CHERRYBROOK STATION GOVERNMENT LAND

State Significant Precinct
Noise and Vibration Assessment

Prepared for:

Landcom
Level 14, 60 Station Street
Parramatta NSW 2150

-

SLR Ref: 610.30775-R01
Version No: -v1.0
April 2022

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Tenancy 202 Submarine School, Sub Base Platypus, 120 High Street
North Sydney NSW 2060 Australia

T: +61 2 9427 8100
E: sydney@slrconsulting.com www.slrconsulting.com

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 Landcom (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
610.30775-R01-v1.0	4 April 2022	Antony Williams	Mark Irish	Antony Williams

DOCUMENT REFERENCES

TABLES

FIGURES

APPENDICES

1 Introduction and Overview

1.1 Overview

This study relates to a proposal to develop land called the 'Cherrybrook Station Government Land State Significant Precinct' (the State Significant Precinct) by Landcom on behalf of the landowner, Sydney Metro. The State Significant Precinct is centred around Cherrybrook Station on the Metro North West Line. The Metro North West Line delivers a direct connection with the strategic centres of Castle Hill, Norwest, Macquarie Park and Chatswood. It covers 7.7 hectares of government-owned land that comprises the Cherrybrook Station, commuter carpark and station access road (Bradfield Parade) and vacant land to the east of the station (referred to as the Developable Government Land) (DGL). It is bound by Castle Hill Road (south), Franklin Road (south east) and Robert Road (north west).

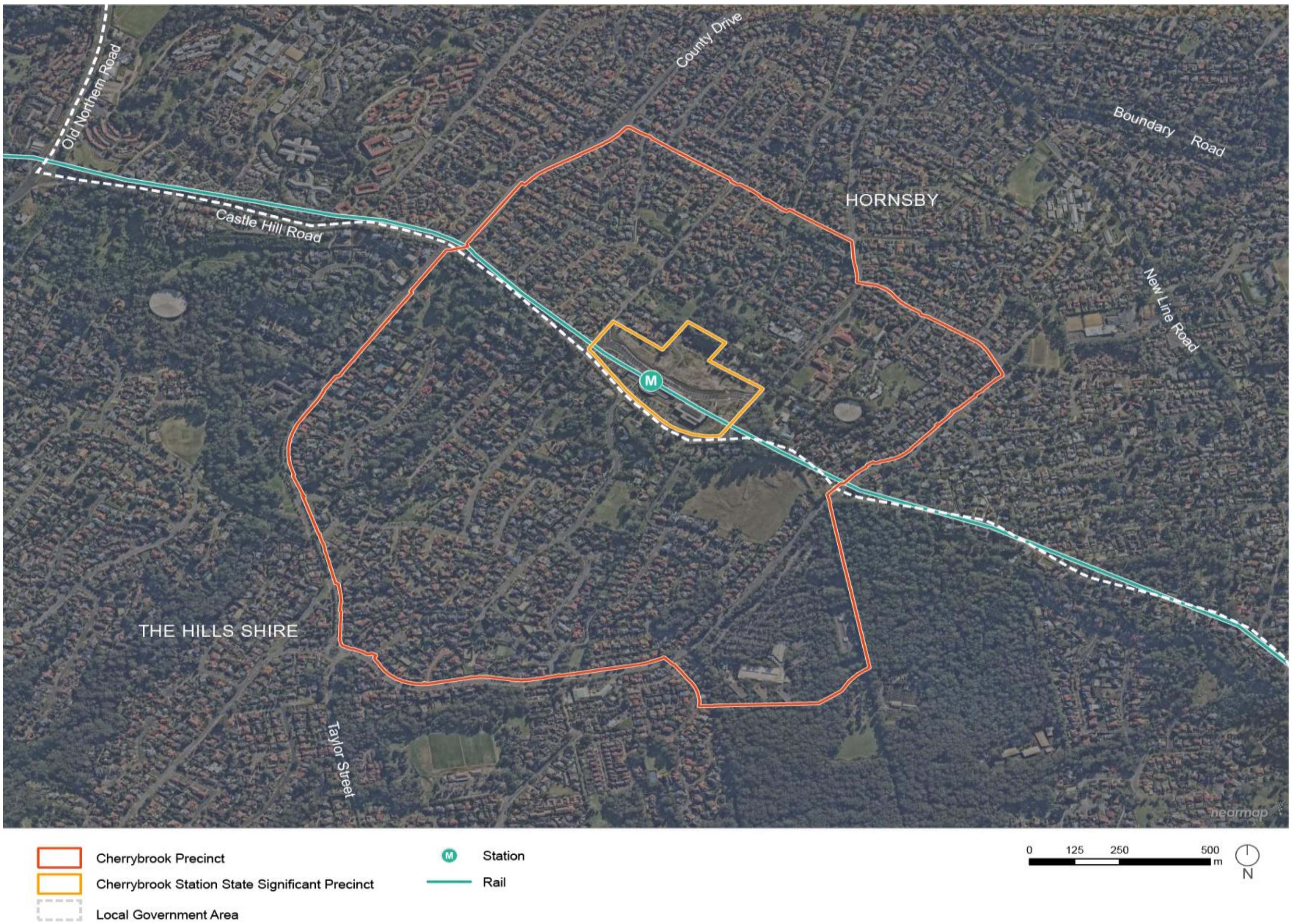
As a State Significant Precinct, the Minister for Planning and Public Spaces (the Minister) has determined that it is of State planning significance and should be investigated for rezoning. This investigation will be carried out in accordance with study requirements issued by the NSW Department of Planning, Industry and Environment (now Department of Planning and Environment (DPE)) in May 2020. These study requirements were prepared in collaboration with Hornsby Shire Council and The Hills Shire Council.

