# NOISE IMPACT ASSESSMENT

## Shopping Centre Development Application
## 19-31 & 33 Town Terrace, Glenmore Park

**Prepared for:**

Home Consortium
PO Box 19
Double Bay NSW 2028

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# BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Home Consortium (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.

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# DOCUMENT CONTROL

| Reference | Date | Prepared | Checked | Authorised |
|---|---|---|---|---|
| 610.30579-R01-v1.0 | 20 October 2021 | Jason Qian | Mark Irish | Mark Irish |
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# CONTENTS



# DOCUMENT REFERENCES

## TABLES

# CONTENTS

## FIGURES



## APPENDICES

# 1 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Home Consortium to prepare a Noise Impact Assessment as part of the Development Application (DA) for the proposed alterations and additions to the existing Glenmore Park Shopping Centre.

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

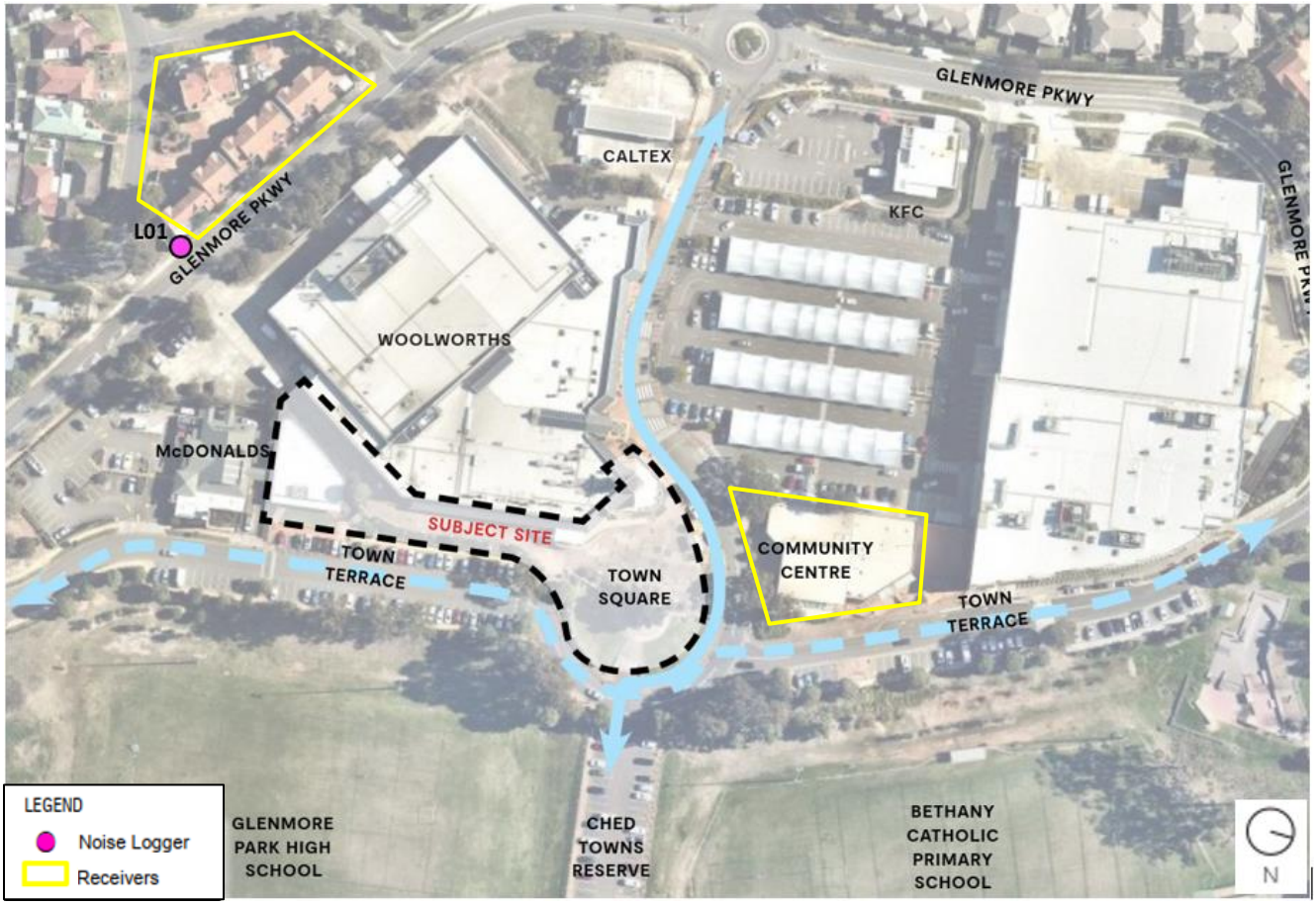
# 2 Project Description

The development is on the eastern side of the existing Glenmore Parking Shopping Centre at 19-31 & 33 Town Terrace, Glenmore Park. **Figure 1** shows the site location and nearest sensitive receivers, which are detailed in **Table 1**.

**Table 1 Summary of Nearest Sensitive Receivers**

| Receiver | Type | Minimum Distance to Site |
|---|---|---|
| 1-11 Candlebark Cct, Glenmore Park | Residential Houses | 60m |
| Glenmore Park Youth and Community Centre | Community Centre | 30m |
| Glenmore Park High School | School | 250m |
| Bethany Catholic Primary School | School | 250m |

## Figure 1 Site Map




The proposed development is shown in **Figure 2**, which includes:

- Construction of a 4-storey commercial type building with an area of approximately 800m$^2$, comprising 16 common car parking spaces on the lower ground floor level. New mechanical plant will be installed on the rooftop of the building (orange zone in **Figure 2**).
- Construction of a pavilion type building for use as a food and drink premises/occupancy with an area of approximately 250m$^2$ and a maximum internal capacity of 80 patrons (red zone in **Figure 2**).
- Reconfiguration of the existing occupancy into multiple occupancies to be used as food and drink premises with an area of approximately 400m$^2$ and a maximum internal capacity of 120 patrons (green zone in **Figure 2**).
- Establishment of outdoor dining areas with an area of approximately 350m$^2$ and a maximum capacity of 160 patrons (blue zone in **Figure 2**).

The proposed operating hours are 7 am to 10 pm, Monday to Sunday.

