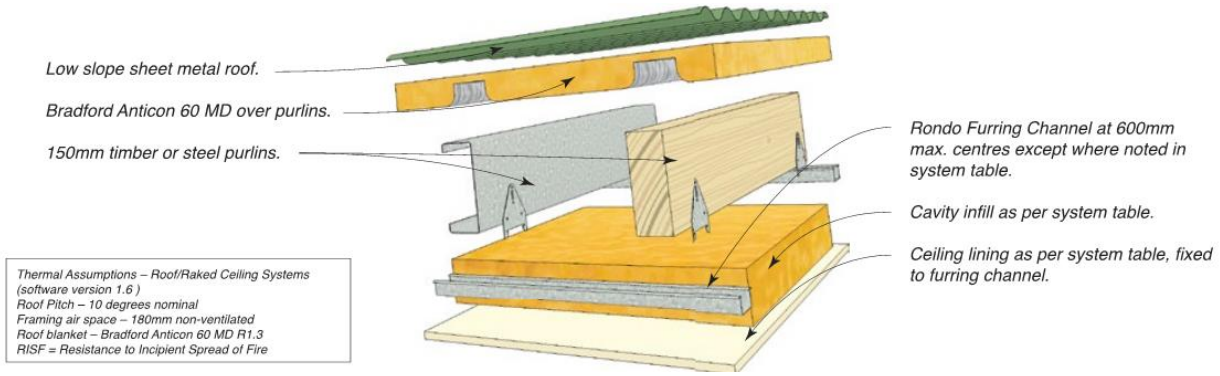
An Rw = 30 dB acoustic rating for hinged doors can typically be achieved by 40mm thick (nominal) solid core timber (24kg/$m^2$). For glazed sliding doors, minimum 8mm thick glazing (framed) must be provided. The sliding door performance relies heavily on type of door seals provided. Based on our experience with sliding doors, it is considered likely from an operational perspective that the maximum expected acoustic rating for such doors will be Rw = 30 dB. In both cases above, acoustic seals to perimeter and threshold such as Raven RP120 and RP8 are required. The door sets must include a threshold detail suitable for effective operation of operable acoustic seals installed in the bottom rail of doors. Door grilles must not be supplied to any acoustic rated door set.

Again, this will limit the overall sound insulation offered by the Level 2 northern facade to approximately Dw 25 - 30 dB (dependant on the ratio of the area of the door to the surrounding solid partition). This is typical for this type of construction, and is not likely to cause any issues.

## 6.3 Roof

Roof and ceilings are to be designed to achieve a minimum acoustic performance of $R_W+C_{tr}$ 33 dB. An example of a roof construction that meets (exceeds at Rw+Ctr 37) this is shown in **Figure 3,** and consists of roof sheeting (i.e. Colorbond or similar) with Bradford Anticon over 150mm roof purlins. Below the roof construction, a ceiling consisting of two layers of 13mm Fyrchek Plasterboard (10.5kg/$m^2$), with 140mm insulation batts (11kg/$m^3$) above is required. Any alternative roof/ceiling system may be used granted the performance is equal or better. This can be confirmed by SLR consulting once a roof system is proposed.

**Figure 3 $R_W+C_{tr}$ = 37 Roof Construction (CSR 6628 System shown as example)**




## 6.4 Glazing

Glazing requirements have been determined along both the northern and southern façades of the building.

For the Level 2 GLA's, the design was driven by traffic noise intrusion, window sizing, room dimensions and finishes.

For the Theatre space, we will also need to consider noise emissions from the space to receivers nearby. Given the glazing to the Theatre is generally fixed rather than operable, and glazing areas are limited, typical single glazing is expected to be sufficient to achieve compliance with the established criteira. Noise levels from the space have been assumed based on the described use and operation of the Theatre as well as capacity.

The overall acoustic performance requirements of window and frame systems are provided in **Table 10** below.

**Table 10 Glazing Performance Requirements**

| Facade | Performance Requirement | Typical Glazing Example[1] |
|---|---|---|
| **Level 2 GLA's** | | |
| North (Gascoigne Street) | Rw 32 | 6.38mm Laminated |
| South (Copeland Street) | Rw 32 | 6.38mm Laminated |
| **Theatre Space** | | |
| North (Gascoigne Street) | Rw 32 | 6.38mm Laminated |
| South (Copeland Street) | Rw 32 | 6.38mm Laminated |

Note 1: It should be noted that performances of entire glazing systems including frame and seals vary for specific thicknesses between manufacturers. For this reason, the overall performance requirement should drive the selection, and manufacturers will need to confirm the entire system will not reduce the performance of the glazing.

# 7 Noise emissions from use

## 7.1 Activity Noise

The primary potential noise generating space within the development is from use of the Theatre. Glazing from the Theatre is not operable, and doors open into an internal Foyer Area.

Acoustic emissions from the Theatre have been assessed based on potential future usage cases of the space. The scenarios in **Table 11** represent the worst-case expected noise levels, based on previous measurements conducted by SLR and the likely noise environment to be present in the proposed Theatre.

**Table 11 Theatre Usage Scenarios**

| Noise Source Activity | Predicted Overall Level, $L_{Aeq(15min)}$ | Comment |
|---|---|---|
| Assembly PA | 80 | Representative of a raised voice, adjusted to the typical level expected to be projected through a PA system |
| Assembly Conversation | 84 | Representative of periods of conversation before or after presentation. Assuming the space is occupied to capacity and approximately one quarter of the occupants are talking |
| Social Event | 90 | Representative of an out of hours event, with consistent music and a high occupancy state |
| Music Performance | 90 | Representative of a music recital/performance |

The proposed source levels are used in conjunction with the building construction requirements, outline in **Section 6**, to predict the expected noise break-out to surrounding sensitive receivers. A summary of the resulting predictions and compliances are presented in **Table 12**.

**Table 12 Noise Breakout Compliance**

| Receiver | Hall Noise Scenario | Criteria $L_{Aeq(15min)}$ | Predicted Contribution $L_{Aeq(15min)}$ | Compliance |
|---|---|---|---|---|
| Residential Location 1- 75 Gascoigne Street (160m to the north) | Assembly PA | 45 | <10 | YES |
| | Assembly Conversation | 45 | 10 | YES |
| | Social Event | 45 | 19 | YES |
| | Music Performance | 45 | 15 | YES |
| Commercial Location 1- 34 Copeland Street (35m to the south) | Assembly PA | 55 | 18 | YES |
| | Assembly Conversation | 55 | 22 | YES |
| | Social Event | 55 | 31 | YES |
| | Music Performance | 55 | 27 | YES |

The results in **Table 12** show that noise emissions from the proposed Theatre are not expected to impose a notable impact on the surrounding receivers.

## 7.2 MEP Plant noise emissions

A basic assessment has been conducted on the mechanical plant in terms of noise emissions affecting nearby residential receivers.

Preliminary locations were proposed for mechanical equipment, with outline equipment types. The equipment types proposed are not particularly noisy, and there are easy mitigation measures that can be utilised based on final equipment selections and locations.

Once these specifics have been determined, mitigation measures will be recommended to ensure DA requirements are met. The MEP Plant noise emissions are expected to comply with requirements through use of standard mitigation measures such as attenuators, lined ductwork and acoustic barriers.

## 7.3 Traffic changes and Car Park Noise emissions

The NSW Road Noise Policy (RNP) requires consideration of noise mitigation where new land use developments increase road traffic noise by more than 2 dB.

For a 2 dB increase in noise to be apparent a corresponding increase in traffic volumes of approximately 60% is required (assuming road speeds and other factors remain unchanged).

Considering there are 13 new car parking spaces to be provided, and access is through the existing much larger car park (not a new entry), the cumulative noise impacts from introducing the 12 additional parking spots will be negligible.

## 7.4 Outdoor space use

There are no new outdoor play or sports areas associated with the Block E development. As such, SLR do not expect any additional levels of noise emission from outdoor space use. On the contrary, the new building of Block E may provide screening to receivers to the south of the site, reducing the noise impact associated with outdoor space use.

Waiting areas for the Theatre are provided in an enclosed Foyer, which has doors opening to the less sensitive northern side of the building. Therefore, SLR do not expect any additional noise levels to be emitted resulting from gathering in the Foyer of the Theatre space.

# 8 Construction Noise Impact

## 8.1 Working Hours

It is expected that works would be undertaken during the standard construction hours of:

- 7.00 am to 6.00 pm Monday to Friday
- 8.00 am to 1.00 pm on Saturdays
- No work on Sundays or Public Holidays.

It is not expected that there would be any requirement for works during evening or night-time periods.

## 8.2 Nearest Receivers

The nearest sensitive receivers are commercial/office and residential properties located to the south and north, at a distance of around 40 m and 160 m, respectively. The nearest receivers are shown in **Figure 4**, with details of the nearest potentially affected sensitive receivers provided in **Table 13**.

### Table 13 Surrounding Sensitive Receivers

| ID | Address | Type | Distance (m) | Direction |
|---|---|---|---|---|
| C01 | 34 Copeland St | Commercial | 40 m | south |
| R01 | 77 Gascoinge St | Residential | 160 m | north |
| R02 | 83 Cox Ave (The Rock Community Centre) | Place of Worship[1] | 70 m | south-east |

Note 1: Receiver criteria applicable only when in use

The sensitive receivers near to the Project are shown in **Figure 4**.

### Figure 4 Nearest Sensitive Receivers

## 8.3 Assessment Criteria

### 8.3.1 Interim Construction Noise Guideline

The NSW *Interim Construction Noise Guideline* (ICNG) is used to assess and manage impacts from construction noise on residences and other sensitive land uses in NSW.

The ICNG requires project specific Noise Management Levels (NMLs) to be established for sensitive receivers based on the existing background noise in the area.

The NMLs are not mandatory limits, however where construction noise levels are predicted or measured to be above the NMLs, feasible and reasonable work practices to minimise noise emissions are to be investigated.

#### 8.3.1.1 Residential Receivers

The ICNG approach for determining NMLs at residential receivers is shown in **Table 14**.

**Table 14 ICNG NMLs for Residential Receivers**

| Time of Day | NML $L_{Aeq(15minute)}$ | How to Apply |
|---|---|---|
| Standard hours<br>Monday to Friday<br>7:00 am to 6:00 pm<br>Saturday<br>8:00 am to 1:00 pm<br>No work on Sundays or public holidays | RBL + 10 dB | • The noise affected level represents the point above which there may be some community reaction to noise.<br>• Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practises to meet the noise affected level.<br>• The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details. |
| | Highly Noise Affected<br>75 dBA | • The Highly Noise Affected (HNA) level represents the point above which there may be strong community reaction to noise.<br>• Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restructuring the hours that the very noisy activities can occur, taking into account:<br>  ◦ Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools or mid-morning or mid-afternoon for works near residences.<br>  ◦ If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times. |
| Outside recommended standard hours | RBL + 5 dB | • A strong justification would typically be required for works outside the recommended standard hours.<br>• The proponent should apply all feasible and reasonable work practices to meet the noise affected level.<br>• Where all feasible and reasonable practises have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community. |

Note 1: The RBL is the Rating Background Level and the methodology for calculating it is described in the NSW *Noise Policy for Industry*.

#### 8.3.1.2 Other Sensitive Land Uses and Commercial Receivers

A number of non-residential land uses have been identified in the project area. These include 'other sensitive' land uses, such as educational institutes, places of worship, and commercial properties. The ICNG NMLs for other sensitive receivers are shown in **Table 15**.

**Table 15 ICNG NMLs for Other Sensitive Receivers**

| Land Use | NML $L_{Aeq(15minute)}$ (Applied when the property is in use) |
|---|---|
| Classrooms at schools and other education institutions | Internal noise level 45 dBA[1] |
| Places of Worship | Internal noise level 45 dBA[1] |
| Community centres | Refer to the recommended 'maximum' internal levels in AS 2107 for specific uses. |
| Commercial | External noise level 70 dBA |

Note 1: The criteria is specified as an internal noise level for this receiver category. As the noise model predicts external noise levels, it has been conservatively assumed that all schools and places of worship have openable windows and external noise levels are therefore 10 dB higher than the corresponding internal level, which is generally considered to be representative of windows being partially open to provide ventilation

### 8.3.2 Summary of Residential NMLs

The residential NMLs for the project are determined using the background noise monitoring and are shown in **Table 16**.

**Table 16 Residential Receiver Construction Noise Management Levels**

| Receiver | Representative Background Monitoring Location | Noise Management Level ($L_{Aeq(15minute)}$ – dBA) | | | |
|---|---|---|---|---|---|
| | | Standard Construction (RBL +10 dB) | Out of Hours (RBL +5 dB) | | |
| | | Daytime | Daytime[1] | Evening | Night-time |
| R01 | L02 | 58 | 46 | 47 | 37 |

Note 1: Day-time out of hours is considered works past 1 pm on Saturday, or any works on Sundays/Public Holidays.

The activities likely to be required to build the project involve conventional construction equipment such as ground excavation equipment, compactors and trucks.

A number of representative construction scenarios have been developed to assess potential impacts during construction are detailed in **Table 17**.

**Table 17 Construction Activities and Sound Power Levels for Construction Equipment**

| Works Number | Scenario Name | Activity Name | Equipment | Items (in 15 min) | On-Time (15 min) | Individual SWL $L_{Aeq}$ | Works SWL $L_{Aeq}$ |
|---|---|---|---|---|---|---|---|
| W.0001 | Site Establishment | Delivery of Materials, general layout setup | Truck | 1 | 11:15 | 107 | 112 |
| | | | Grader | 1 | 11:15 | 110 | |
| | | | Hand Tools (electric) | 1 | 11:15 | 96 | |
| | | | Generator (small) | 1 | 15:00 | 93 | |
| W.0002 | Earth Works | Preparation for foundation works | Truck | 1 | 11:15 | 107 | 116 |
| | | | Backhoe | 1 | 11:15 | 104 | |
| | | | Mobile Crane - Franna | 1 | 11:15 | 98 | |
| | | | Dozer | 1 | 11:15 | 114 | |
| | | | 12t Excavator | 1 | 11:15 | 100 | |
| | | | Grader | 1 | 15:00 | 108 | |
| W.0003 | Concrete works | Foundation works | Concrete Mixer Truck | 1 | 11:15 | 103 | 108 |
| | | | Concrete Pump | 1 | 11:15 | 106 | |
| W.0004 | Primary Construction Works | Infrastructure construction | Mobile Crane (35 tonne) | 1 | 11:15 | 98 | 105 |
| | | | hand tools (electric) | 1 | 7:30 | 96 | |
| | | | Welding Equipment | 1 | 7:30 | 97 | |
| | | | Hand Tools | 1 | 7:30 | 102 | |
| | | | generator (small) | 1 | 15:00 | 93 | |

Note 1: The ICNG requires that activities identified as particularly annoying (such as jackhammering, rock breaking and power saw operation) have a 5 dB 'penalty' added to predicted noise levels when using the quantitative method.

Note 2: Sound Power Levels have been taken from DEFRA, RMS *Construction Noise and Vibration Guideline* and TfNSW *Construction Noise and Vibration Strategy*.