The outcome of the State Significant Precinct process will be new planning controls. This will enable the making of development applications to create a new mixed-use local centre to support Cherrybrook Station and the needs of the local community.

At the same time, DPE is also working with Hornsby Shire and The Hills Shire Councils, as well as other agencies such as Transport for NSW, to undertake a separate planning process for a broader area called the Cherrybrook Precinct. Unlike the State Significant Precinct, the outcome of this process will not be a rezoning. Instead, it will create a Place Strategy that will help set the longer term future for this broader area. Landcom will be consulted as part of this process.

Figure 1 illustrates the site boundaries of the State Significant Precinct and the Cherrybrook Precinct.

Figure 1 Cherrybrook Precinct and Cherrybrook Station State Significant Precinct (subject of this proposal)



Source: NSW Department of Planning & Environment

1.2 Purpose

The purpose of this study is to address the relevant study requirements for the State Significant Precinct, as issued by DPE. It is part of a larger, overall State Significant Precinct Study. This State Significant Precinct Study undertakes planning investigations for the precinct in order to achieve a number of objectives that are summarised as follows (refer to the State Significant Precinct Study Planning Report for a full list of the study requirements):

- Facilitate a mixed-use local centre at Cherrybrook Station that supports the function of the station and the needs of the local community
- Deliver public benefit through a mixed use local centre
- Deliver transport and movement initiatives and benefits
- Demonstrate the suitability of the site for the proposed land uses
- Prepare a new planning framework for the site to achieve the above objectives.

1.3 Proposal

The proposed new planning controls for the State Significant Precinct are based on the investigations undertaken as part of the State Significant Precinct Study process. A Reference Scheme has also been prepared to illustrate one way in which the State Significant Precinct may be developed in the future under the proposed new planning controls.

The proposed planning controls comprise amendments to the Hornsby LEP 2013 to accommodate:

- Rezoning of the site for a combination of R4 High Density Residential, B4 Mixed Use and RE1 Public Recreation zoned land;
- Heights of between 18.5m – 22m;
- FSR controls of 1:1 – 1.25:1;
- Inclusion of residential flat buildings as an additional permitted use on the site in the B4 Mixed Use zone;
- Site specific LEP provisions requiring the delivery of a minimum quantity of public open space and a maximum amount of commercial floor space; and
- New site-specific Design Guide addressing matters such as open space, landscaping, land use, built form, sustainability and heritage.

The Reference Scheme (refer to **Figure 2**) seeks to create a vibrant, transit-oriented local centre, which will improve housing choice and affordability and seeks to integrate with Hornsby's bushland character. The Reference Scheme includes the following key components:

- Approximately 33,350m^2 of residential GFA, with a yield of approximately 390 dwellings across 12 buildings ranging in height from 2 to 5 storeys (when viewed from Bradfield Parade).
- A multi-purpose community hub with a GFA of approximately 1,300m^2.
- Approximately 3,200m^2 of retail GFA.
- Over 1 hectare of public open space, comprising:
  - A village square with an area of approximately 1,250m^2, flanked by active retail and community uses.
  - A community gathering space with an area of approximately 3,250m^2.
  - An environmental space around the pond and Blue Gum High Forest with an area of approximately 8,450m^2.
- Green corridors and pedestrian through site links, providing opportunities for potential future precinct-wide integration and linkages to the north.

Figure 2 Reference Scheme

Parcel	*Area	Res GFA	Units	Non-Res GFA	Community	Portion FSR*
A	8,597	12,031	141	749		1.49
B	9,610	11,924	140	2,452	1,300	1.68
C	2,574	2,736	32			1.06
D	6,715	6,621	78			0.98
	27,272	**33,312**	**391**	**3,201**	**1,300**	

Source: SJB

1.4 Scope of Works and Study Requirements

This report details the existing sources of noise at the site, identifies nearby sensitive receivers and summarises the findings of existing noise surveys completed within the study area.

The potential noise and vibration impacts to the State Significant Precinct (the Precinct) from existing sources have been predicted and mitigation measures recommended, where appropriate. Impacts from the Precinct to existing receivers have also been considered.

The study requirements relevant to noise and vibration are shown in **Table 1**.