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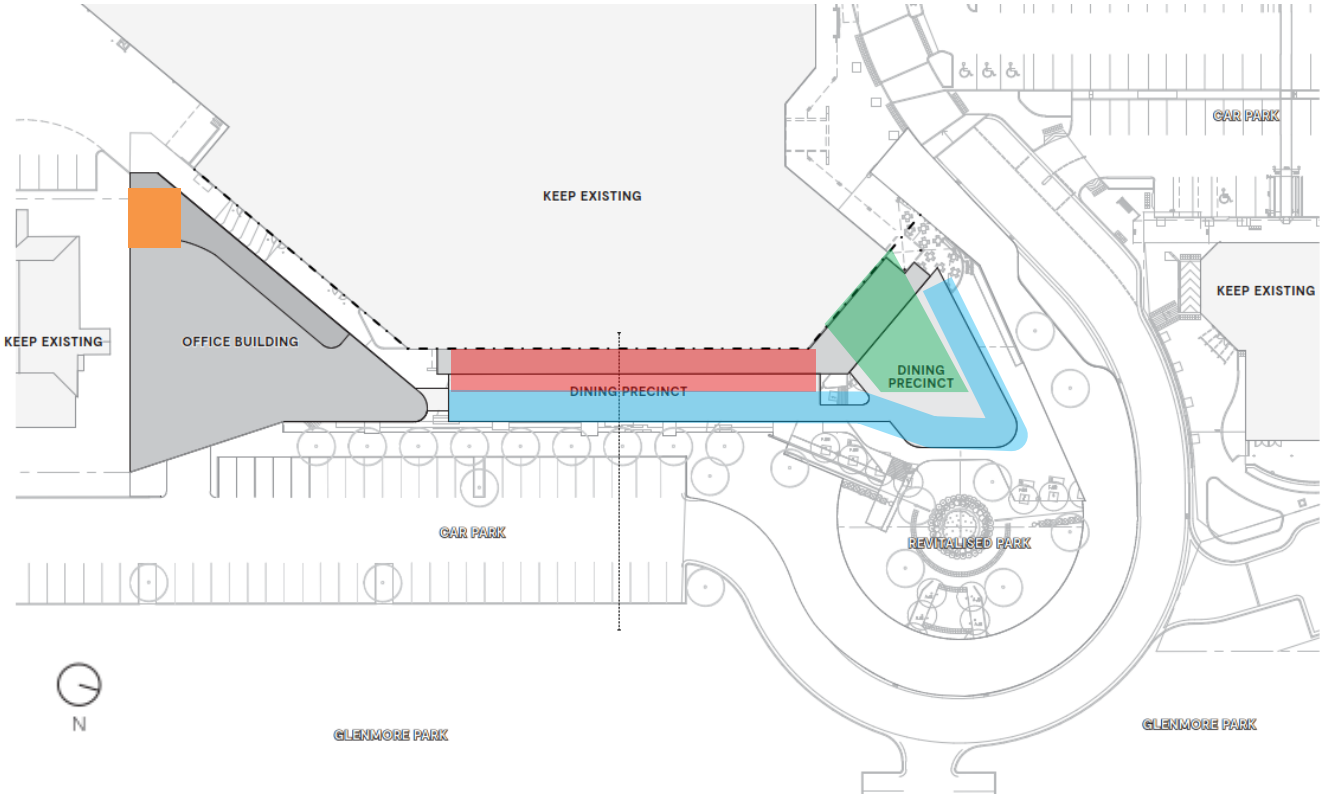
**Figure 2 Site Layout**




# 3 Existing Noise Environment

Unattended noise monitoring was completed at the location shown in **Figure 1** during the period of 29 September to 7 October 2021. The measured noise levels at monitoring location L01 have been used to determine the existing noise environment at the nearest residential receivers.

The monitoring equipment was positioned to measure existing noise levels that are representative of receivers potentially most affected by the proposed development, within constraints such as accessibility, security and landowner permission.

The noise monitoring equipment continuously measured existing noise levels in 15-minute periods during the daytime, evening and night-time. All equipment carried current National Association of Testing Authorities (NATA) calibration certificates and equipment calibration was confirmed before and after each measurement.

The measured data has been processed to exclude noise from extraneous events and periods affected by unsuitable weather conditions, such as strong wind or rain (measured at Penrith Lake weather station), to establish representative existing noise levels.

The noise monitoring results are summarised in **Table 2**. Details of the monitoring location together with graphs of the measured daily noise levels are provided in **Appendix B**.

**Table 2 Summary of Unattended Noise Logging Results**

| ID | Measured Noise Levels (dBA) | | | | | |
|---|---|---|---|---|---|---|
| | Background Noise (RBL) | | | Average Noise ($L_{Aeq}$) | | |
| | Day | Evening | Night | Day | Evening | Night |
| L01 | 44 | 39 | 31 | 64 | 62 | 55 |

Note 1: The assessment periods are the daytime which is 7 am to 6 pm Monday to Saturday and 8 am to 6 pm on Sundays and public holidays, the evening which is 6 pm to 10 pm, and the night-time which is 10 pm to 7 am on Monday to Saturday and 10 pm to 8 am on Sunday and public holidays. See the NSW EPA *Noise Policy for Industry*.

The Rating Background Levels (RBLs) at Location 1 during the time periods between 7 am and 10 pm are presented in octave band spectrums in **Table 3** below.

**Table 3 RBL Octave Band Spectra for Daytime Periods**

| Location | Time Period | Overall dBA | Sound Pressure Level, Octave Band Centre Frequency (Hz), dB | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| L01 | 7:00 am to 10 pm | 43 | 48 | 49 | 45 | 38 | 35 | 35 | 35 | 26 | 24 |

Note 1: The octave band noise levels are unweighted.

Note 2: The shopping centre is not in operation between 10:00 pm and 12:00 midnight.

# 4 Operational Noise Criteria

## 4.1 Mechanical Plant – Noise Policy for Industry

The *Noise Policy for Industry* (NPfI) was released in 2017 and sets out the NSW *Environment Protection Authority's* (EPA's) requirements for the assessment and management of noise from industry in NSW.

### 4.1.1 Trigger Levels

The NPfI describes 'trigger levels' which indicate the noise level at which feasible and reasonable noise management measures should be considered. Two forms of noise criteria are provided – one to account for 'intrusive' noise impacts and one to protect the 'amenity' of particular land uses.

- The **intrusiveness** of an industrial noise source is generally considered acceptable if the $L_{Aeq}$ noise level of the source, measured over a period of 15 minutes, does not exceed the background noise level by more than 5 dB. Intrusive noise levels are only applied to residential receivers. For other receiver types, only the amenity levels apply.
- To limit continual increases in noise levels from the use of the intrusiveness level alone, the ambient noise level within an area from all industrial sources should remain below the recommended **amenity** levels specified in the NPfI for that particular land use.

For this assessment, the area surrounding the proposal is considered to be 'suburban'.

The noise emission trigger levels for industrial noise generated by the proposal are provided in **Table 4**. The Project Noise Trigger Level is the lowest value of the intrusiveness or amenity noise level for each period and these are shown in the table in bold.

**Table 4 Project Noise Trigger Levels for Surrounding Receivers**

| Receiver Type | Time of Day | Recommended Amenity Noise Level (dBA) | Measured Noise Level (dBA) | | Project Noise Trigger Levels LAeq(15minute) (dBA) | |
|---|---|---|---|---|---|---|
| | | | RBL[1] | LAeq(period) | Intrusiveness | Amenity[2,3] |
| Residential | Day | 55 | 44 | 64 | **49** | 53 |
| | Evening | 45 | 39 | 62 | **44** | 50 |
| | Night | 40 | 31 | 55 | **36** | 43 |
| School classroom – internal | Noisiest 1-hour period when in use | **35** | N/A | N/A | N/A | N/A |
| Community Centre (passive recreation area) | When in use | **50** | N/A | N/A | N/A | N/A |

Note 1: RBL = Rating Background Level.