## 8.4 Construction Noise Assessment

Noise predictions from the construction works have been predicted to the facade of the nearest receivers during the daytime and are summarised in **Table 18**.

The results represent the worst-case noise levels where all equipment in each scenario is working concurrently. For most construction activities, it is expected that the construction noise levels would frequently be lower than predicted.

### Table 18 Construction Noise Impacts, $L_{Aeq(15minute)}$ dBA

| Scenario and Works ID | Receiver | Predicted External $L_{Aeq(15minute)}$ | | |
|---|---|---|---|---|
| | | Daytime NML | Predicted Level | Exceedance |
| W.001 Site Establishment | C01 - Copeland St Commercial | 70 | 74 | 4 |
| | R01 - Residential along Gascoigne St | 52 | 51 | - |
| | R02 – The Rock Community Centre | 45 (Internal) | 56 (Internal)[1] | 11 |
| W.002 Earth Works | C01 - Copeland St Commercial | 70 | 78 | 8 |
| | R01 - Residential along Gascoigne St | 52 | 55 | 3 |
| | R02 – The Rock Community Centre | 45 (Internal) | 60 (Internal)[1] | 15 |
| W.003 Concrete Works | C01 - Copeland St Commercial | 70 | 69 | - |
| | R01 - Residential along Gascoigne St | 52 | 47 | - |
| | R02 – The Rock Community Centre | 45 (Internal) | 52 (Internal)[1] | 7 |
| W.004 Primary Construction Works | C01 - Copeland St Commercial | 70 | 67 | - |
| | R01 - Residential along Gascoigne St | 52 | 44 | - |
| | R02 – The Rock Community Centre | 45 (Internal) | 49 (Internal)[1] | 4 |

Note 1: Internal noise emissions are predicted with a conservative difference of 10 dB between external and internal noise levels to account for an open window. These predictions and their exceedances would only be applicable when the space is in use.

Note 2: A conservative 3 dB allowance for facade reflections is applied to external noise levels.

The above shows the following:

- High noise impacts are predicted during the worst-case scenarios due to the proximity of the adjacent receivers.
- Residential exceedances during earth works are relatively minor. Some mitigation may be required to control the noise for the receivers to the north of the premises. Refer to **Section 8.5** for standard mitigation measures.
- No works during the evening or night-time are proposed.

## 8.5 Mitigation

Due to the nature of construction activities and the proximity of the works to the sensitive receivers, it is inevitable that noise impacts will occur at certain times during the works.

Consequently, the project should apply all feasible and reasonable work practices to meet the NMLs, where possible, and inform all potentially impacted sensitive receivers of the nature of works to be carried out, the expected noise levels, duration of noise generating construction works, and contact details during construction.

The recommended construction migitaion measures are shown in **Table 19**.

**Table 19 Recommended Mitigation Measures**

| Project stage | Measure |
|---|---|
| Scheduling | Where ever possible, highly noisy intensive works should only be undertaken during the following hours, unless otherwise assessed and justified:<br>- 7 am to 6 pm Mondays to Fridays, inclusive; and<br>- 8 am to 1 pm Saturdays; and<br>- at no time on Sundays or public holidays. |
| | Provide respite periods when noisy works are undertaken outside standard hours of construction or during periods where high noise impacts are likely. |
| | Carry out community consultation to determine the need and frequency of respite periods. |
| | Avoid loading and unloading of materials / deliveries outside of daytime hours. |
| Site Layout | Site entry and exit points should be located as far as possible from sensitive receivers. |
| | Compounds and work areas should be designed to as one-way to minimise the need for vehicles to reverse. |
| | Work compounds, parking areas, equipment and stockpiles should be positioned away from noise-sensitive locations and/or in shielded locations. |
| | Trucks should not idle near to residential receivers. |
| | Stationary sources of noise, such as generators, should be located away from sensitive receivers. |
| Contractor management | Training should be provided to project personnel, including relevant sub-contractors, on noise and vibration requirements and the location of sensitive receivers during inductions and toolbox talks. |
| | Delivery vehicles should be fitted with straps rather than chains for unloading, wherever possible. |
| | Truck drivers should avoid compression braking as far as practicable. |
| | Where night-time works are required, trucks should use broadband reversing alarms. |
| Noise source mitigation | Use the minimum sized equipment necessary to complete the work and where possible, use alternative, low-impact construction techniques. |
| | Power tools should use mains power where possible rather than generators. |
| | Shut down machinery, including generators, when not in operation. |
| | Avoid dropping materials from a height and dampen or line metal trays, as necessary. |
| | Ensure equipment is operated in the correct manner. |

| Project stage | Measure |
|---|---|
| | All equipment should be appropriately maintained and fitted with noise control devices, where practicable, including acoustic lining of engine bays and air intake / discharge silencers, etc. |
| | Use residential-grade mufflers on equipment where reasonable. |
| | Where possible, use dampened 'city' bits on jackhammers and rockbreakers. |
| Community consultation | Provide appropriate notice to affected receivers prior to starting works. |
| | Provide signage detailing the works being undertaken and a 24 hour contact number. |
| | Where there are complaints regarding noise, review and implement additional control measures, where feasible and reasonable. |
| Monitoring | Conduct noise and/or vibration monitoring in response to any valid complaints received. |

### 8.5.1 Complaint Handling

The construction contractor will adopt the following protocol for handling complaints. This protocol is intended to ensure that the issues are addressed and that appropriate corrective action is identified and implemented as necessary:

- The construction contractor will record all verbal and telephone complaints in writing and will forward all complaints to the Project Manager, together with details of the circumstance leading to the complaint and all subsequent actions.
- The Project Manager will investigate the complaint in order to determine whether an exceedance of the appropriate criteria has occurred.
- If excessive noise and/or vibration impacts have been caused, corrective action will be planned and implemented by the contractor
- Complainants will be told by the Project Manager that their complaint is being addressed, and that corrective action is being taken, where necessary.
- Follow up monitoring or other investigations will be carried out by the Project Manager and the construction contractor, as needed, to confirm the effectiveness of the corrective action.
- Complainants will be informed of the corrective action taken to mitigate the adverse impacts.

### 8.5.2 Community Consultation and Liaison

Community consultation will be undertaken by the construction contractor where necessary, including:

- Advising the community of work to be undertaken.
- Recording and managing any complaints.

These and other elements of the community consultation will be addressed under the relevant procedures for the subject works.

# 9 Conclusion

This acoustic assessment includes a survey of the existing noise environment; derivation and establishment of project specific noise criteria through consultation with various NSW and Australian guidelines and Council pre-DA meeting; establishment of noise level criteria with respect to the appropriate criteria and minimum acoustic performance specifications for external and internal construction elements based on specified external noise ingress limits. Additionally, preliminary mechanical equipment selections and spatials have been reviewed in order to provide treatment recommendations.

Acoustic requirements contained in this report are based on the relevant standards, guidelines and policies listed in **Section 5**.

Following our assessment, SLR confirms that the requirements of the relevant guidelines and policies including both the Noise Policy for Industry, and the State Environmental Planning Policy (Education) can be achieved.

# APPENDIX A

Acoustic Terminology

## 1 Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that in common usage 'noise' is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or $L_P$ are commonly used to represent Sound Pressure Level. The symbol $L_A$ represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is $2 \times 10^{-5}$ Pa.

## 2 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4,000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

| Sound Pressure Level (dBA) | Typical Source | Subjective Evaluation |
|---|---|---|
| 130 | Threshold of pain | Intolerable |
| 120 | Heavy rock concert | Extremely noisy |
| 110 | Grinding on steel | |
| 100 | Loud car horn at 3 m | Very noisy |
| 90 | Construction site with pneumatic hammering | |
| 80 | Kerbside of busy street | Loud |
| 70 | Loud radio or television | |
| 60 | Department store | Moderate to quiet |
| 50 | General Office | |
| 40 | Inside private office | Quiet to very quiet |
| 30 | Inside bedroom | |
| 20 | Recording studio | Almost silent |

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

## 3 Sound Power Level

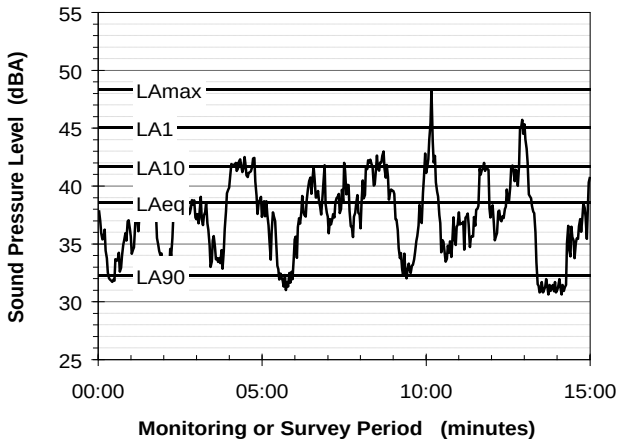
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or $L_W$, or by the reference unit $10^{-12}$ W.

The relationship between Sound Power and Sound Pressure may be likened to an electric radiator, which is characterised by a power rating, but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

## 4 Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels $L_{AN}$, where $L_{AN}$ is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the $L_{A1}$ is the noise level exceeded for 1% of the time, $L_{A10}$ the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.




Of particular relevance, are:

$L_{A1}$ The noise level exceeded for 1% of the 15 minute interval.

$L_{A10}$ The noise level exceeded for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

$L_{A90}$ The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

$L_{Aeq}$ The A-weighted equivalent noise level (basically, the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the 'repeatable minimum' $L_{A90}$ noise level over the daytime and night-time measurement periods, as required by the EPA. In addition, the method produces mean or 'average' levels representative of the other descriptors ($L_{Aeq}$, $L_{A10}$, etc).

## 5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components), and is normally regarded as more offensive than 'broad band' noise.

## 6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

## 7 Frequency Analysis

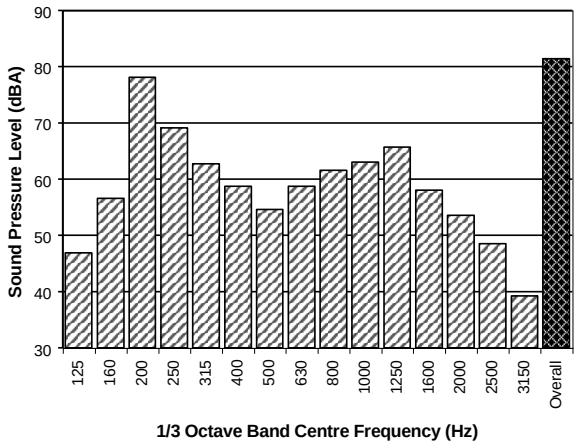
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (3 bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.




## 8 Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements. Where triaxial measurements are used, the axes are commonly designated vertical, longitudinal (aligned toward the source) and transverse.

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log ($V/V_o$), where $V_o$ is the reference level ($10^{-9}$ m/s). Care is required in this regard, as other reference levels may be used by some organisations.

## 9 Human Perception of Vibration

People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

## 10 Over-Pressure

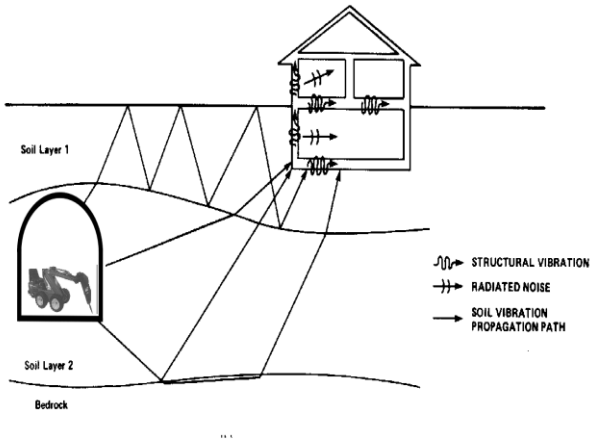
The term 'over-pressure' is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

## 11 Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents an example of the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.




The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise

# APPENDIX B

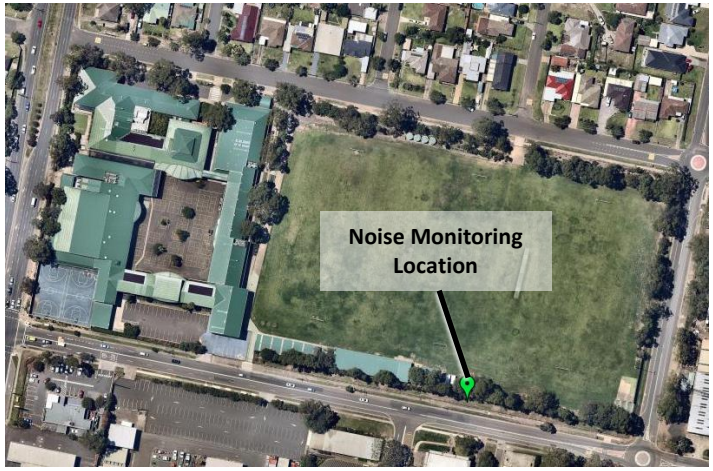
Statistical Ambient Noise Level Measurements

| Noise Monitoring Location | L.01 | Map of Noise Monitoring Location |
|---|---|---|
| **Noise Monitoring Address** | **St Dominic's College Copeland St Boundary , Kingswood** | |

Logger Device Type: Svantek 957, Logger Serial No: 16207041
Sound Level Meter Device Type: Brüel and Kjær 2270, Sound Level Meter Serial No: 3008204

Ambient noise logger deployed at boundary of St Dominic's College. Logger located within fence line, with direct view of Copeland Street to the north.

Attended noise measurements indicate the ambient noise environment at this location is dominated by frequent light and heavy vehicle passbys from Copeland Street. School activities and plane flyovers also contribute to the LAeq at this location.