Table 1 Study Requirements

Requirement	Section Reference
18.1 – Provide a preliminary noise, vibration impact and air quality assessment for the proposal. The assessment will address the relevant policies and guidelines including *State Environmental Planning Policy (Infrastructure)* 2007, *Development Near Rail Corridors and Busy Roads – Interim Guideline*, *Assessing Vibration: A Technical Guideline* (2006) and *Policy and Guidelines for Noise and Vibration Generating Development*, Hornsby Shire Council (2000).	This report (air quality impacts have been assessed separately)
18.2 – Model and demonstrate that the proposal can meet the recommended noise, vibration and air quality standards and/or appropriate mitigations measures can be achieved on the site. This includes any noise or air quality impacts potentially generated from the metro tunnel and open cut station.	**Section 4**, **5** and **5.5**
18.3 – Recommend appropriate noise and vibration and air quality measures. The consultant is expected to work with the urban designer, and suggest measures to be provided for the protection of future residents of buildings including through the careful siting and layout of the building envelopes whilst maintaining natural ventilation through open windows.	**Section 5.5** and **5.5.2**

1.5 Terminology

Specific acoustic terminology is used within this assessment. An explanation of common acoustic terms is included in **Appendix A**.

2 Noise Sources Potentially Impacting the Precinct

Existing noise sources that have the potential to impact the Precinct include:

- Road traffic noise, particularly from Castle Hill Road
- Rail noise from the Metro North West Line which runs beneath the precinct and station noise from the open cut Cherrybrook Station
- Noise from new non-residential areas within the Precinct, such as retail space, commercial tenancies, community facilities, etc, affecting future receivers within the Precinct.

2.1 Road Traffic Noise

Road Traffic Noise on the Precinct

There are a number of existing roads that have the potential to impact the Precinct. Castle Hill Road is the closest major road, which is to the immediate south-west of the site. The south-east section of the Precinct is immediately adjacent to Castle Hill Road with the rest of the Precinct being separated by around 60 to 120 m. Robert Road and Franklin Road are also close to the northern and southern boundaries of the site, respectively.

Road traffic typically generates very low vibration levels which are well below the applicable criteria. Where large discontinuities such as potholes, road plates or joins in the pavement occur, vibration levels can be perceived in close proximity to the road when heavy vehicles travel over them. Those vibration generating circumstances are a maintenance issue, rather than a design issue and are not assessed.

Road Traffic Noise Increase due to the Precinct

There is potential for increased noise levels due to additional traffic generated by the Precinct from the introduction of new medium to high density residential units. Increased road traffic noise levels have the potential to affect existing receivers surrounding the Precinct.

2.2 Rail Traffic Noise

The Metro North West Line is in a tunnel approximately underneath Castle Hill Road, on a south-east to north-west alignment through the Precinct. Cherrybrook Station is an open cut station to the north-east of Castle Hill Road, which is within the Cherrybrook Precinct.

There is potential for noise, vibration and ground-borne noise impacts within the Precinct from the operation of the rail line.

2.3 Operational Industrial Noise

At this stage of the development the future non-residential uses of the Precinct are unknown. It is expected that the area surrounding the station would be of mixed-use and would likely accommodate small scale commercial developments such as retail, restaurants/cafes, community facilities, etc. No heavy industrial developments are proposed in the Precinct.

There is also potential for noise impacts from station activities, such as:

- Mechanical and electrical services for the station and ancillary facilities
- Station car parks
- Station Public Address (PA) system.

No existing commercial or industrial areas have been identified in the area surrounding the Precinct.

3 Description of the Existing Environment

3.1 Existing Noise Surveys and Monitoring Locations

Unattended noise monitoring was completed in the study area in May 2016. The measured noise levels have been used to determine the existing noise environment and to set the criteria used to assess the potential impacts from the project. The use of this data is considered valid due to it being measured before construction of Metro North West when background noise levels in the area were likely lower than they currently are. This would result in a conservative assessment of the potential impacts from the proposal.

The monitoring equipment was positioned to measure existing noise levels that are representative of receivers potentially most affected by the project, 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) or manufacturer 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 adverse weather conditions, such as strong wind or rain, to establish representative existing noise levels in the study area.

The noise monitoring locations are shown in **Figure 3** and the results are summarised in **Table 2**. Details of each 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	Address	Measured Noise Level (dBA)							
		Noise Policy for Industry Periods[1]						Road Traffic Periods[2]	
		Background Noise (RBL)[3]			Average Noise (L_{Aeq})			Average Noise (L_{Aeq})	
		Day	Evening	Night	Day	Evening	Night	Day (15hr)	Night (9hr)
L01	Inala School, Cherrybrook	55	51	36	71	70	67	71	67
L02	25 Glenhope Road, Cherrybrook	36	37	30	58	56	51	58	51
L03	7 Robert Road, Cherrybrook	37	39	31	55	52	49	54	50

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*.

Note 2: Operational road traffic noise assessment periods are the daytime which is 7 am to 10 pm and the night-time which is 10 pm to 7 am. See the NSW EPA *Road Noise Policy*.

Note 3: RBL = Rating Background Level, as defined in the *Noise Policy for Industry*.

Figure 3 Site Plan and Noise Monitoring Locations

Note: Non-residential uses are also proposed at ground floor of some of the residential buildings shown above.

3.2 Attended Noise Measurements

Short-term attended noise monitoring was also completed at each monitoring location. The attended measurements allow the contributions of the various noise sources at each location to be determined. Detailed observations from the attended measurements are provided in **Appendix B**.

The attended measurements were generally found to be consistent with the results of the unattended noise monitoring and show that existing noise levels are typically dominated by road traffic noise from the surrounding road network.