Note 2: The high traffic project amenity noise level equal to LAeq(period) minus 15 dB, if the LAeq is 10 dB or more above the recommended amenity noise level.

Note 3: The project amenity noise levels have been converted to a 15 minute level by adding 3 dB.

## 4.2 Patron Noise – Liquor Act 2007

The Liquor Act 2007 provides informal mechanisms for complaints to be made when the amenity of local areas is disturbed by the use of licensed premises and registered clubs (including disturbances caused by patrons). Typical noise conditions that are imposed upon licensed premises are as follows:

> *The LA10* noise level emitted from the licensed premises shall not exceed the background noise level in any Octave Band Centre Frequency (31.5 Hz – 8k Hz inclusive) by more than 5 dB between 07:00 am and 12:00 midnight at the boundary of any affected residence.*
>
> ** For the purposes of this condition, the LA10 can be taken as the average maximum deflection of the noise emission from the licensed premises.*

It is noted that the Liquor Act 2007 has withdrawn the above criteria. However, in the absence of alternative criteria to assess noise impact from a licensed premises, the criteria above has been adopted.

These criteria are applicable to noise emissions from the indoor and outdoor areas in the restaurant. Octave band spectral criteria for each assessment period has been summarised in **Table 5** based on the results shown in **Table 3**.

**Table 5 Project Specific Noise Criteria – LA10 Criteria**

| Location | Time Period | Overall dBA | Sound Pressure Level, Octave Band Centre Frequency (Hz), dB | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| L01 | 7:00 am to 10 pm | 48 | 53 | 54 | 50 | 43 | 40 | 40 | 40 | 31 | 29 |

Note 1: The octave band noise levels are unweighted.

Note 2: The proposed development is not in operation between 10:00 pm and 12:00 midnight.

## 4.3 Traffic Noise

It is noted that vehicle numbers on surrounding roads would need to increase by around 60% from existing for a 2 dB increase to be apparent. Considering the average daily traffic volumes on Glenmore Parkway section close to the proposed development is approximately 35,000 vehicles[1], the proposed development needs to increase 21,000 vehicles per day to be considered acoustically significant to the nearest residential receivers.

# 5 Construction Noise Criteria

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

The ICNG contains procedures for determining project specific Noise Management Levels (NMLs) based on the existing background noise in the area. Representative 'worst-case' noise levels from construction of a project are predicted and then compared to the NMLs in a 15-minute assessment period to determine the likely impact.

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.

## 5.1 Residential Receivers

The ICNG approach for determining NMLs at residential receivers is shown in **Table 6**.

**Table 6 ICNG NMLs for Residential Receivers**

| Time of Day | NML (dBA) LAeq(15minute) | How to Apply |
|---|---|---|
| Standard Construction Hours:<br>Monday to Friday<br>7 am to 6 pm<br>Saturday<br>8 am to 1 pm<br>No work on Sundays or public holidays | Noise affected<br>RBL[1] + 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 LAeq(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. |

[1] The traffic number is quoted from Infrastructure Australia's report "*Project Business Case Evaluation – The Northern Road Upgrade (between Peter Brock Drive, Oran Park and Jamison Road, South Penrith)" dated 9 February 2017.*

| Time of Day | NML (dBA) $L_{Aeq(15minute)}$ | How to Apply |
|---|---|---|
| Outside Standard Construction Hours | Noise affected 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 ICNG refers to the calculation procedures in the NSW *Industrial Noise Policy* (INP). The INP has been superseded by the NSW EPA *Noise Policy for Industry* (NPfI).

Works are recommended to be completed during Standard Construction Hours where possible. More stringent requirements are placed on works that are required to be completed outside Standard Construction Hours (ie during the evening or night-time, or on Sundays/public holidays) which reflects the greater sensitivity of communities to noise impacts during these periods.

## 5.2 Sleep Disturbance

Construction projects often require certain works to be completed during the night-time. Where night works are located close to residential receivers there is potential for sleep disturbance impacts.

The ICNG lists five categories of works that might be undertaken outside of Standard Construction Hours:

- The **delivery of oversized equipment or structures** that require special arrangements to transport on public roads
- **Emergency work** to avoid the loss of life or damage to property, or to prevent environmental harm
- **Maintenance and repair of public infrastructure** where disruption to essential services or considerations of worker safety do not allow work within standard hours
- **Public infrastructure works** that shorten the length of the project and are supported by the affected community
- Works where a proponent demonstrates and justifies **a need to operate outside the recommended standard hours**.

The ICNG recommends that an assessment of sleep disturbance impacts should be completed where construction works are planned to extend over more than two consecutive nights. The ICNG refers to the NSW *Environmental Criteria for Road Traffic Noise* for assessing the potential impacts, which notes that to limit the level of sleep disturbance the $L_1$ level (or $L_{Amax}$) should not exceed the existing $L_{90}$ (or RBL) by more than 15 dB.

## 5.3 Summary of Residential NMLs

The residential NMLs for the project have been determined using the results from the unattended noise monitoring and are shown in **Table 7**.

**Table 7 Residential Receiver Construction Noise Management Levels**

| Receiver | Representative Background Monitoring Location | Noise Management Level $L_{Aeq(15minute)}$ (dBA) | | | | Sleep Disturbance Screening Criteria (RBL +15 dB) |
|---|---|---|---|---|---|---|
| | | Standard Construction Hours (RBL +10 dB) | Out of Hours (RBL +5 dB) | | | |
| | | Daytime | Daytime[1] | Evening | Night-time | |
| Residential | L01 | 54 | 49 | 44 | 36 | 46 |

Note 1: Daytime 'out of hours' is 7 am to 8 am and 1 pm to 6 pm on Saturday, and 8 am to 6 pm on Sunday and public holidays.

## 5.4 'Other Sensitive' Land Uses and Commercial Receivers

A number of non-residential land uses have been identified in the study area. These include 'other sensitive' land uses such as educational institutes and indoor recreational areas.. The ICNG NMLs for 'other sensitive' receivers relevant to this development are shown in **Table 8**.

**Table 8 ICNG NMLs for 'Other Sensitive' Receivers**

| Land Use | Noise Management Level $L_{Aeq(15minute)}$ (Applied when the property is in use) |
|---|---|
| Classrooms at schools and other education institutions | Internal noise level 45 dBA[1] |
| Community centres | Internal noise level 50 dBA[1,2] |

Note 1: Criteria specified as an internal noise level. As the noise assessment predicts external noise levels, it has been conservatively assumed that schools and community centres have openable windows and external noise levels are 10 dB higher than the corresponding internal level, which represents windows being partially open for ventilation.

Note 2: Refer to the recommended 'maximum' internal levels of "Leisure centre and gaming" in AS 2107.

# 6 Noise Assessment

## 6.1 Mechanical Plant

Precise details of the mechanical plant selection are not determined at this stage, as this will take place during the detailed design phase of the project.

The external noise emissions of mechanical plant associated with the development should be controlled so that the operation of such plant does not adversely impact upon nearest sensitive receivers within the subject development. The criteria for noise emissions from mechanical plant and equipment are documented in **Table 4**.

## 6.2 Patron Noise

Vocal noise from patrons has potential to affect the acoustical amenity of nearby residential receivers. The noise emissions will be dependent on the voice levels of patrons.