**Ambient Noise Logging Results – ICNG Defined Time Periods**

| Monitoring Period | Noise Level (dBA) | | | |
|---|---|---|---|---|
| | RBL | LAeq | $L_{10}$ | $L_1$ |
| Daytime | 49 | 63 | 65 | 71 |
| Evening | 42 | 61 | 64 | 69 |
| Night-time | 37 | 57 | 57 | 65 |

**Ambient Noise Logging Results – RNP Defined Time Periods**

| Monitoring Period | Noise Level (dBA) | |
|---|---|---|
| | LAeq(period) | LAeq(1hour) |
| Daytime (7am-10pm) | 62 | 64 |
| Night-time (10pm-7am) | 56 | 63 |

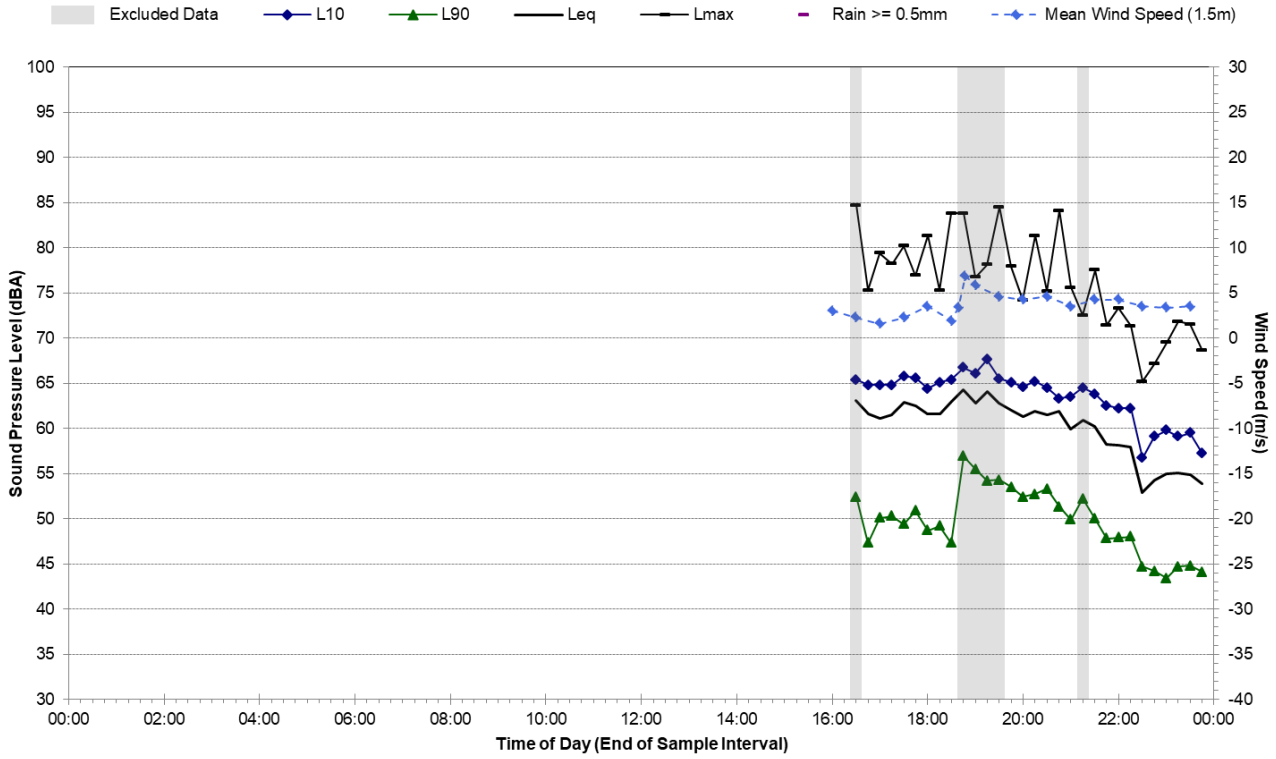
**Attended Noise Measurement Results**

| Date | Start Time | Measured Noise Level (dBA) | | |
|---|---|---|---|---|
| | | LA90 | LAeq | LAmax |
| 30/11/18 | 10:31 | 48 | 63 | 78 |
| 30/11/18 | 10:47 | 49 | 62 | 79 |