4 Noise and Vibration Criteria

4.1 Internal Noise Level Criteria – Residential

4.1.1 State Environment Planning Policy

The *State Environment Planning Policy* (Infrastructure) 2007 (Infrastructure SEPP) provides guidelines for new residential development near existing road and railway infrastructure. The key objectives are to:

- Protect the safety and integrity of key transport infrastructure from adjacent development
- Ensure that the development achieves appropriate acoustic amenity by meeting internal noise criteria.

The key clauses of the Infrastructure SEPP (also in the NSW *Development near Rail Corridors and Busy Roads – Interim Guideline*) that relate to noise and vibration requirements for the project are:

Rail Corridors

Clause 87 Development for any of the following purposes that is on land that is in or immediately adjacent to a rail corridor and the consent authority considers development is likely to be adversely affected by rail noise or vibration:

- Building for residential use
- A place of worship
- A hospital
- An educational establishment or childcare centre.

Road Corridors

Clause 102 Development for any of the following purposes that is on land in or adjacent to a road corridor for a freeway, a tollway, or a transit way or any other road with an annual average daily traffic volume of more than 40,000 vehicles and that the consent authority considers is likely to be adversely affected by road noise or vibration:

- Building for residential use
- A place of worship
- A hospital
- An educational establishment or childcare centre.

4.1.2 Internal Noise Criteria

For Clauses 87 (Rail) and 102 (Road) If the development is for the purpose of a building for residential use, the consent authority must be satisfied that appropriate measures will be taken to ensure that the following L_{Aeq} noise levels are not exceeded:

- In any bedroom in the building: 35 dBA at any time (10pm – 7am)
- Anywhere else in the building (other than a garage, kitchen, bathroom, or hallway): 40 dBA at any time.

As the study requirements refer to natural ventilation being maintained, the following internal criteria for open windows are recommended (taken from the *City of Sydney Development Control Plan* since no specific criteria are included in the *Hornsby Development Control Plan*):

- In any bedroom in the building: 45 dBA at any time (10pm – 7am)
- Anywhere else in the building (other than a garage, kitchen, bathroom, or hallway): 55 dBA at any time.

4.1.3 Ground-borne Noise – Metro North West

Ground-borne noise impacts may be present where buildings are constructed over or adjacent to land over tunnels and the corresponding airborne noise level is not dominant. The NSW *Development near Rail Corridors and Busy Roads – Interim Guideline* specifies a night-time residential criteria of 35 dBA $L_{Amax,slow}$ which is required to be complied with by 95% of train passbys.

4.1.4 Vibration Criteria

There are no specific vibration requirements in the Infrastructure SEPP. Vibration transmission into the buildings would need to be controlled to meet the ground-borne noise criteria. Where ground-borne noise levels are met then vibration would also typically be sufficiently controlled.

4.2 Internal Noise Criteria – Non-residential uses

All internal non-residential areas shall be designed to mitigate external noise intrusion to the recommended internal noise criteria based upon their use in AS 2107:2016 *Acoustics – Recommended design sound levels and reverberation times for building interiors*.

4.3 Operational Noise Criteria

The future non-residential uses of the Precinct may include small scale commercial developments such as retail, restaurants/cafes, community facilities, etc. Industrial noise from mechanical plant at these developments has the potential to impact the surrounding noise sensitive receivers and future residential sections of the Precinct.

The NSW *Noise Policy for Industry* (NpfI) was released in 2017 and sets out the requirements for the assessment and management of operational noise from industry in NSW.

4.3.1 Industrial Noise Trigger Levels

The NpfI defines how to determine 'trigger levels' for noise emissions from industrial developments. Where a development is likely to exceed the trigger levels at existing noise sensitive receivers, feasible and reasonable noise management measures are required to be considered to reduce the impacts.

There are two types of trigger levels – 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 representative 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 study area is considered to be 'suburban' as per the NpfI definitions.

The trigger levels for industrial noise from the Precinct are summarised in **Table 3**. The Project Noise Trigger Levels (PNTL) are the most stringent of the intrusiveness and amenity trigger level for each period and are highlighted below.

Figure 3 shows that monitoring location L01 is adjacent to Castle Hill Road where high existing background noise levels were measured due to existing road traffic noise, this is considered a representative location for areas of the Precinct that would be immediately next to Castle Hill Road.

Location L03 is on Robert Road and set back from Castle Hill Road, where lower background levels were measured due to screening provided by existing buildings. This location is considered representative of the northern areas of the Precinct that are more distant from Castle Hill Road and which would be partially shielded by Cherrybrook Station.

Table 3 Project Noise Trigger Levels

NCA	Receiver Type	Period	Amenity Noise Level L_{Aeq} (dBA)	Measured Noise Level (dBA)		Project Noise Trigger Levels $L_{Aeq(15minute)}$ (dBA)	
				RBL[1]	$L_{Aeq(period)}$	Intrusiveness	Amenity[2,3]
L01	Inala School, Castle Hill Road	Daytime	55	55	71	60	**59**[5]
		Evening	45	51	70	**56**	58[5]
		Night-time	40	36	67	**41**	55[5]
L03	7 Robert Road, Cherrybrook	Daytime	55	37	55	**42**	53
		Evening	45	37 (39 actual)[4]	52	**42**	43
		Night-time	40	31	49	**36**	38

Note 1: RBL = Rating Background Level.