Typical noise levels from patron voices are derived from Table 16.1 in the *"Handbook of Acoustical Measurements and Noise Control"* by C.M. Harris. The sound power spectra of male speech for various levels of vocal effort are summarised in **Table 9**.

**Table 9 Typical $L_{10}$ Sound Power Level of a Single Person at Various Vocal Strengths**

| Vocal Strength Descriptor | Overall dBA | Octave Band Centre Frequency (Hz), dB | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 31.5[1] | 63[1] | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| Casual | 61 | n/a | n/a | 54 | 57 | 60 | 51 | 49 | 47 | 45 |
| Normal | 66 | n/a | n/a | 57 | 63 | 66 | 58 | 54 | 51 | 46 |
| Raised | 73 | n/a | n/a | 62 | 67 | 72 | 66 | 61 | 58 | 51 |

Note 1: No appreciable data is measurable or available for vocal noise at such low frequency.

The calculation of patron noise in worst-case scenario assumes 80 talking patrons with raised voice outdoor and 100 talking patrons with raised voice indoor (one listener per speaker). Patrons are likely to be gathered in groups greater than two and thus this method is considered to be conservative.

**Table 10 Received Patron Noise Level at Nearest Residential Receiver**

| Sensitive Receiver Location | Overall dBA | Octave Band Centre Frequency (Hz) dB | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| Worst Case Scenario | 33 | 27 | 32 | 34 | 26 | 18 | 13 | 5 |
| **Project Specific Noise Criteria** | | | | | | | | |
| 7:00 am to 10 pm | 48 | 50 | 43 | 40 | 40 | 40 | 31 | 29 |
| **Exceedances (Worst Case Scenario)** | | | | | | | | |
| 7:00 am to 10 pm | - | - | - | - | - | - | - | - |

Based on the results presented in **Table 10**, the noise emission from patrons complies with the criteria at nearest residential receivers in the worst case scenario.

## 6.3 Construction Noise

Detailed construction methodologies are not determined at this stage. The Roads and Maritime (now TfNSW) *Construction Noise and Vibration Guideline* (CNVG) contains a number of 'standard mitigation measures' for mitigating and managing construction impacts. The measures should be applied to construction of the proposal, where feasible and reasonable.

If required, the detailed assessment should be carried out prior to construction. If the predicted construction levels exceed the NMLs detailed in **Table 7** and **Table 8**. The use of 'additional mitigation measures' recommended in CNVG should be applied where feasible and reasonable.

## 6.4 Traffic Noise

The Roads & Traffic Authority (now TfNSW) *Guide to Traffic Generating Developments* introduces the method to calculate the traffic generation rate for daily and peak hour periods as shown in **Table 11**

**Table 11 Traffic Generation Rate for Different Types of Development**

| Type of Development | Traffic Generation Rate |
|---|---|
| Office and Commercial | **Daily vehicle trips:** 10 per 100m$^2$ gross floor area<br>**Evening peak hour vehicle trips:** 2 per 100m$^2$gross floor area. |
| Restaurant | **Daily vehicle trips:** 5 per 100m$^2$ gross floor area<br>**Evening peak hour vehicle trips:** 60 per 100m$^2$gross floor area. |

**Table 12 Predicted Increase of Vehicle Number**

| Type of Development | Total Area (m$^2$) | Predicted Traffic Generation Rate | |
|---|---|---|---|
| | | Daily | Evening Peak Hour |
| Office | 800 | 80 | 16 |
| Restaurant | 1000 | 600 | 50 |
| **Total** | | 680 | 66 |
| **Estimated Traffic Generation Rate to be Acoustic Apparent.** | | 21,000 | 875 |
| **Compliance** | | Yes | Yes |

Based on the results presented in **Table 12**, the increase of vehicle number caused by proposed development is not considered to be acoustically significant to the nearest sensitive receivers.

# 7 Conclusion

SLR Consulting Australia Pty Ltd has conducted a noise impact assessment associated with regards to the proposed alterations and additions to the existing Glenmore Park Shopping Centre.

The scope of the assessment involved a survey of the existing noise environment; derivation and establishment of noise criteria with reference to NSW and Australian guidelines; and a noise impact assessment with respect to the appropriate criteria.

# 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 4000 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 dBA or 2 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA 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

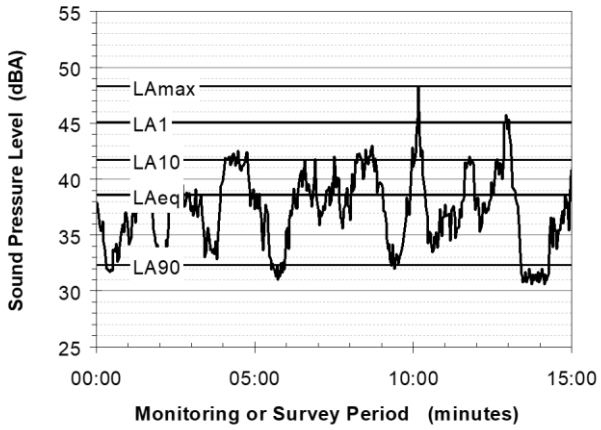
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or $L_W$, or by the reference unit $10^{-12}$ W.

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 exceed 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

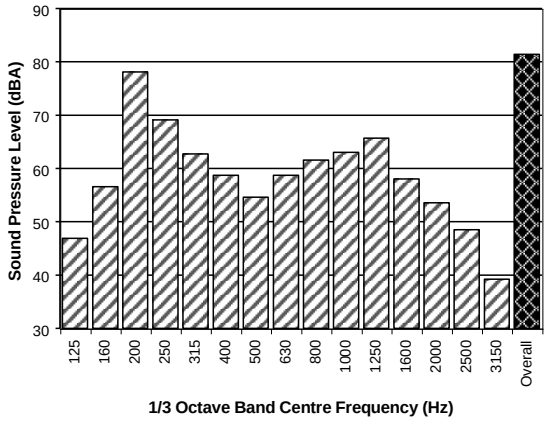
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

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 organizations.

## 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

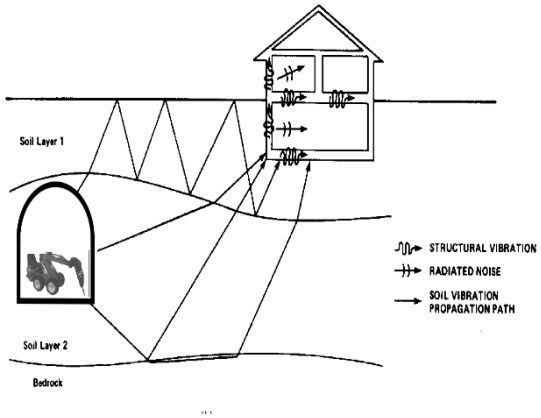
The term 'over-pressure' is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