Photo of Noise Monitoring Location

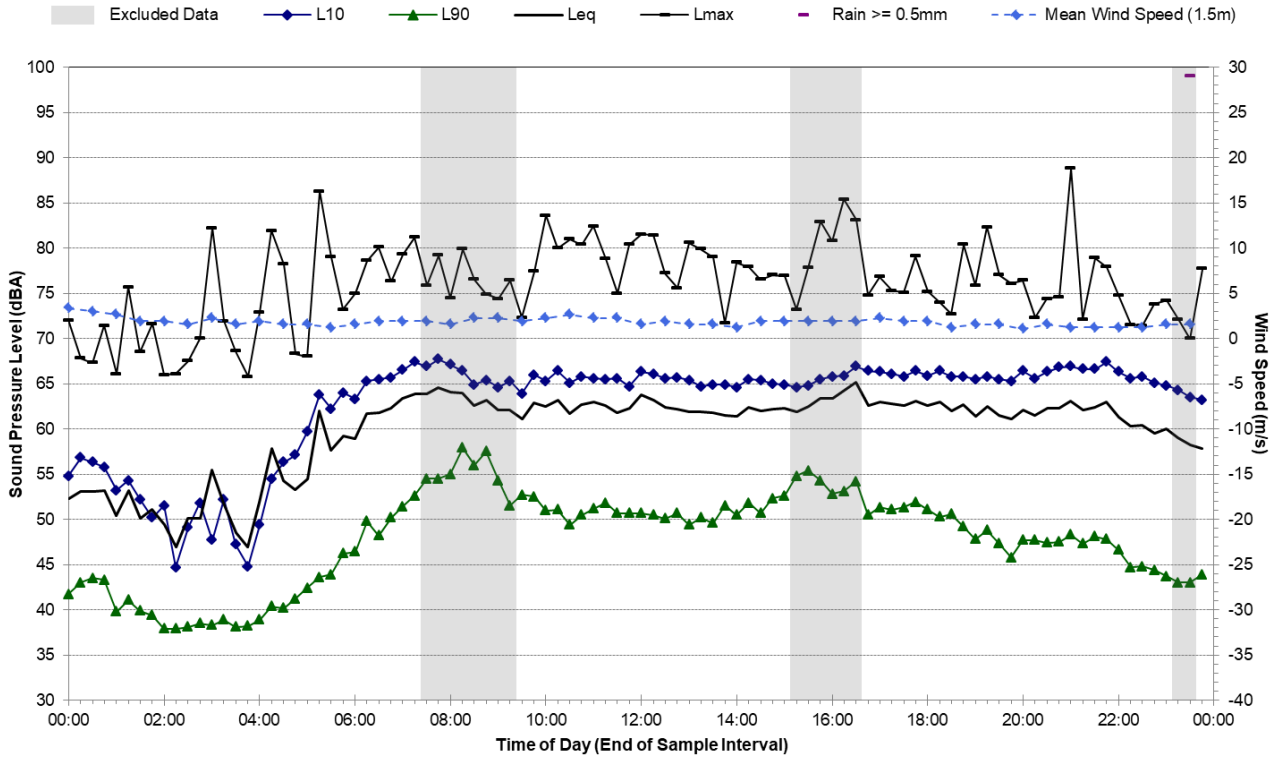
## Statistical Ambient Noise Levels

### L.01 - Copeland St, Kingswood - Thursday, 31 January 2019



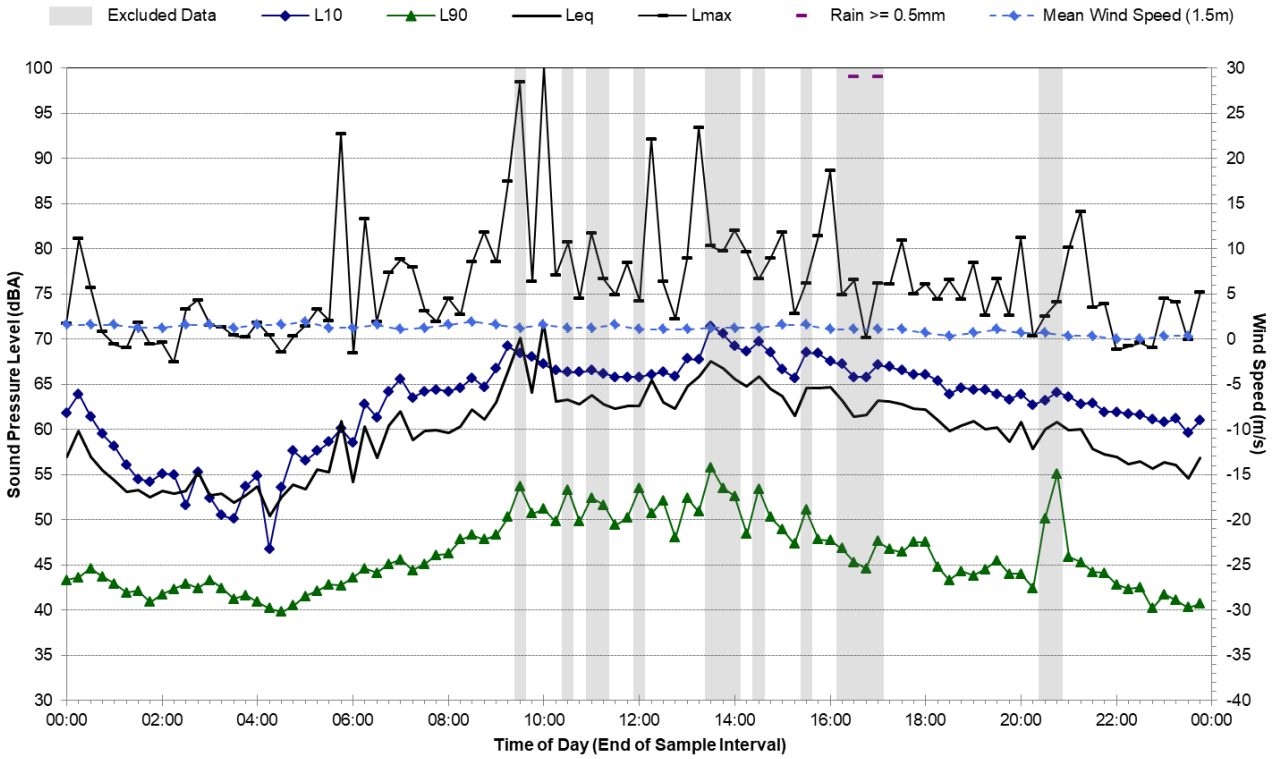

## Statistical Ambient Noise Levels

### L.01 - Copeland St, Kingswood - Friday, 1 February 2019



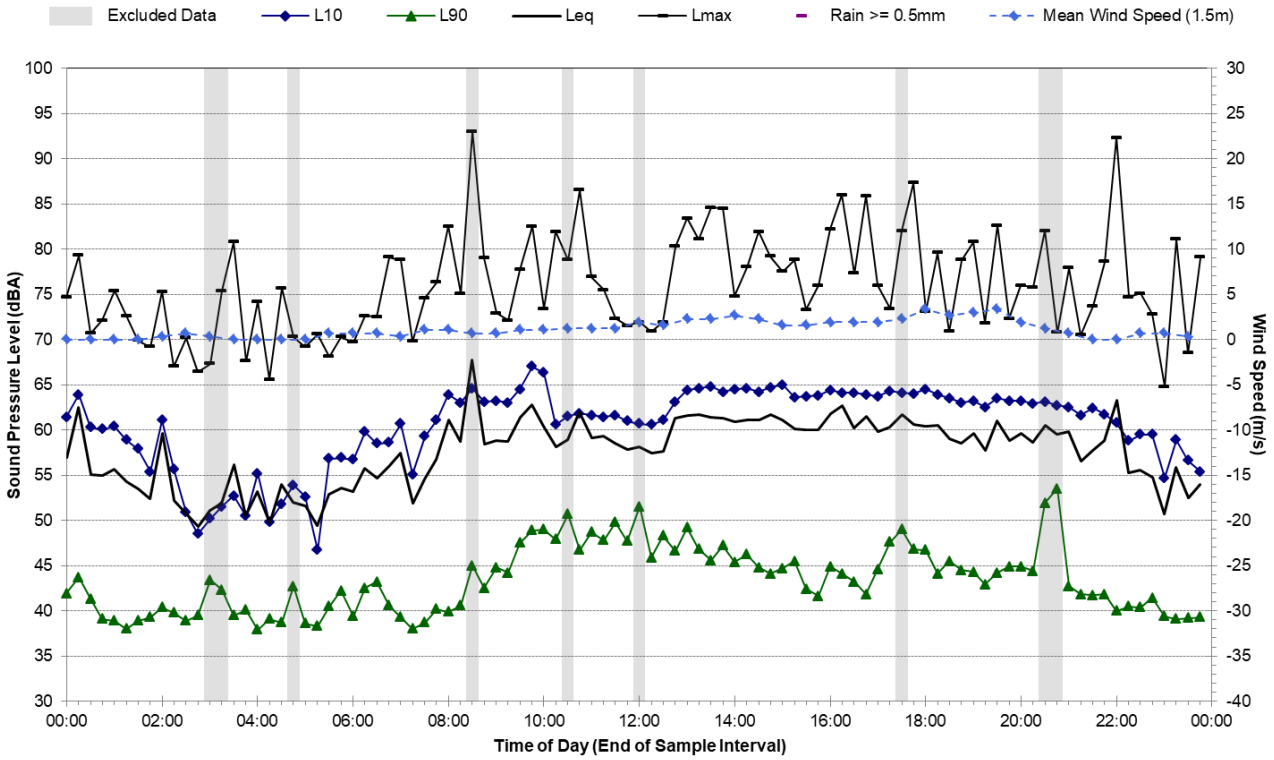
## Statistical Ambient Noise Levels

### L.01 - Copeland St, Kingswood - Saturday, 2 February 2019



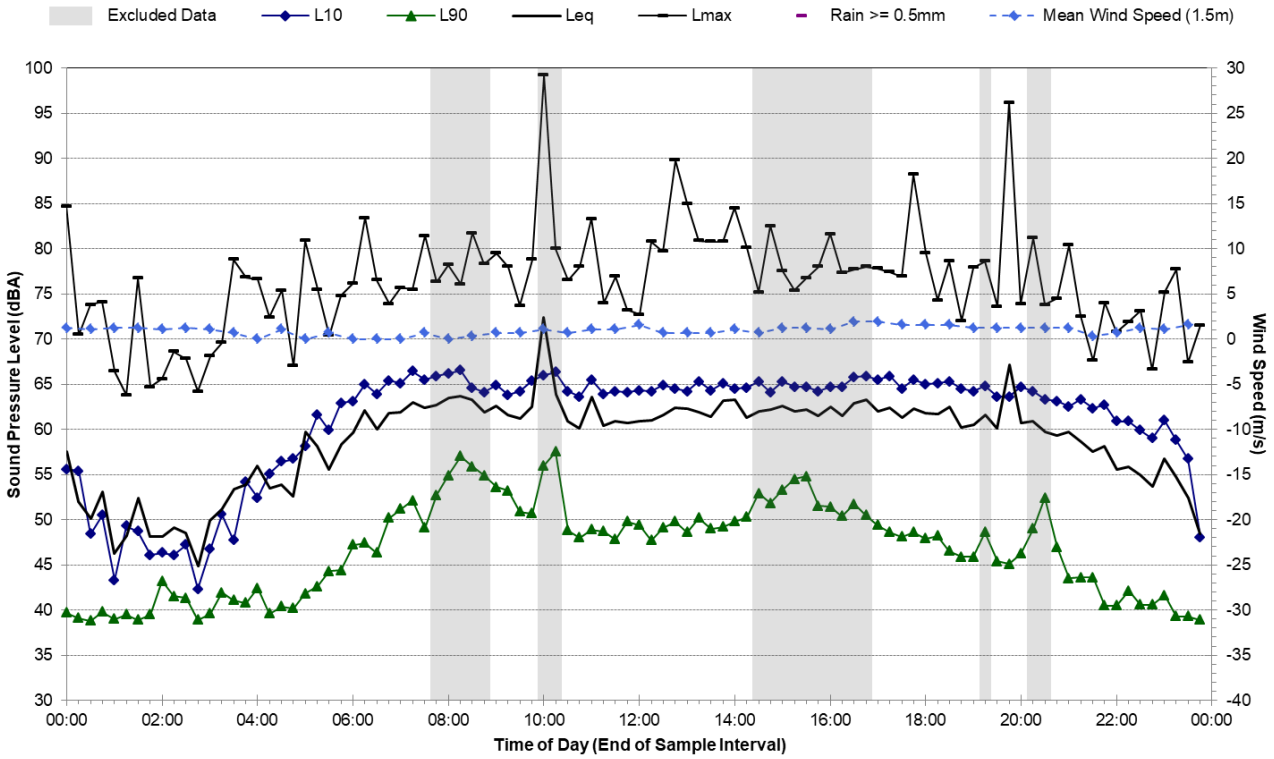

## Statistical Ambient Noise Levels

### L.01 - Copeland St, Kingswood - Sunday, 3 February 2019



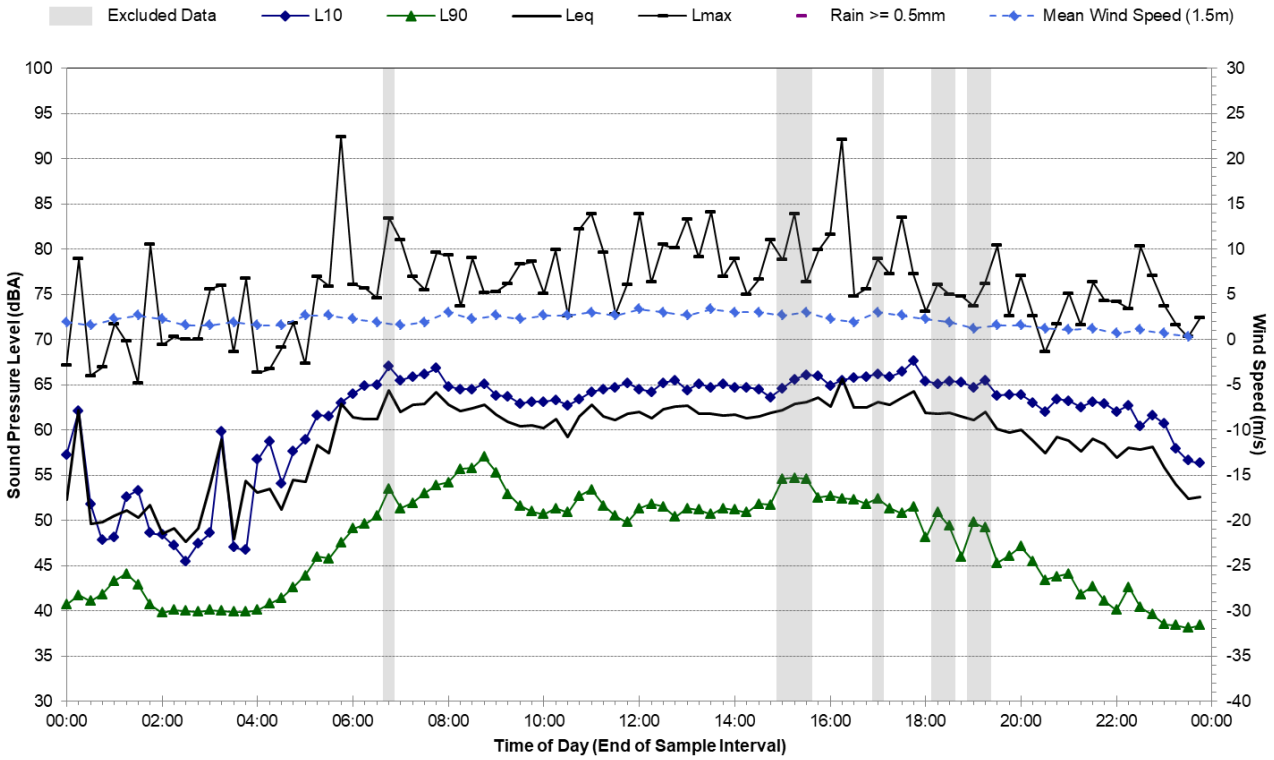
# Statistical Ambient Noise Levels

## L.01 - Copeland St, Kingswood - Monday, 4 February 2019



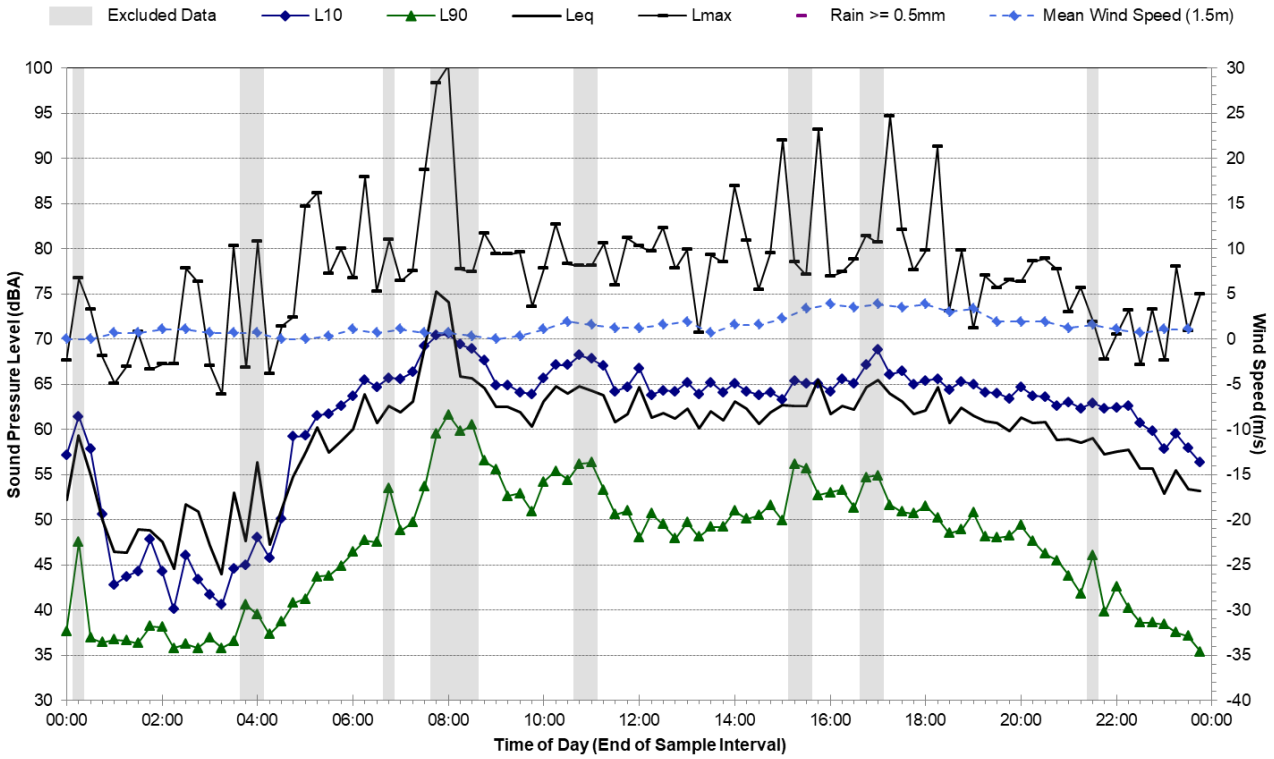

# Statistical Ambient Noise Levels

## L.01 - Copeland St, Kingswood - Tuesday, 5 February 2019



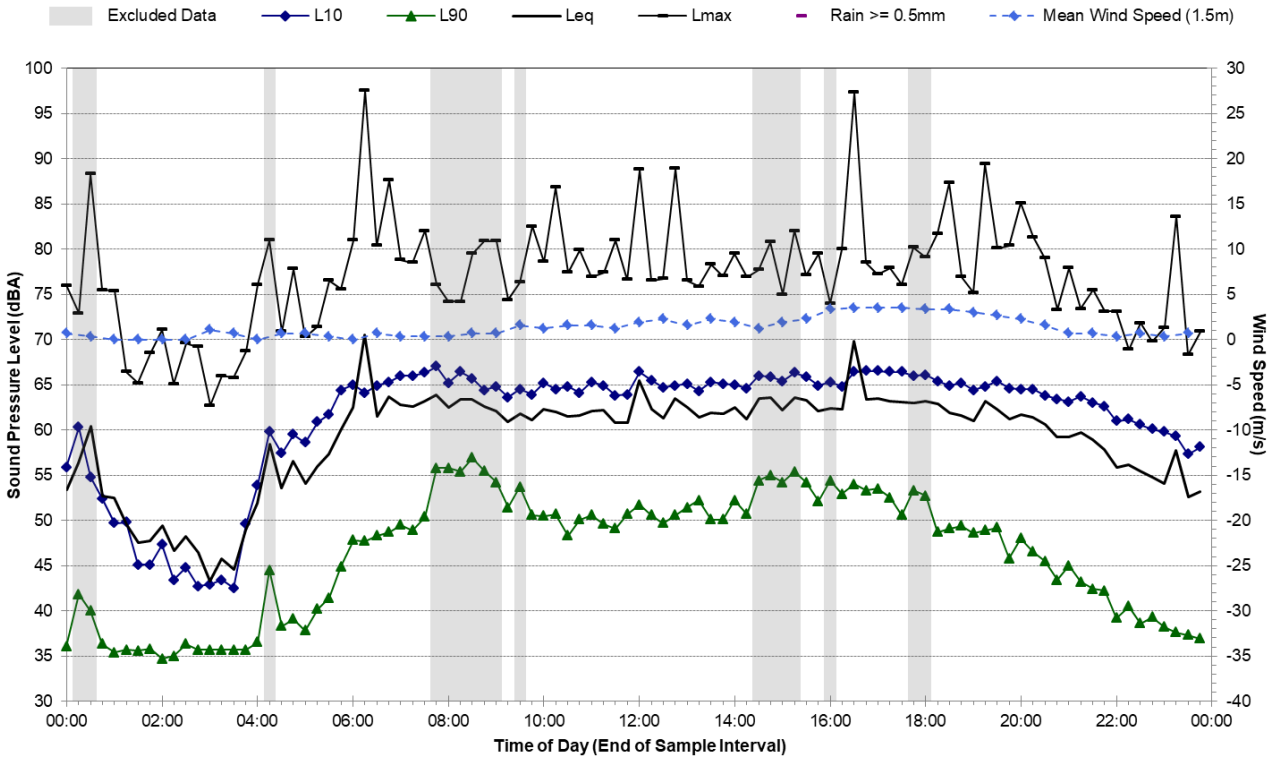
## Statistical Ambient Noise Levels

### L.01 - Copeland St, Kingswood - Wednesday, 6 February 2019



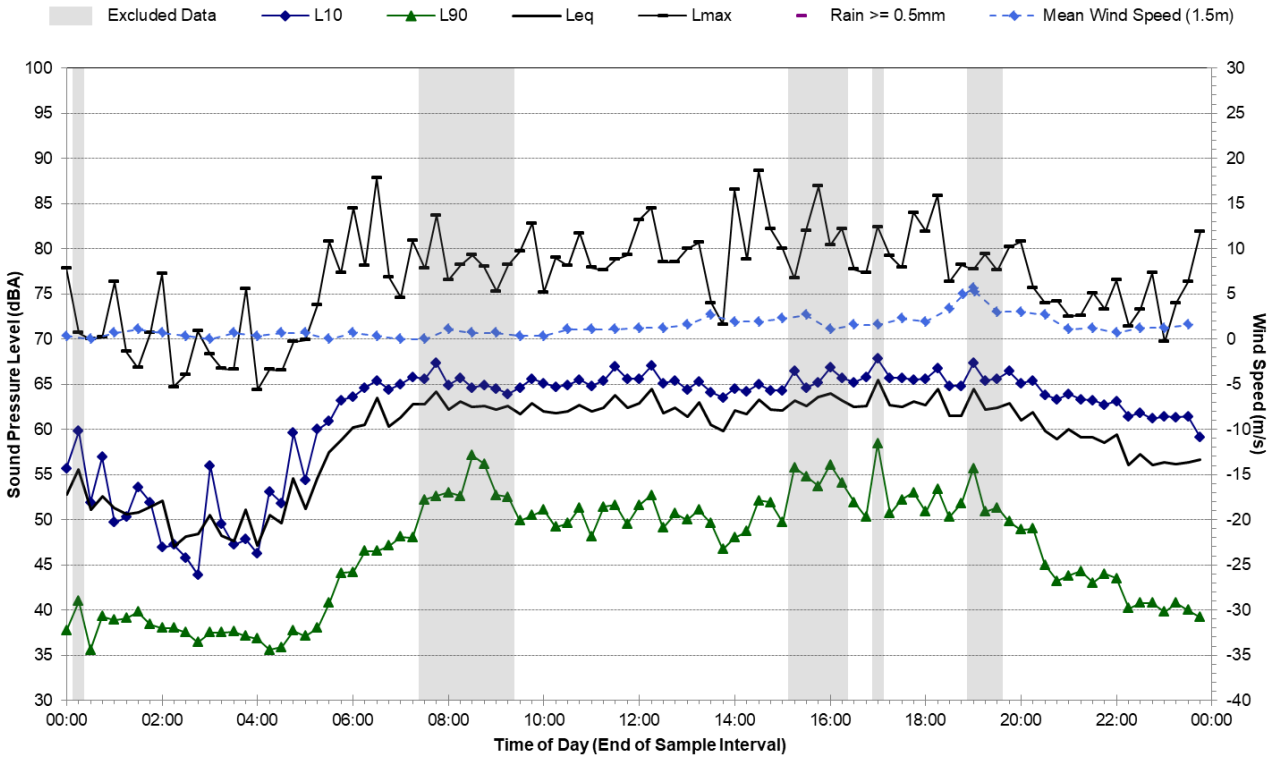

## Statistical Ambient Noise Levels

### L.01 - Copeland St, Kingswood - Thursday, 7 February 2019



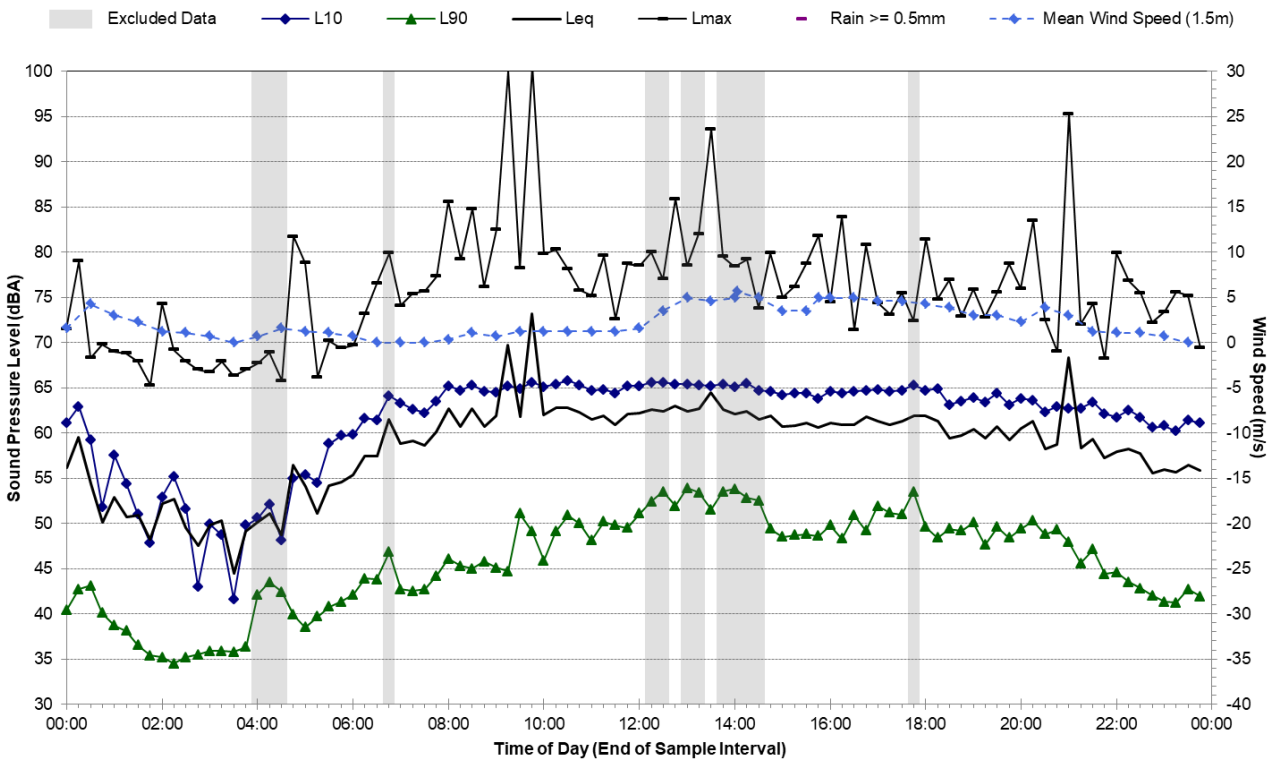
## Statistical Ambient Noise Levels

### L.01 - Copeland St, Kingswood - Friday, 8 February 2019



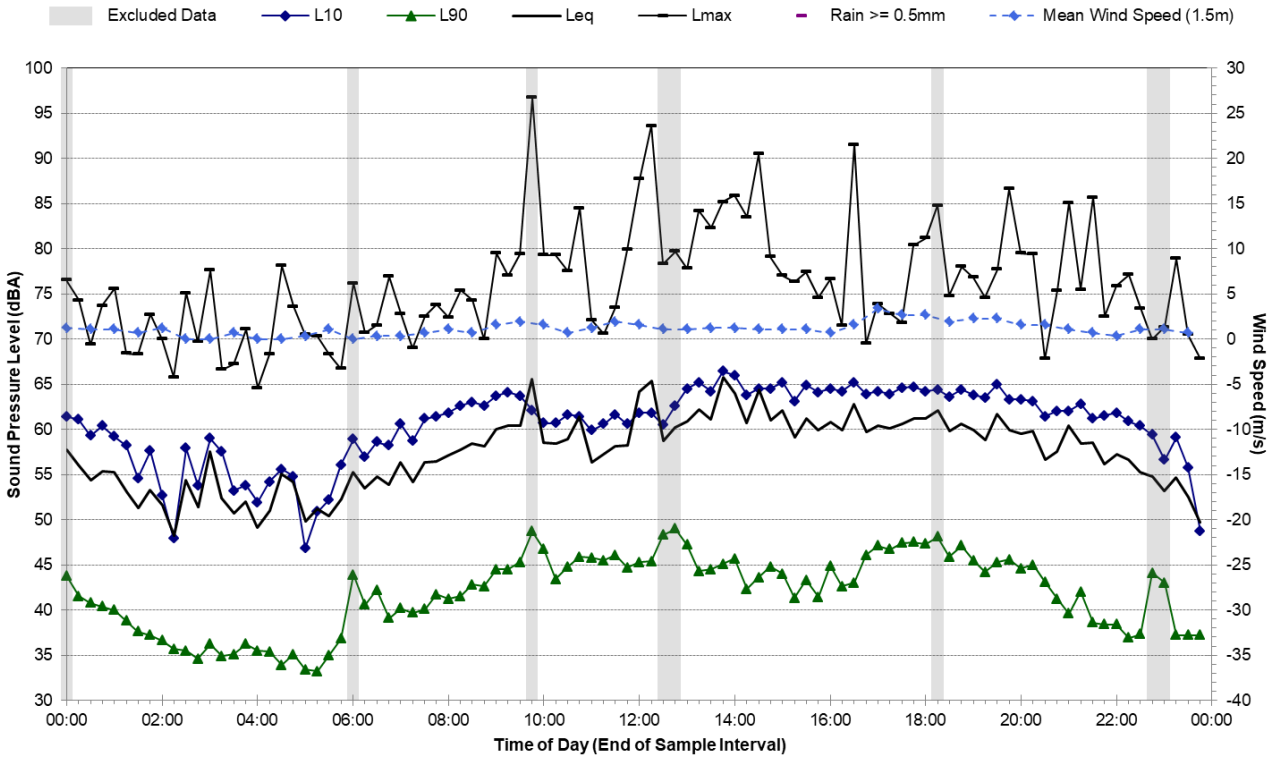

## Statistical Ambient Noise Levels

### L.01 - Copeland St, Kingswood - Saturday, 9 February 2019



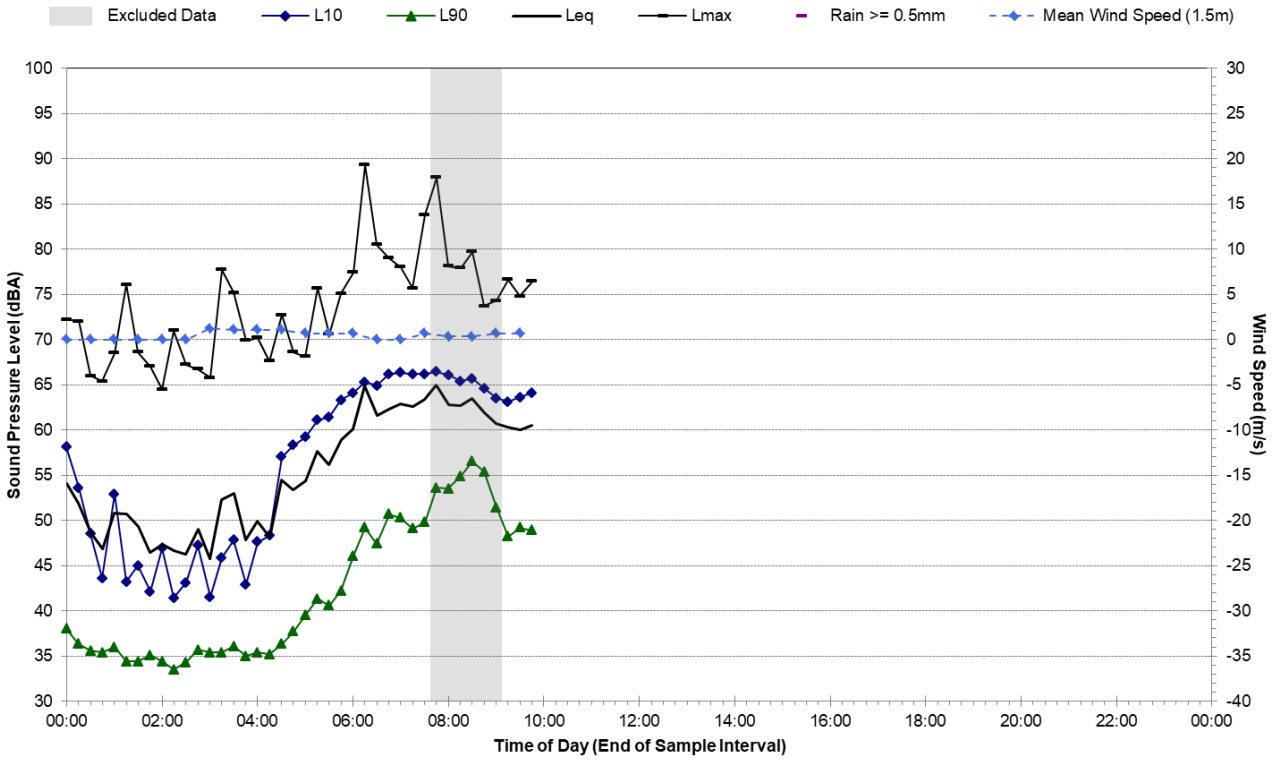