Note 2: The recommended amenity noise levels have been reduced by 5 dB, where appropriate, to give the project amenity noise levels due to other sources of industrial noise likely to be built in the area in the future.

Note 3: The project amenity noise levels have been converted to a 15-minute level by adding 3 dB, as outlined in the NpfI.

Note 4: The evening RBL has been reduced to match the daytime RBL due to the measured evening RBL being higher than the daytime, as outlined in the NpfI.

Note 5: The measured L_{Aeq} noise level was dominated by existing road traffic noise and exceeds the recommended amenity noise level by 10 dB or more, therefore, the 'high traffic project amenity noise level' is the existing $L_{Aeq(traffic)}$ noise level minus 15 dB, as outlined in the NpfI.

5 Noise and Vibration Assessment

5.1 Noise Model

A noise model of the study area has been used to predict the potential impacts to the surrounding receivers. Local terrain, receiver buildings and structures were digitised in the noise model to develop a three-dimensional representation of the Precinct and surrounding areas.

Indicative heights of buildings in the Precinct were estimated from the architectural drawings provided.

5.2 Road Traffic Noise Assessment

The potential road traffic noise levels in the Precinct have been predicted using *Calculation of Road Traffic Noise* (CoRTN) (UK Department of Transport, 1988) algorithms in SoundPLAN software.

5.2.1 Road Traffic Scenarios

The impact assessment has been undertaken by using the following assessment scenarios:

- Base (2016) – an 'existing' or 'validation' scenario to validate the noise model against the existing noise monitoring (see **Section 3**).
- Future (2026) – to assess road traffic noise impacts on the Precinct. Whilst the Infrastructure SEPP does not require an assessment of a future traffic growth scenario, the project traffic flows used in the noise modelling reflect the anticipated design for the year 2026.

5.2.2 Road Traffic Noise Model Inputs

Existing Traffic – Validation

The existing traffic volumes in the study area were taken from Roads and Maritime data measured in 2013 and factored up by a nominal 3% growth per year to approximate 2016, which is when the existing noise monitoring was completed. The data is shown in **Table 4**.

Table 4 Traffic Data – Existing (Combined Directions)

Traffic Counter Location	Time Period	Volume
Castle Hill Road (2013)	AADT[1]	26,558
Castle Hill Road (2016)[2]	AADT	29,021

Note 1: Annual Average Daily Traffic.

Note 2: Volume approximated from the 2013 measured data by applying a 3% growth per year to give 2016 data.

Future Traffic

Traffic volumes in the study area were provided by the project team. The traffic flows used in the modelling are detailed in **Table 5**.

Table 5 Project Traffic Flows (two way)

Road Section	Start Point	2026 Full Development Traffic Data		
		Daytime 15 hour	Night-time 9 hour	Speed (km/h)
Castle Hill Road	West of Highs Road	52,691	7,411	60
	Between Highs Road and Bradfield Parade	31,776	4,497	60
	Between Bradfield Parade and Glenhope Road	30,348	4,289	60
	Between Glenhope Road and Franklin Road	29,346	4,152	60
	Between Franklin Road and Edward Bennett Drive	30,973	4,382	60
	East of Edward Bennett Drive	35,878	5,070	60
Robert Road	North of Caste Hill Road	3,234	448	50
Franklin Road	Between Castle Hill Road and Bradfield Parade	3,131	441	50
	North of Bradfield Parade	4,565	650	50
Bradfield Parade	Between Castle Hill Road and Robert Road	6,247	888	40
	Between Robert Road and Franklin Road	6,738	956	40

Note: Individual HGV percentages have been applied to each road with an average of 3.5% for the daytime and 5.7% for the night-time.

Pavement Surface

The existing roadway pavement surfaces are typically variable in age and condition and are understood to be Dense Graded Asphaltic Concrete (DGA). The future pavement surfaces have been assumed to also be DGA.

5.2.3 Road Traffic Noise Model Validation

The predicted road traffic noise levels for the 2016 existing scenario have been compared to the noise levels measured during the existing noise survey (see **Section 3**) to validate the road traffic noise model.

The measured and predicted noise levels have been compared using single point receiver calculations at noise model locations coinciding with the monitoring locations. The results are shown in **Table 6**.

Table 6 Model Validation – Comparison of Predicted Noise Levels to Measured Noise Levels

ID	Noise Logging Location	Noise Level (dBA)					
		Measured Existing		Predicted Existing		Difference – Predicted Minus Measured	
		Daytime $L_{Aeq(15hour)}$	Night-time $L_{Aeq(9hour)}$	Daytime $L_{Aeq(15hour)}$	Night-time $L_{Aeq(9hour)}$	Daytime $L_{Aeq(15hour)}$	Night-time $L_{Aeq(9hour)}$
L01	35 Mariam Place, Cherrybrook	56	52	57	52	+1	0
L02	Inala School	71	67	71	67	0	0

Comparison of the above shows a good correlation between the predicted and measured data sets within the project area.