## 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 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.



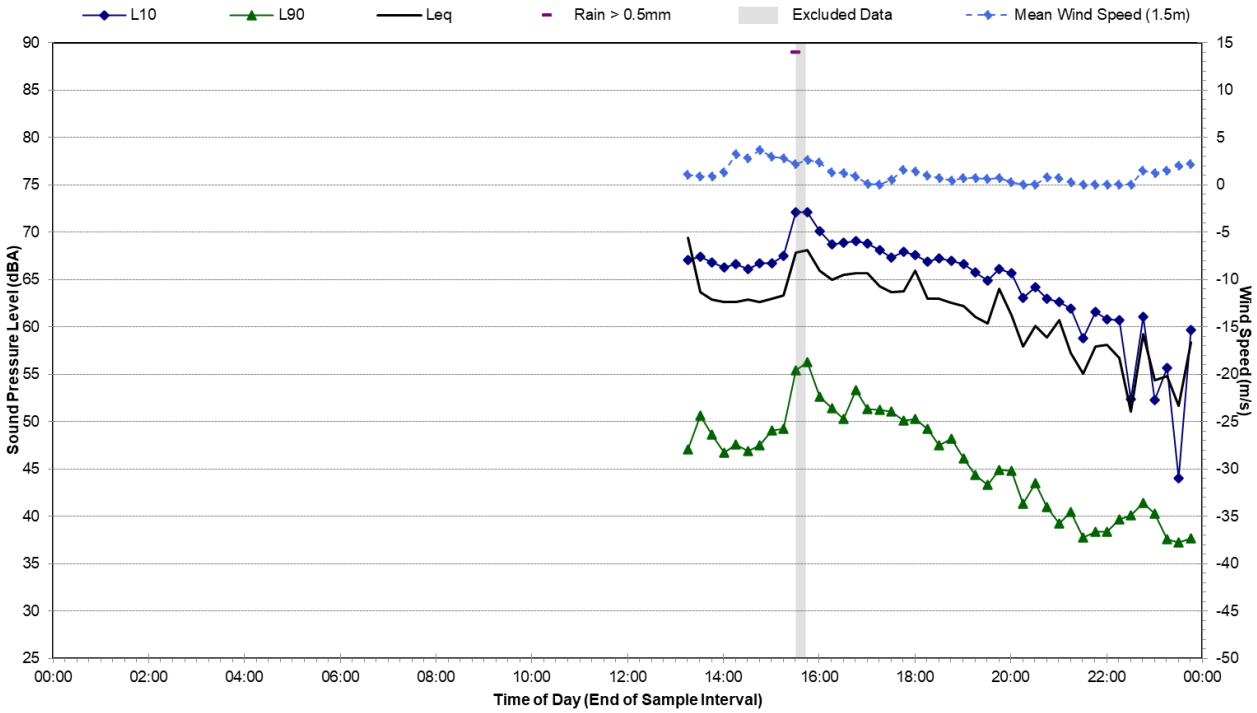

The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect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