## Statistical Ambient Noise Levels

### L.01 - Copeland St, Kingswood - Sunday, 10 February 2019




## Statistical Ambient Noise Levels

### L.01 - Copeland St, Kingswood - Monday, 11 February 2019



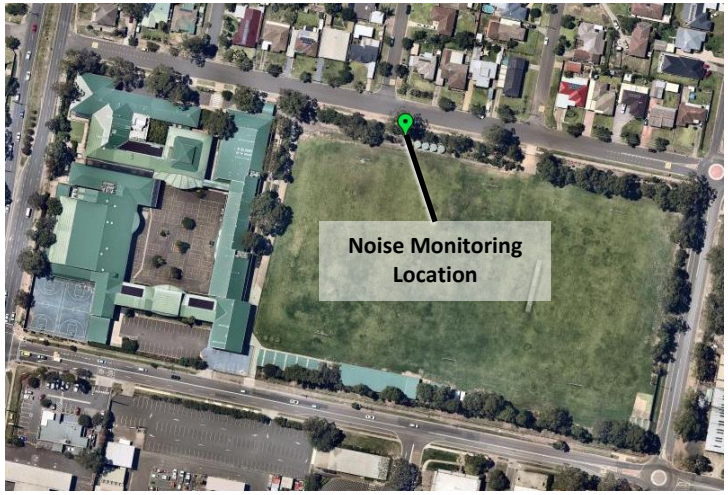
| Noise Monitoring Location | L.02 |
|---|---|
| **Noise Monitoring Address** | **St Dominic's College Gascoigne St Boundary, Kingswood** |

Logger Device Type: Svantek 957, Logger Serial No: 16301437
Sound Level Meter Device Type: Brüel and Kjær 2270, Sound Level Meter Serial No: 3008204

Ambient noise logger deployed at boundary of St Dominic's College. Logger located within fence line, with direct view of Gascoigne Street to the north.

Attended noise measurements indicate the ambient noise environment at this location is dominated by school activity. Infrequent road traffic noise from Gascoigne Street also contributes to the LAeq at this location.

**Map of Noise Monitoring Location**




**Ambient Noise Logging Results – ICNG Defined Time Periods**

| Monitoring Period | Noise Level (dBA) | | | |
|---|---|---|---|---|
| | RBL | LAeq | $L_{10}$ | $L_1$ |
| Daytime | 42 | 55 | 53 | 64 |
| Evening | 41 | 54 | 51 | 62 |
| Night-time | 35 | 49 | 43 | 51 |

**Ambient Noise Logging Results – RNP Defined Time Periods**

| Monitoring Period | Noise Level (dBA) | |
|---|---|---|
| | LAeq(period) | LAeq(1hour) |
| Daytime (7am-10pm) | 55 | 58 |
| Night-time (10pm-7am) | 49 | 57 |

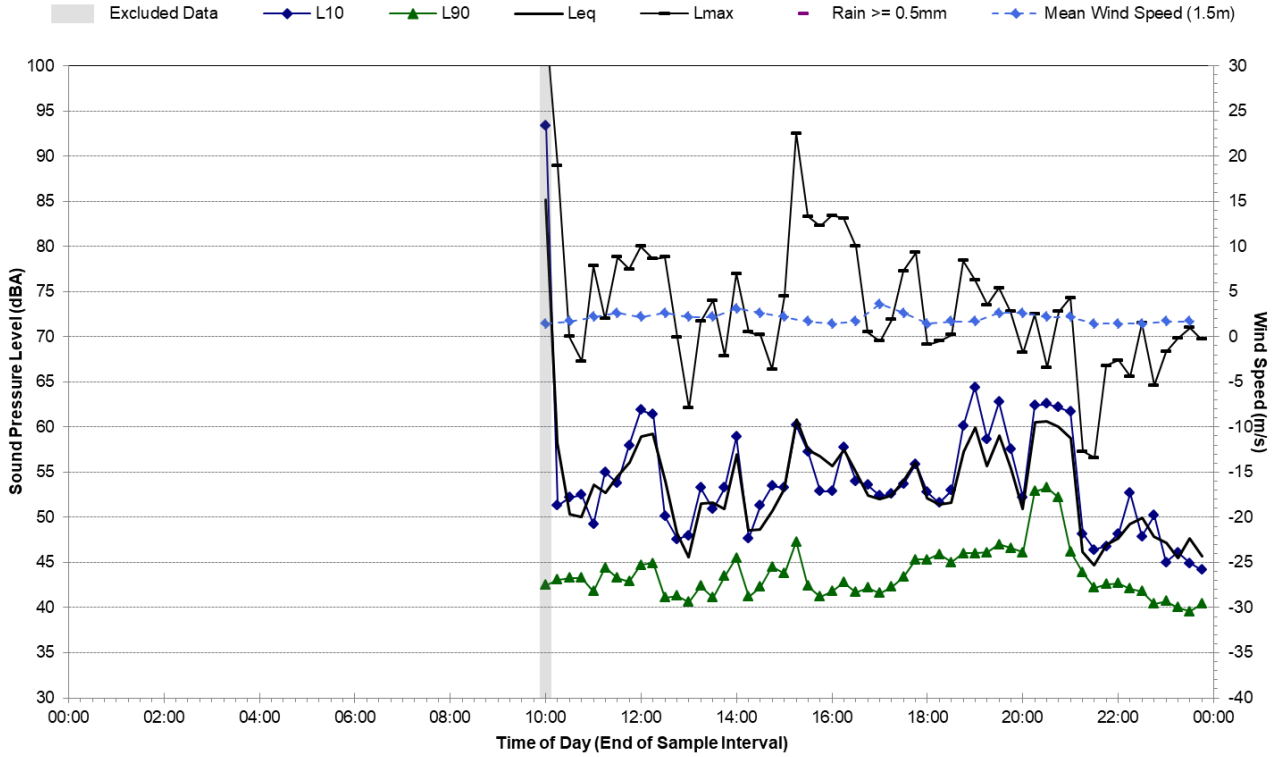
**Attended Noise Measurement Results**

| Date | Start Time | Measured Noise Level (dBA) | | |
|---|---|---|---|---|
| | | LA90 | LAeq | LAmax |
| 30/11/18 | 09:55 | 44 | 54 | 78 |