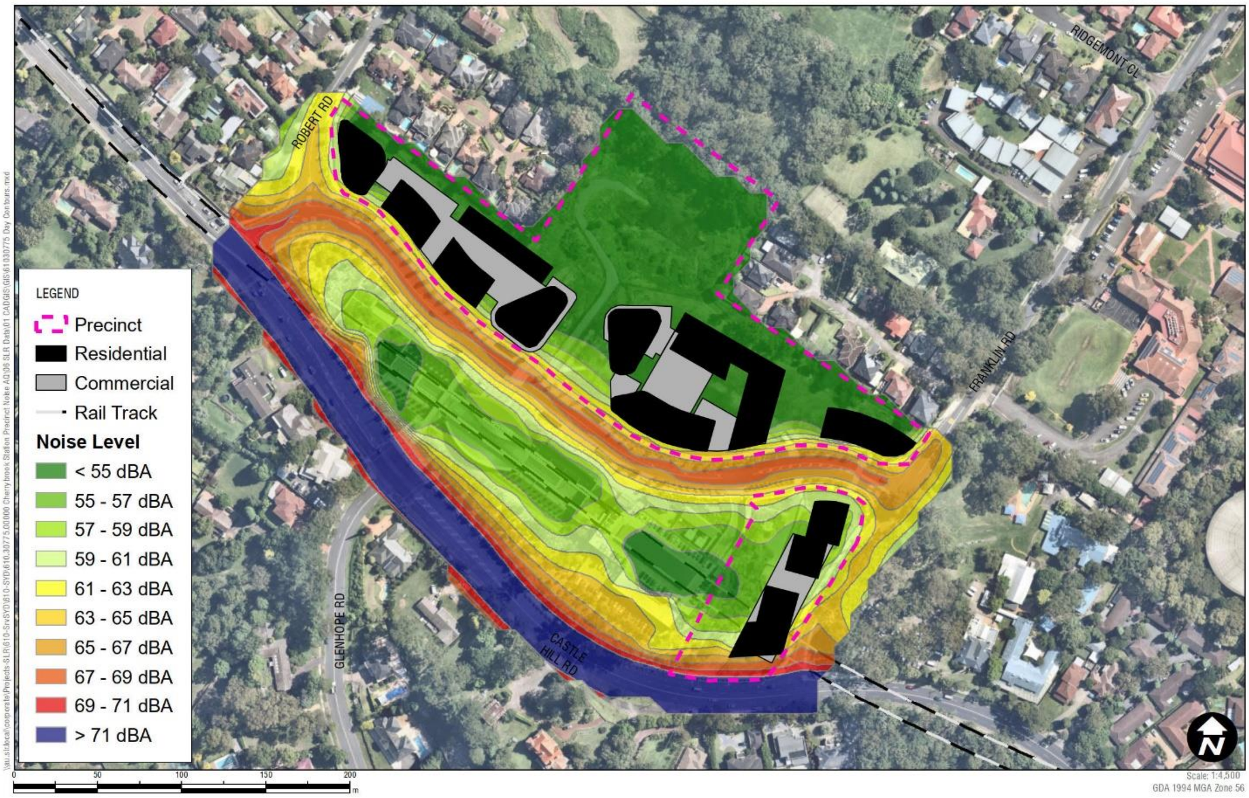
Noise models will commonly predict noise levels within 2 dB of the measured data. On the basis of the comparison of the noise model predictions with the existing noise measurement results, it is concluded that the noise model provides results which enable a representative assessment of the project.

5.2.4 Road Traffic Noise Impacts at the Precinct

Noise levels have been predicted across the Precinct during the daytime and night-time periods in 2026. The results are provided below in **Figure 4** as grid noise maps that represent the predicted existing road traffic noise levels at 1.5 m above ground level and facade noise maps in **Figure 5**.

The daytime noise predictions represent the period from 7 am to 10 pm and the night-time period is 10 pm to 7 am.

Figure 4 Grid Noise Maps – Daytime (top) and Night-time (bottom)



Note: Non-residential uses are also proposed at ground floor of some of the residential buildings shown above.

Figure 5 Facade Noise Maps, Daytime (top) and Night-time (bottom)

To give an indication of the required facade construction, the indicative facade reduction performance for each building is shown in **Table 7**.

Table 7 Range of Noise Impacts by Building

Building[1]	Use	Worst-case Predicted Facade Noise Level (dBA)		Indicative Facade Noise Reduction (dB)[2]
		Daytime $L_{Aeq(15hour)}$	Night-time $L_{Aeq(9hour)}$	
1	Residential	71	66	31
2	Residential	65	60	25
3	Residential	65	60	25
4	Residential	65	61	25
5	Residential	66	62	26
6	Residential	66	61	26
7	Residential	52	47	12
8	Residential	42	37	<10
9	Residential	62	57	22
10	Residential	66	61	26
11	Residential	45	40	<10
12	Residential	66	61	26
13	Residential	66	61	26
14	Residential	66	61	26

Note 1: While the reference scheme includes 12 buildings (described in **Section 1.3**), for the purposes of this noise and vibration assessment the built form has been assessed as 14 separate buildings.

Note 2: In general, daytime noise levels are predicted to be approximately 5 dB above night-time noise levels and hence the required reduction to bedrooms and living spaces is similar.