# APPENDIX B

Daily Noise Monitoring Graph – Location 1

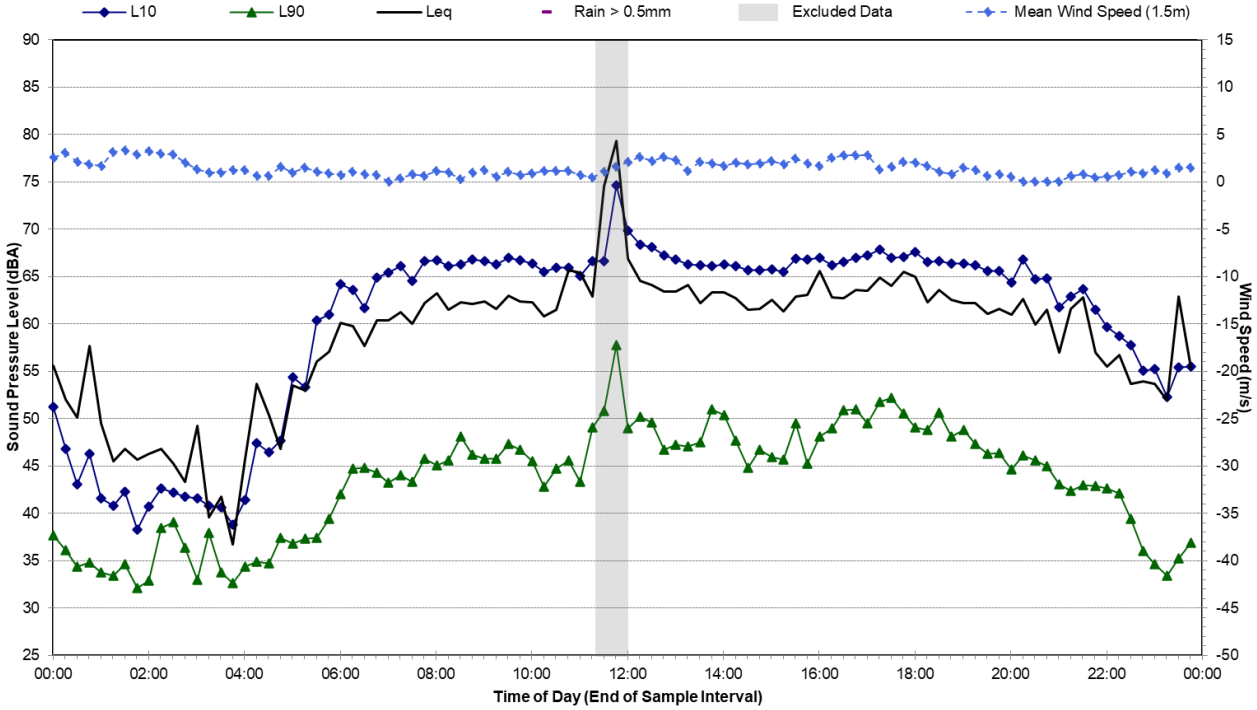
## Statistical Ambient Noise Levels

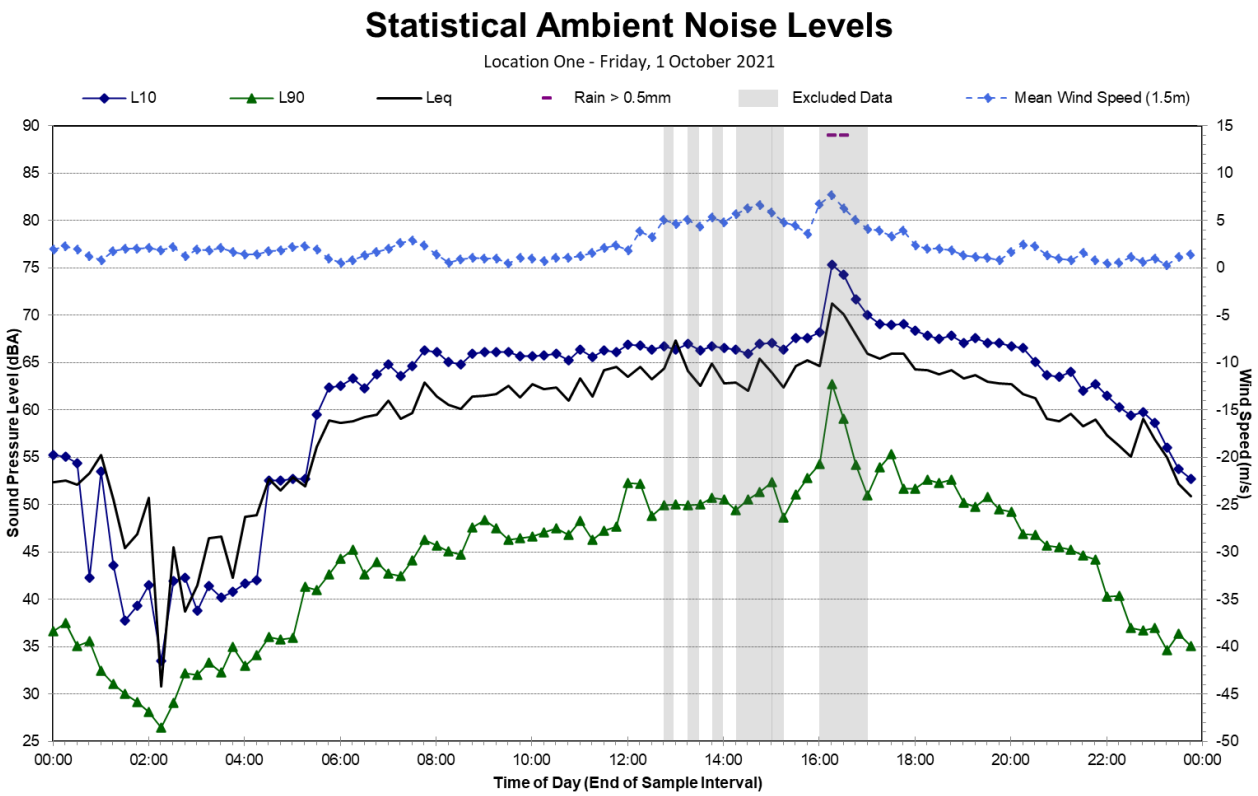
Location One - Wednesday, 29 September 2021