**Photo of Noise Monitoring Location**

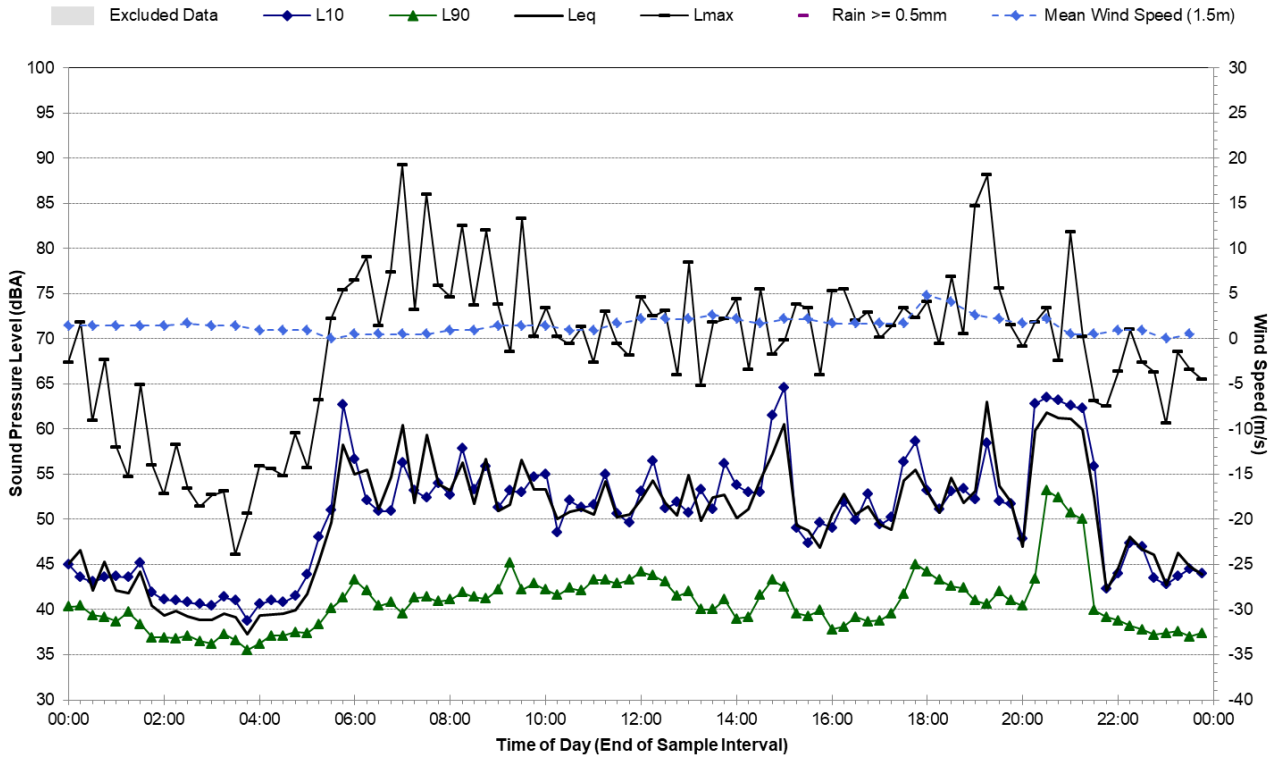
## Statistical Ambient Noise Levels

### L.02 - Gascoigne St, Kingswood - Friday, 30 November 2018



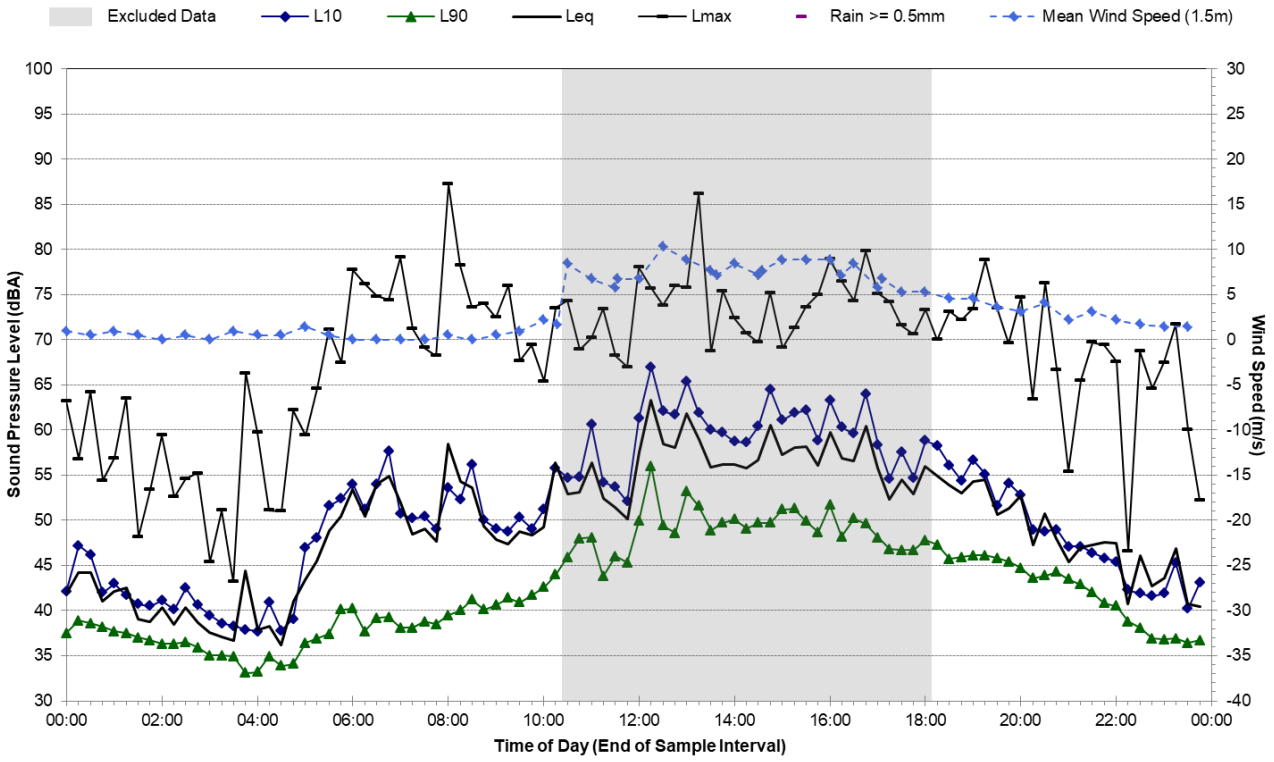

## Statistical Ambient Noise Levels

### L.02 - Gascoigne St, Kingswood - Saturday, 1 December 2018



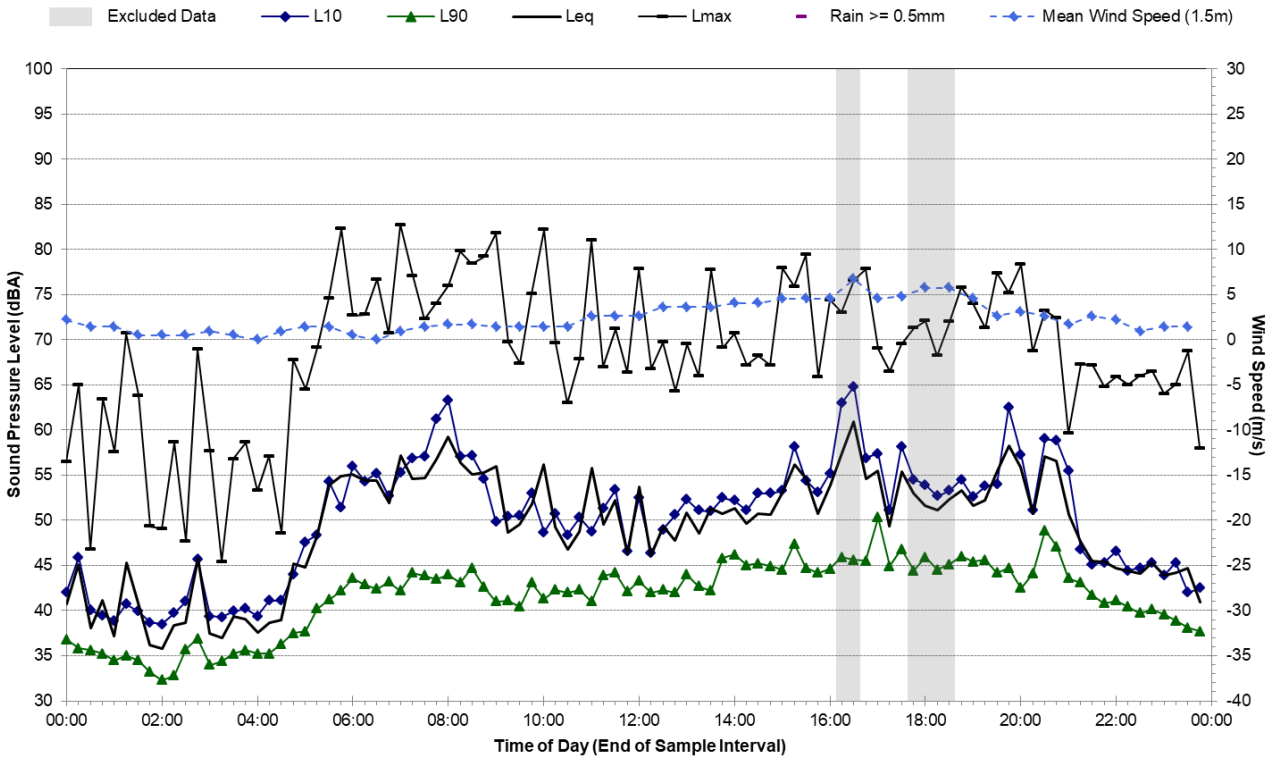
## Statistical Ambient Noise Levels

### L.02 - Gascoigne St, Kingswood - Sunday, 2 December 2018



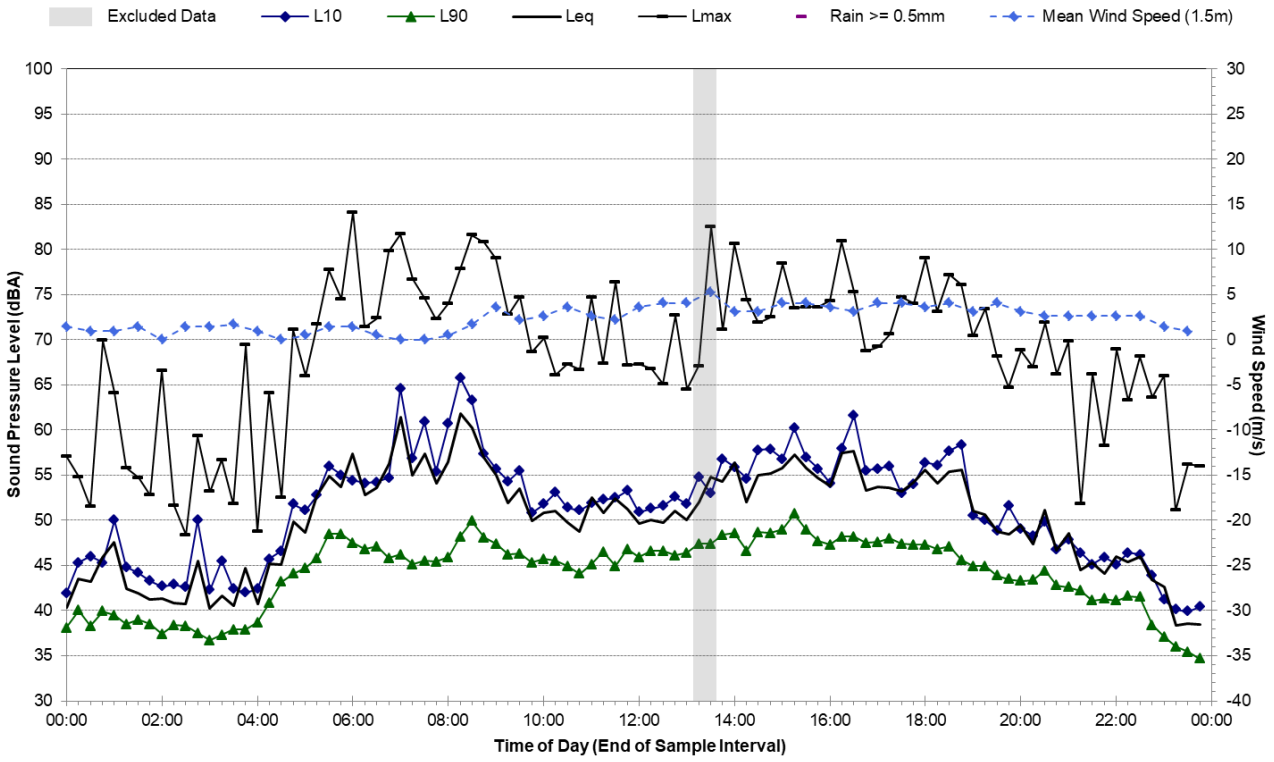

## Statistical Ambient Noise Levels

### L.02 - Gascoigne St, Kingswood - Monday, 3 December 2018



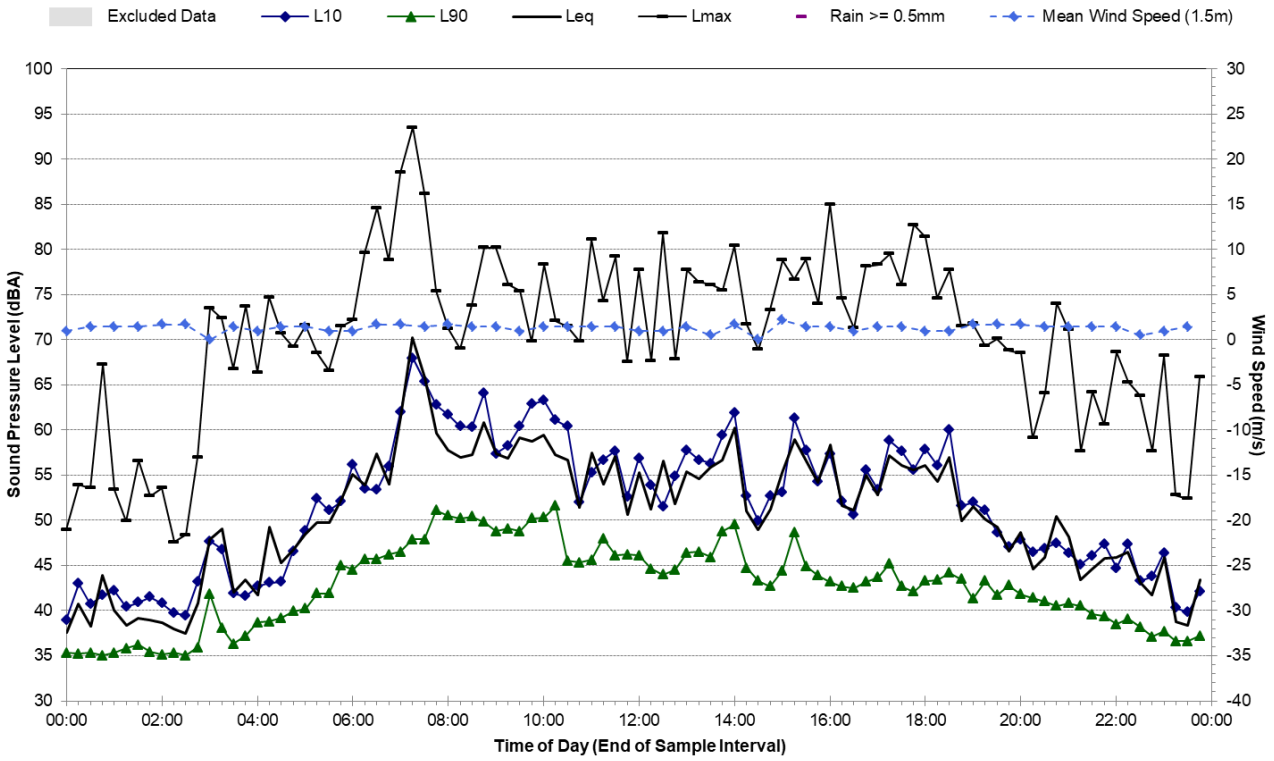
# Statistical Ambient Noise Levels

## L.02 - Gascoigne St, Kingswood - Tuesday, 4 December 2018



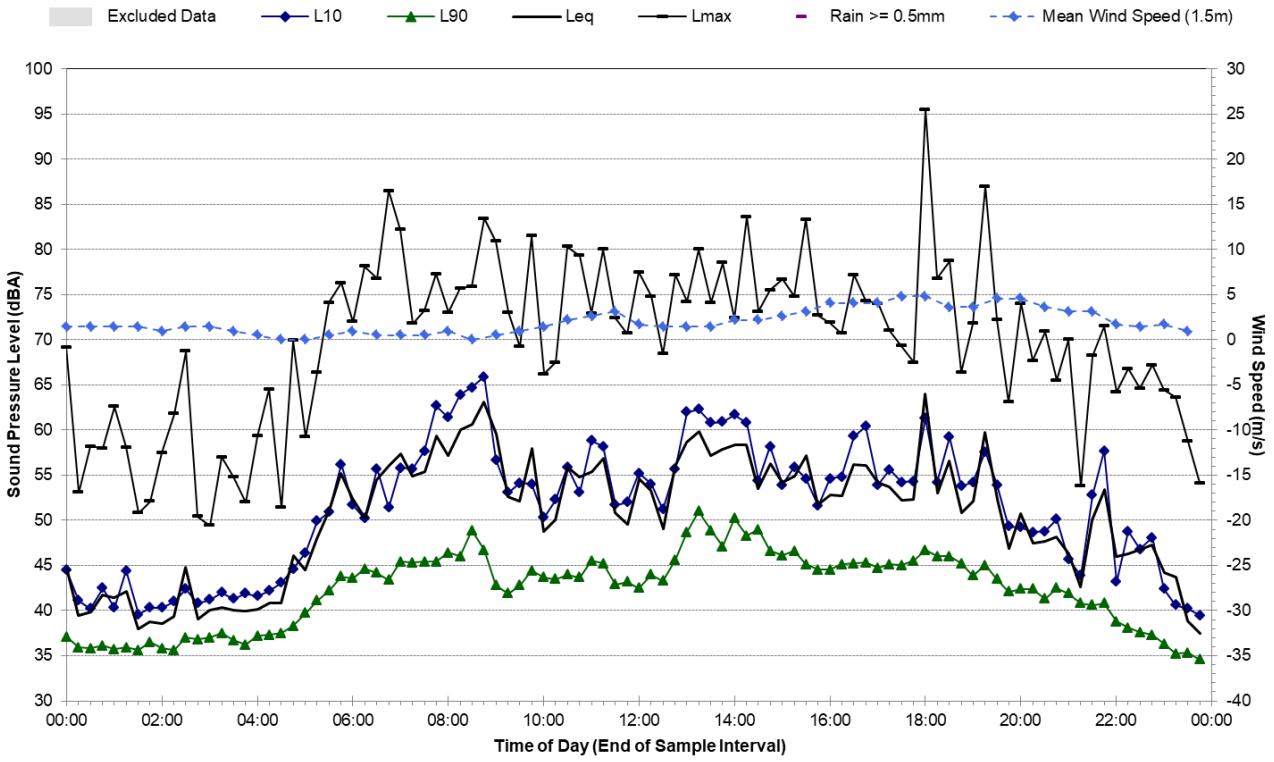