The above assessment shows:

- The worst-case noise levels in the Precinct are predicted to be in the region of 60 to 70 dBA during the daytime period, with night-time levels typically being around 5 dB lower.
- The highest impacts are seen at Building 1, which is immediately adjacent to Castle Hill Road. Noise levels reduce as the set-back distance from the road increases and where additional shielding is provided by interviewing structures or buildings. Facades of buildings facing Bradfield Parade are also predicted to be impacted, with worst-case noise levels of around 66 dB predicted during the daytime and 62 dB during the night-time.
- Standard window glazing typically attenuates external noise levels by around 20 dB with windows closed and 10 dB with windows open (allowing for natural ventilation). Where attenuation of more than 20 dB is required (see **Table 7**), then upgraded glazing would likely be required along with alternative means of ventilation to allow residents to keep windows closed. It is noted that one of the study requirements is for natural ventilation to be provided to the future buildings (see **Table 1**) and this is discussed in more detailed in **Section 5.5.2**.
- The predicted noise levels indicate that upgraded glazing would likely be required for most facades of residential buildings which have line of sight to Castle Hill Road or Bradfield Parade.

5.3 Rail Airborne Noise Assessment

Cherrybrook Station is an open station with a depth of around 7 m below ground level. A canopy covers part of the platform for shade.

The nearest Precinct buildings are around 50 m to the north of Cherrybrook Station and would overlook it. The station is located adjacent to Castle Hill Road, and in between Robert Road and Franklin Road.

The noise sources at Cherrybrook Station include:

- Rail noise from trains entering and leaving the station
- PA announcements on platforms.

5.3.1 Discussion of Impacts

Airborne noise from trains at the station would generally be minimal (compared to road traffic noise) as train speeds would be low in the open-air section as trains approach and depart from the station.

PA announcements would occur on a relatively frequent basis, however, the existing and future noise levels at the site are controlled by relatively high road traffic noise impacts, particularly during peak periods, which is expected to generally be higher than PA noise from the station. PA announcements may be more noticeable during periods when traffic volumes are lower, however, as the future buildings would be designed to control peak road traffic noise impacts, this is expected to also be sufficient to control PA noise.

Based on the above, the potential airborne noise impacts at the Precinct from the operation of Cherrybrook Station and Metro North West are expected to be negligible and no specific mitigation is required.

5.4 Rail Ground-borne Noise Assessment

Train noise in buildings adjacent to rail tunnels is predominantly caused by the transmission of ground-borne vibration rather than the direct transmission of noise through the air. After entering a building, this vibration may cause the walls and floors to vibrate faintly and hence to radiate audible noise, which is commonly termed ground-borne or regenerated noise. This type of noise can be experienced in buildings adjacent to many urban underground rail systems.

The alignment of the Metro North West tunnels in relation to the Precinct layout is shown in **Figure 6**. Building 1, in the south-east corner of the site, is located directly above the Metro North West alignment.

The potential ground-borne noise levels at buildings in the Precinct have been predicted using an in-house developed model which includes a number of assumptions regarding the likely future construction of the buildings at the site.

Ground-borne Noise Predictions

The predicted ground-borne noise levels are shown in **Table 8** and **Figure 6**.

Table 8 Summary of Predicted Ground-borne Noise Levels

Building	Use	Predicted Ground-borne Noise Level (dBA) $L_{Amax(slow)95\%}$	Compliance
Criteria		***35***	
1	Residential	35-40	Potentially exceeds
2	Residential	30-35	Marginal compliance
3 to 14	Residential	<25	Yes

Figure 6 Predicted Ground-borne Noise Levels

The above shows:

- The ground-borne noise levels at most buildings in the Precinct are predicted to comply with the criteria of 35 dBA for bedrooms (night-time) and 40 dBA for other habitable rooms in residential receivers. Building 1 may be subject to a marginal exceedance of the night-time 35 dBA criterion, however, it is noted that the assessment is conservative as assumes limited coupling loss between the ground.

The likelihood of potential ground-borne noise impacts in the Precinct and requirements for any vibration isolation of individual buildings should be assessed further during detailed design when more information is available regarding the specific details of the site.

5.5 Recommendations for Impacts

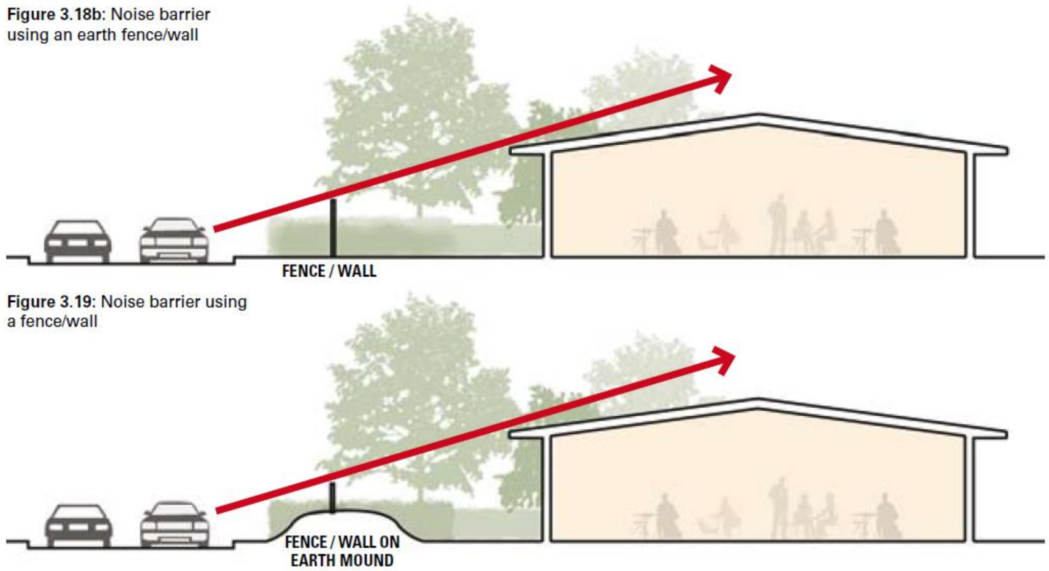
Sensitive receivers in the Precinct which have line of sight to busy roads will likely be affected by noise impacts and noise mitigation measures would need to be incorporated into the design of the site.