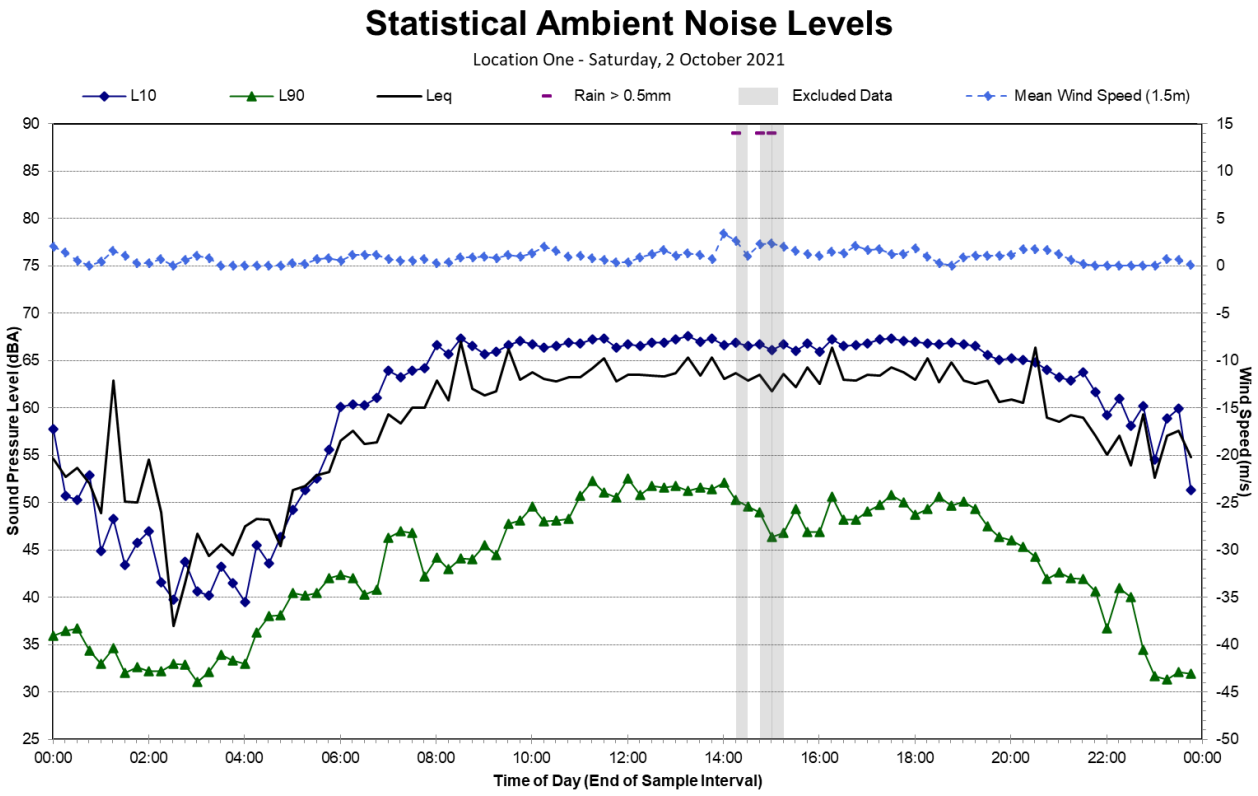


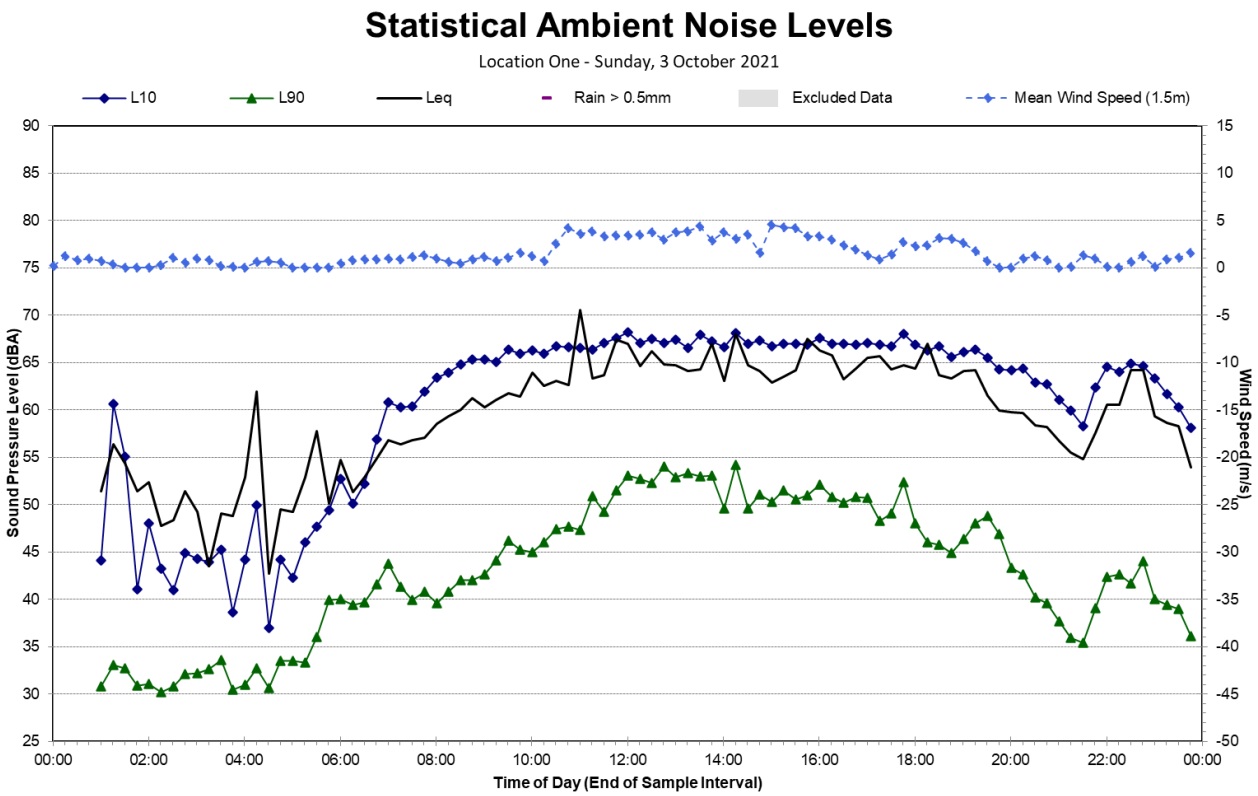

## Statistical Ambient Noise Levels

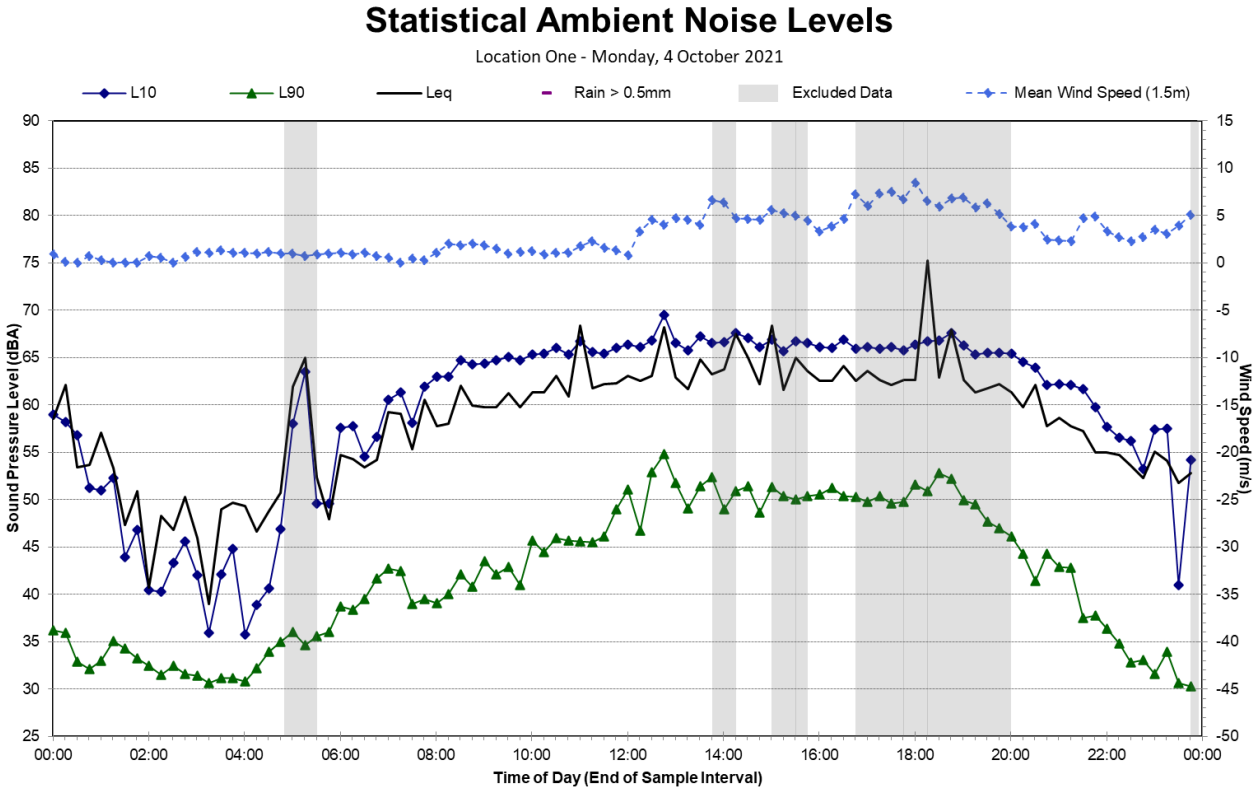
Location One - Thursday, 30 September 2021