# Statistical Ambient Noise Levels

## L.02 - Gascoigne St, Kingswood - Wednesday, 5 December 2018



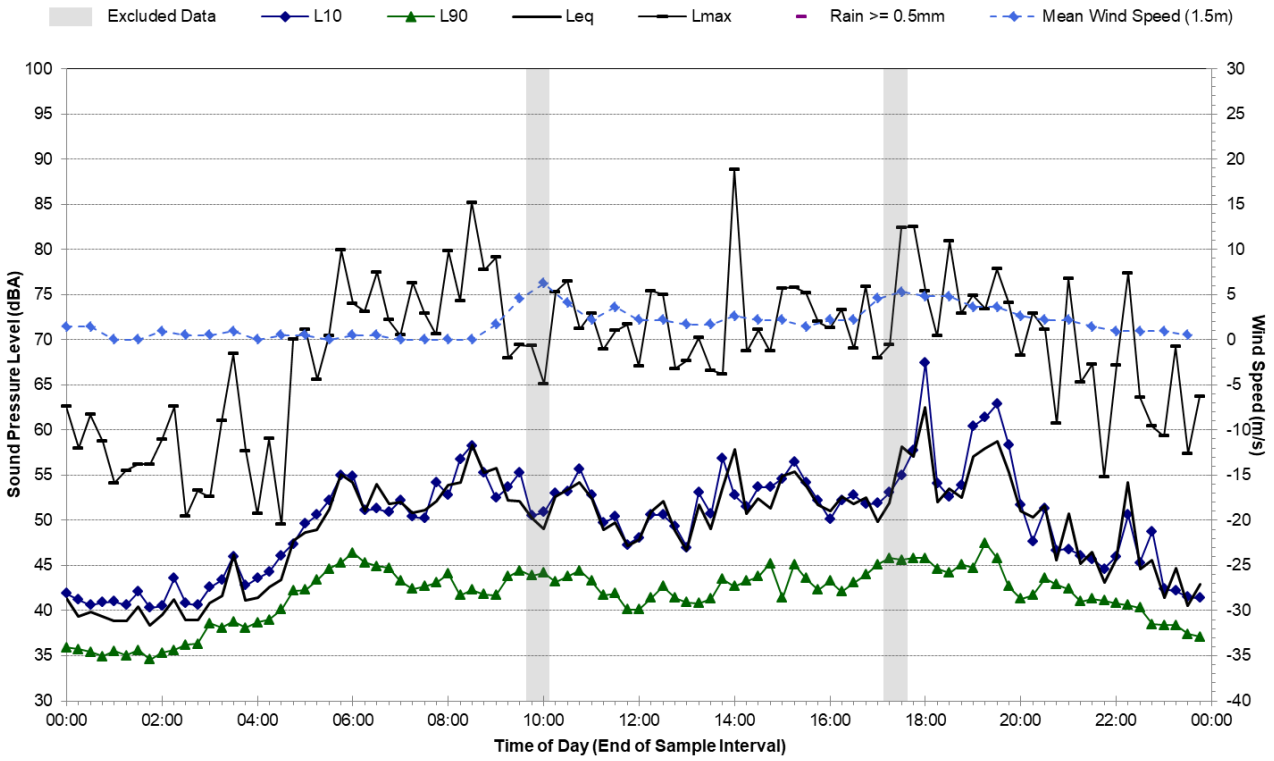
## Statistical Ambient Noise Levels

### L.02 - Gascoigne St, Kingswood - Thursday, 6 December 2018



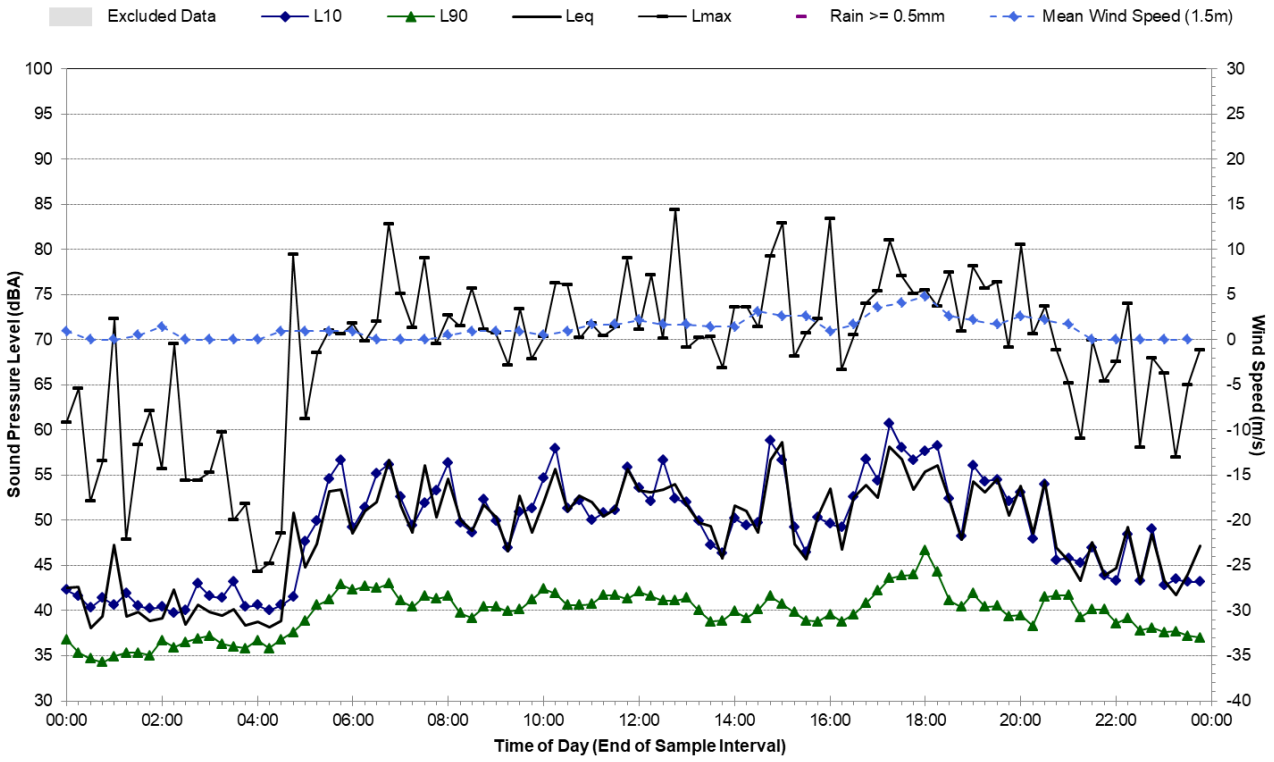

## Statistical Ambient Noise Levels

### L.02 - Gascoigne St, Kingswood - Friday, 7 December 2018



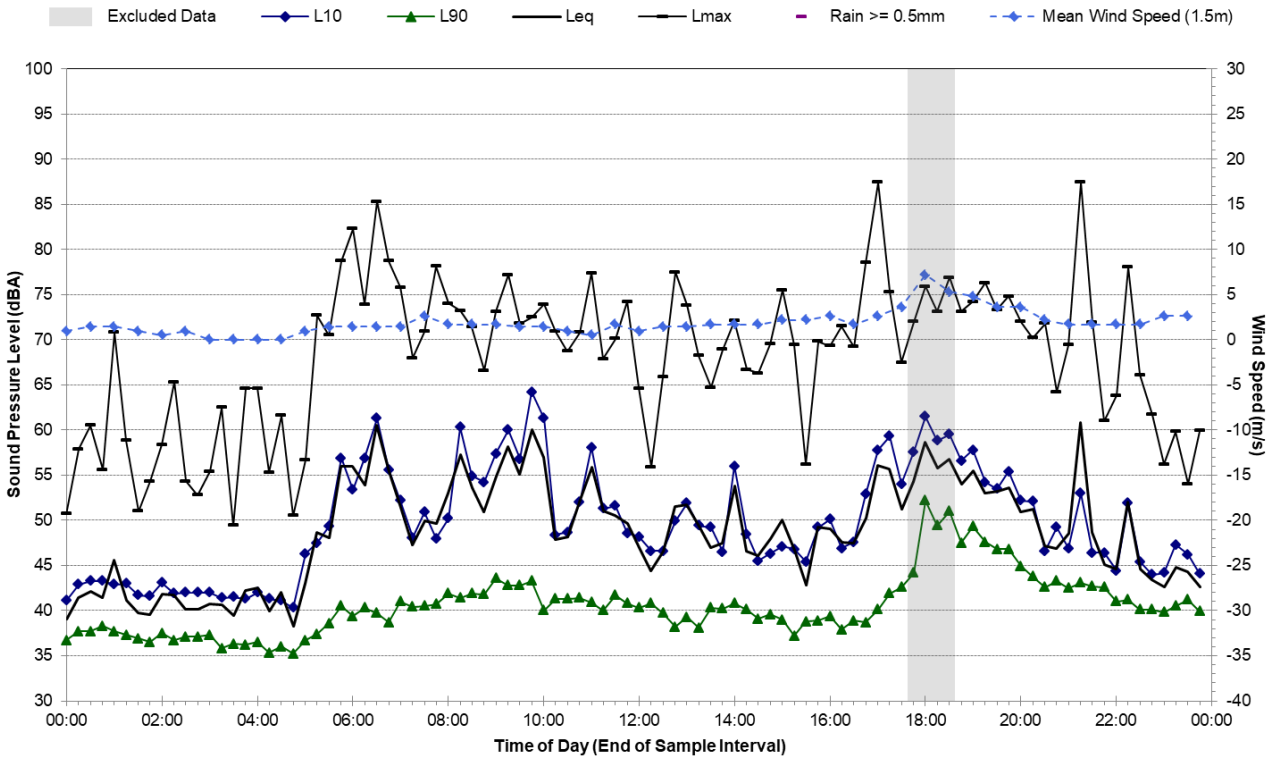
# Statistical Ambient Noise Levels

## L.02 - Gascoigne St, Kingswood - Saturday, 8 December 2018



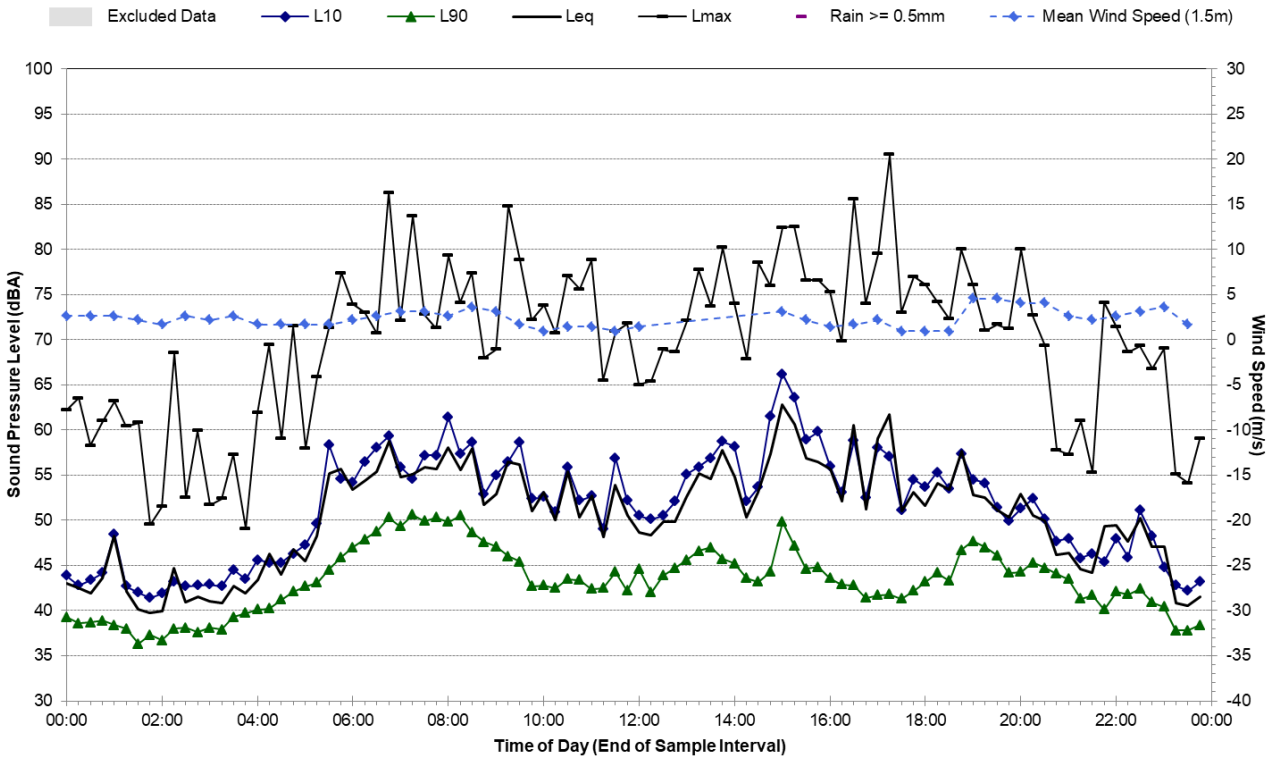

# Statistical Ambient Noise Levels

## L.02 - Gascoigne St, Kingswood - Sunday, 9 December 2018



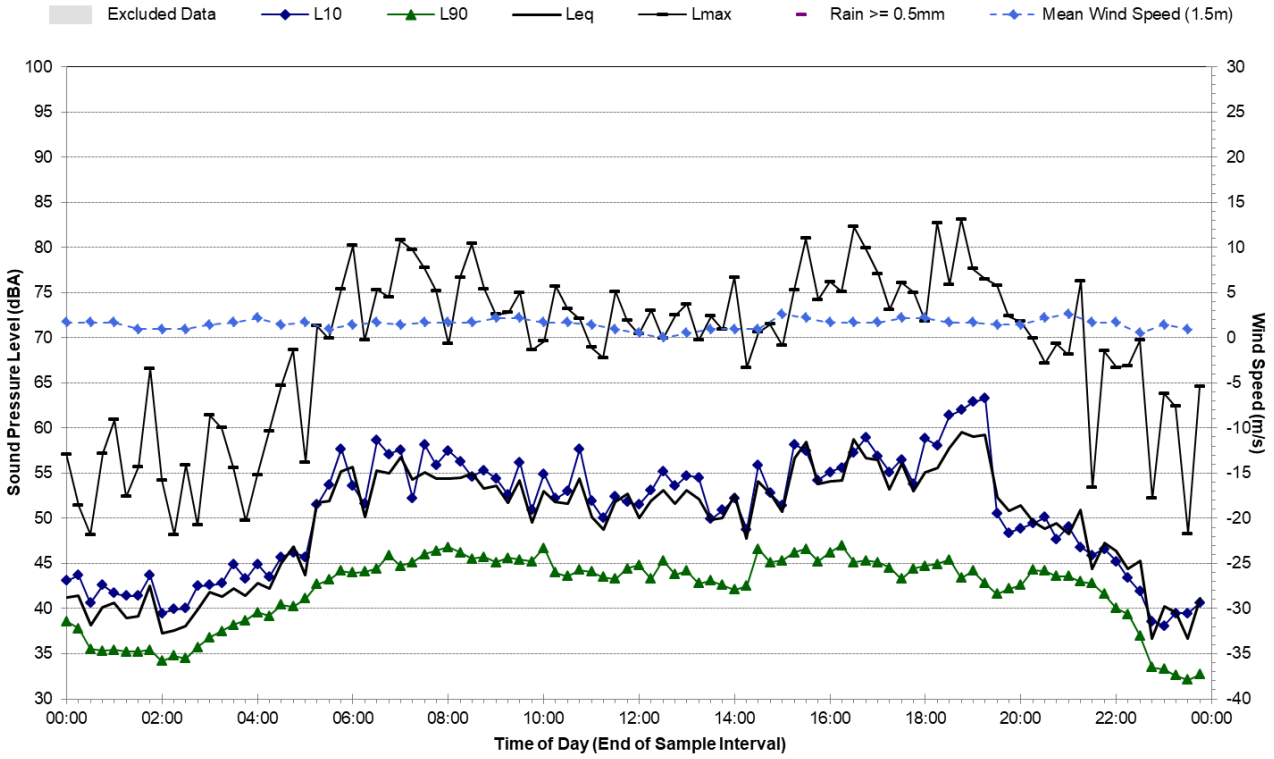