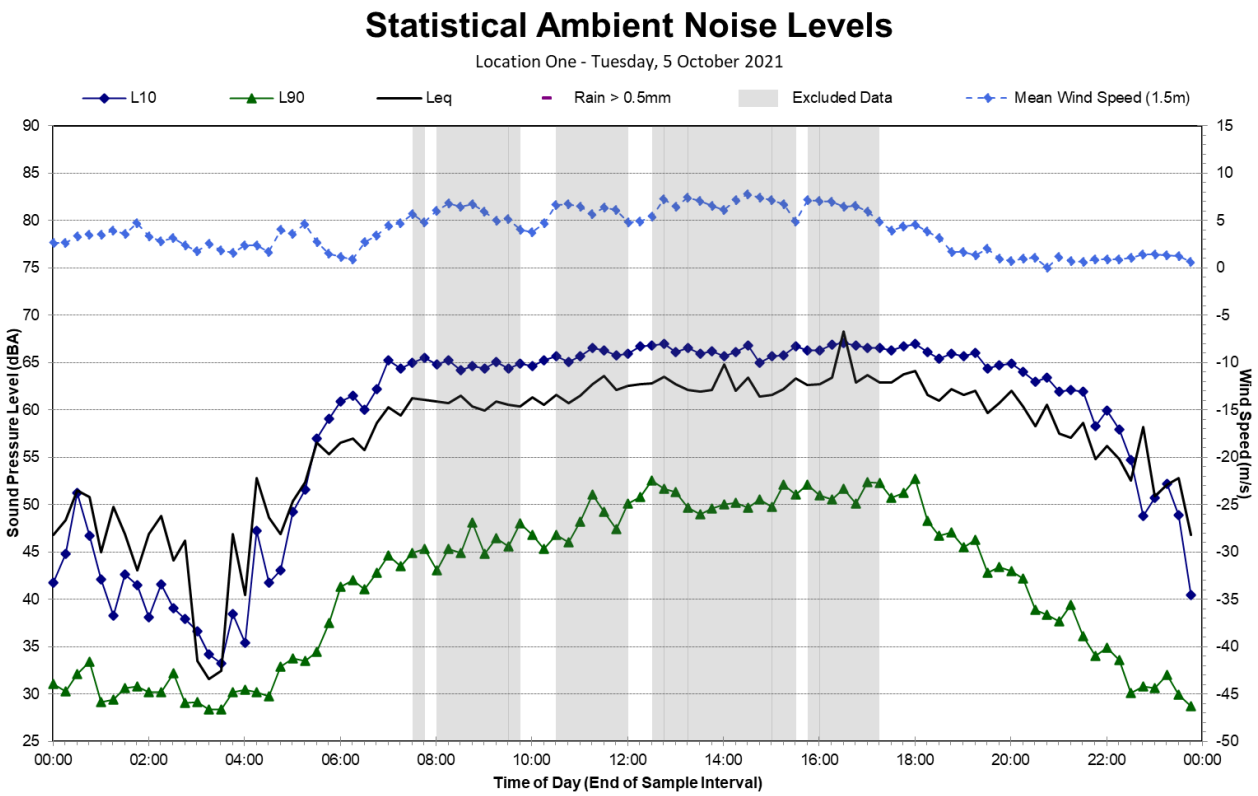


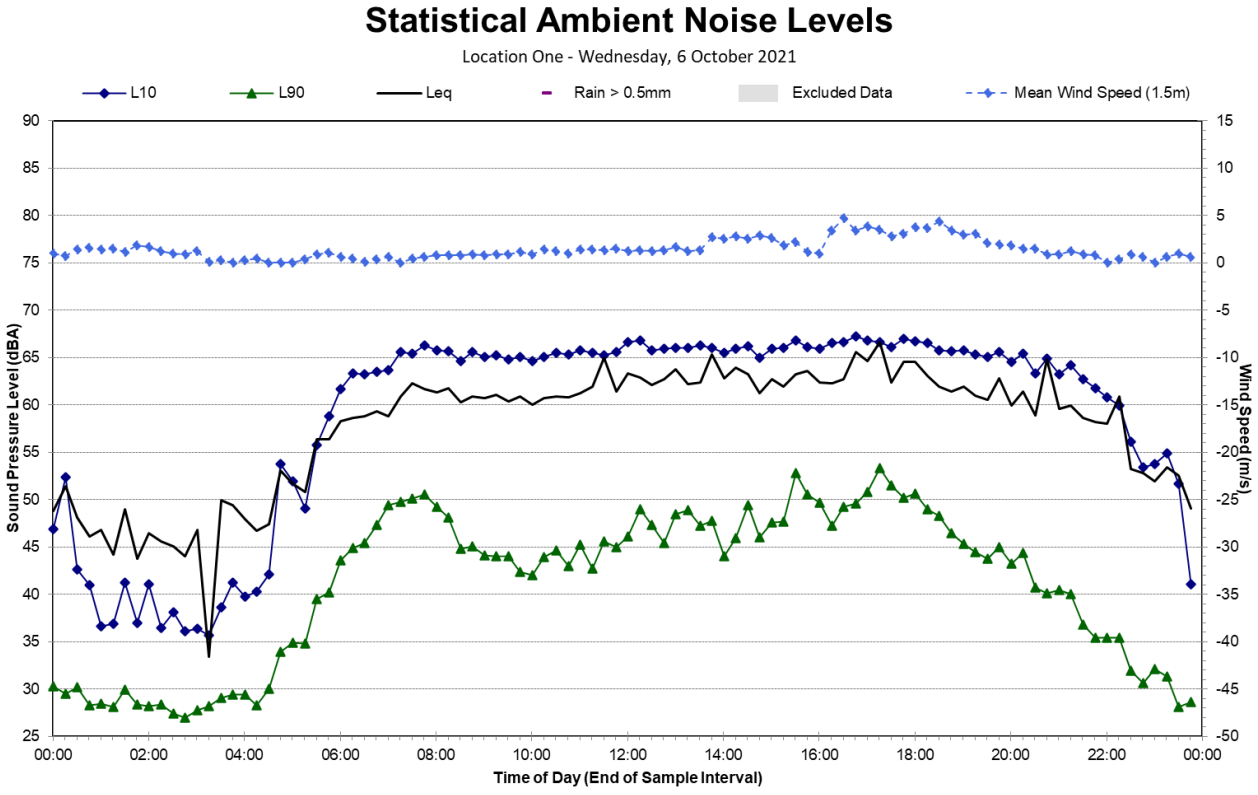


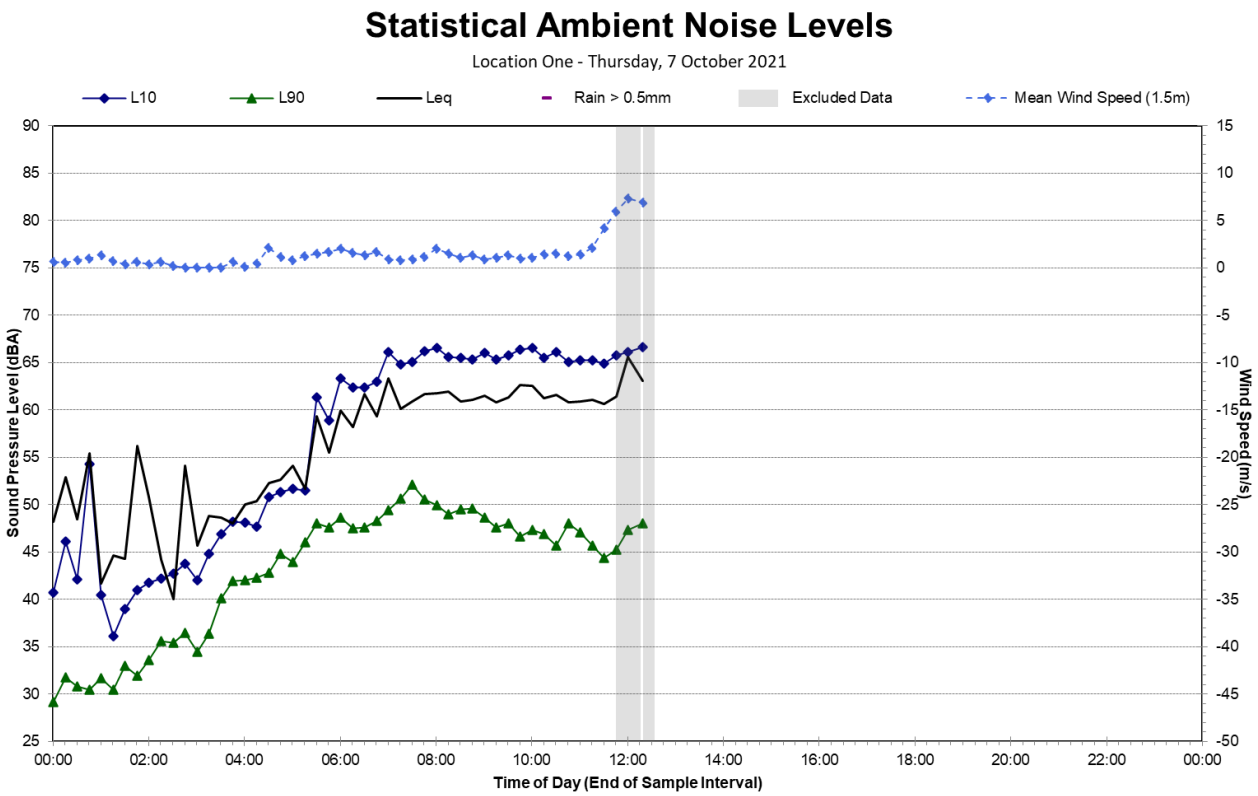









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