## Statistical Ambient Noise Levels

### L.02 - Gascoigne St, Kingswood - Monday, 10 December 2018



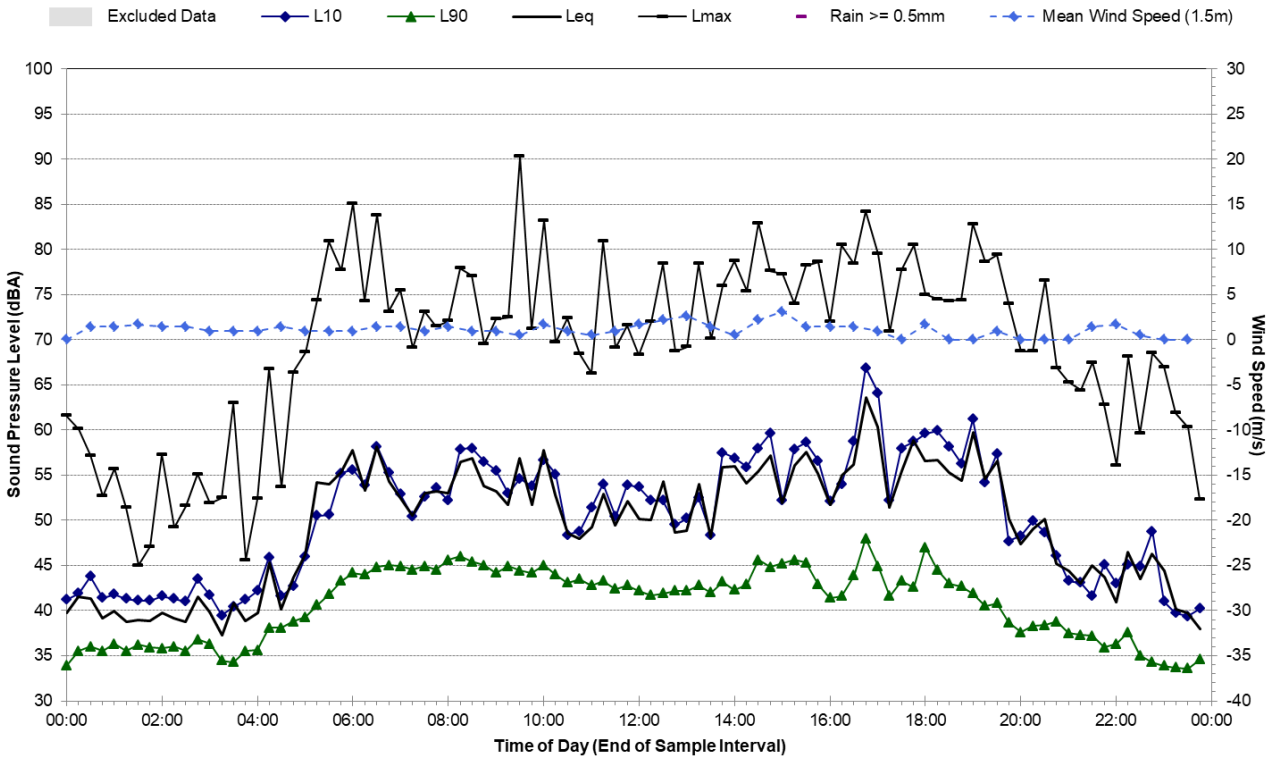

## Statistical Ambient Noise Levels

### L.02 - Gascoigne St, Kingswood - Tuesday, 11 December 2018



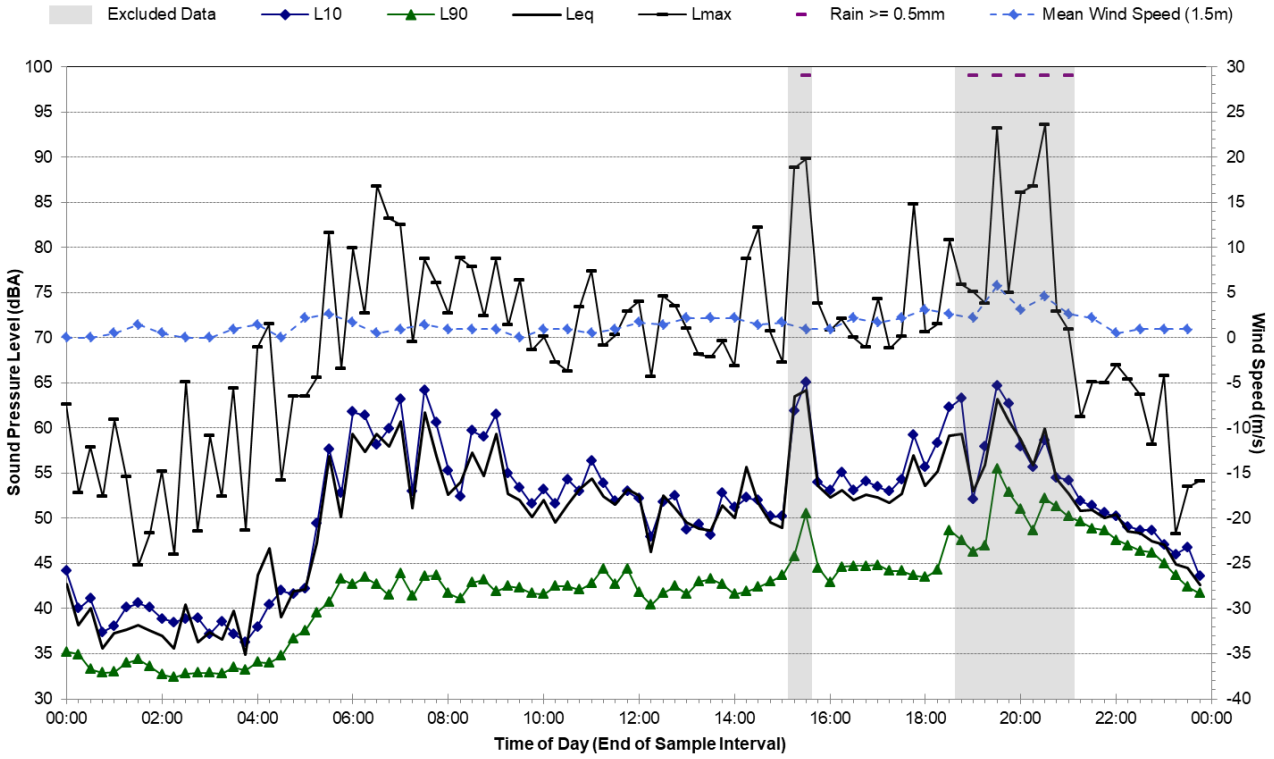
## Statistical Ambient Noise Levels

### L.02 - Gascoigne St, Kingswood - Wednesday, 12 December 2018



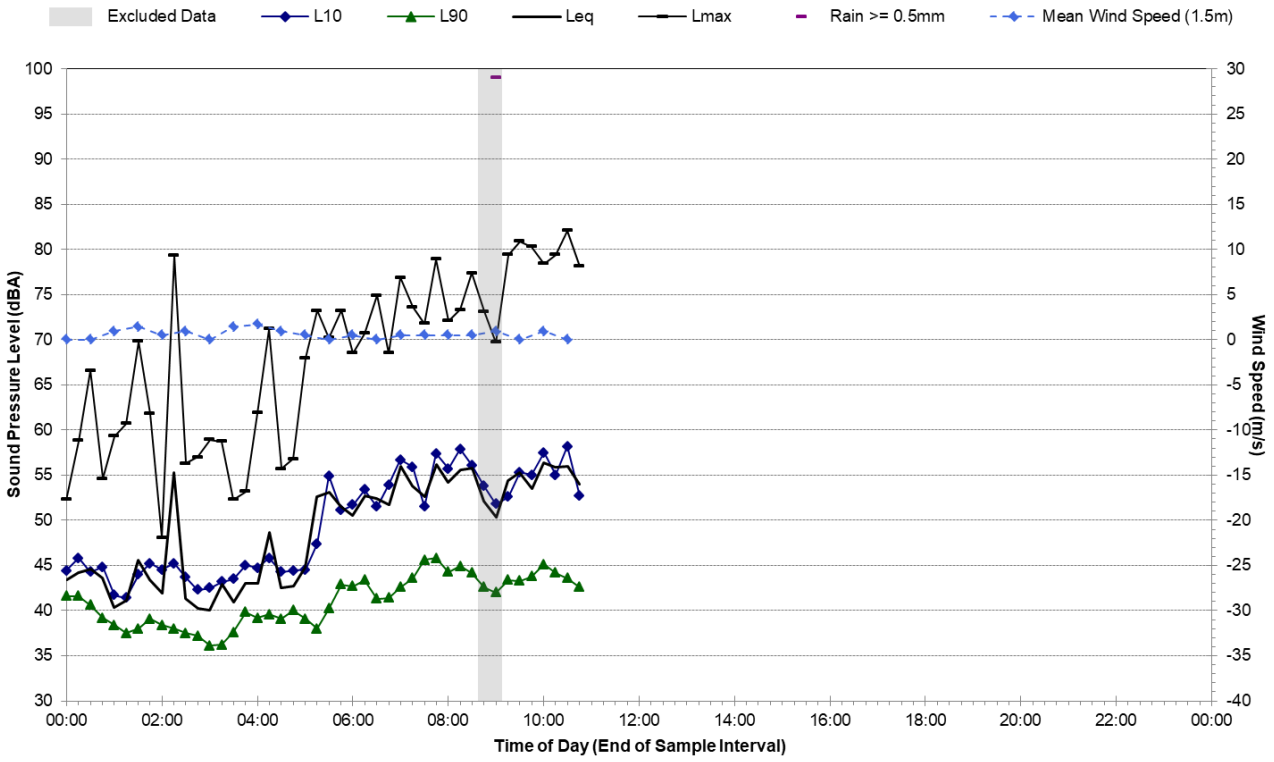

## Statistical Ambient Noise Levels

### L.02 - Gascoigne St, Kingswood - Thursday, 13 December 2018



# Statistical Ambient Noise Levels

## L.02 - Gascoigne St, Kingswood - Friday, 14 December 2018



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