The preferred mitigation strategy would be determined at a later stage in the project and would likely use a combination of the measures discussed below.

5.5.1 Noise Barriers

Noise barriers can be an effective way to reduce road noise impacts. Example barriers are shown in **Figure 7**.

Figure 7 Noise Barrier



Note: Taken from DP&I Development near Rail Corridors and Busy Roads – Interim Guideline.

While noise barriers can provide significant noise benefit they can also introduce a number of negative aspects, including access to property, aesthetic impacts, daylight access, overshadowing, drainage, graffiti, restriction of line-of-sight, maintenance access and safety concerns.

Noise barriers are, however, unlikely to be considered a feasible approach for mitigating the impacts for the following reasons:

- Noise barriers are most commonly used next to major motorways and are less common on arterial roads such as the Castle Hill Road or on roads where access is required to be maintained.
- Noise barriers are generally only effective for ground and first floors of adjacent receivers, and typically provide no benefit to upper floors of multi-storey apartment blocks.

5.5.2 Increased Facade Specifications and Natural Ventilation

The assessment in **Section 5.2** concluded that facades of buildings facing Castle Hill Road and Bradfield Parade are likely to require increased glazing to mitigate high external noise levels and to provide a suitable internal noise environment.

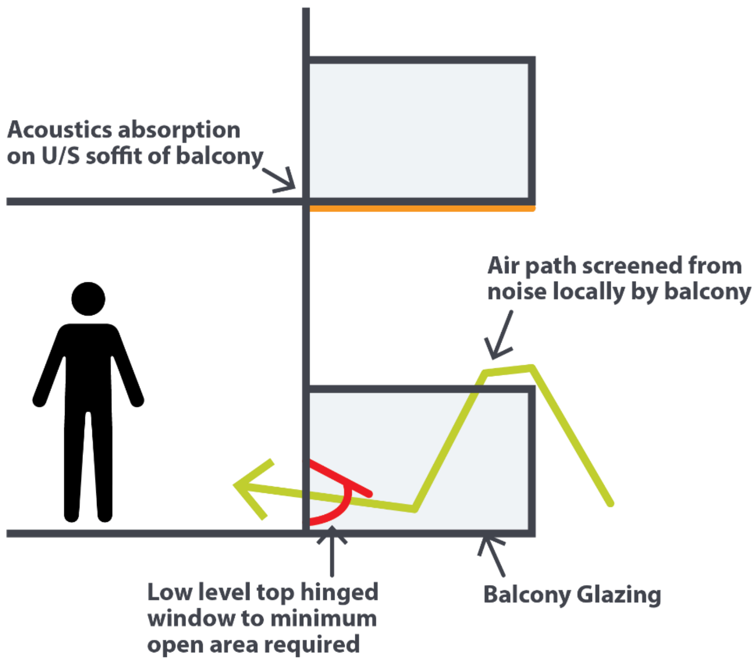
It is expected that 12 mm glazing may be required on facades with the highest impacts and 10.38 mm on less exposed apartments. The requirements should be verified during detailed design when details of the proposed buildings, their uses, internal layout and room dimensions are known. It is noted that increased glazing specifications are relatively cheap to include in the design of buildings but can be prohibitively expensive to retrofit.

Natural Ventilation

One of the study requirements is for natural ventilation to be provided to the future buildings. While this would be relatively straightforward to provide in cases where ventilation can be taken from a non-noise impacted facade, such as from the rear of buildings, the provision of natural ventilation to habitable spaces which face Castle Hill Road would be more difficult due to high external noise levels.

Engineering solutions can be designed which use localised balcony screening, low-level openable windows and acoustic absorption on balcony surfaces to control noise ingress. A conceptual design of this system is shown in **Figure 8**.

Figure 8 Concept of Attenuated Balcony Openings (section view)



This system is expected to achieve a noise reduction of around 20 dB, which may be sufficient to attenuate external noise levels to meet the open window internal noise criteria discussed in **Section 4.1.2** at most locations in the Precinct. One exception to this is likely to be Building 1 in the south-east, which is immediately adjacent to Castle Hill Road and exposed to high traffic noise levels. The noise reduction at the building may not be sufficient and may require windows to be kept closed and ventilation provided by mechanical means.

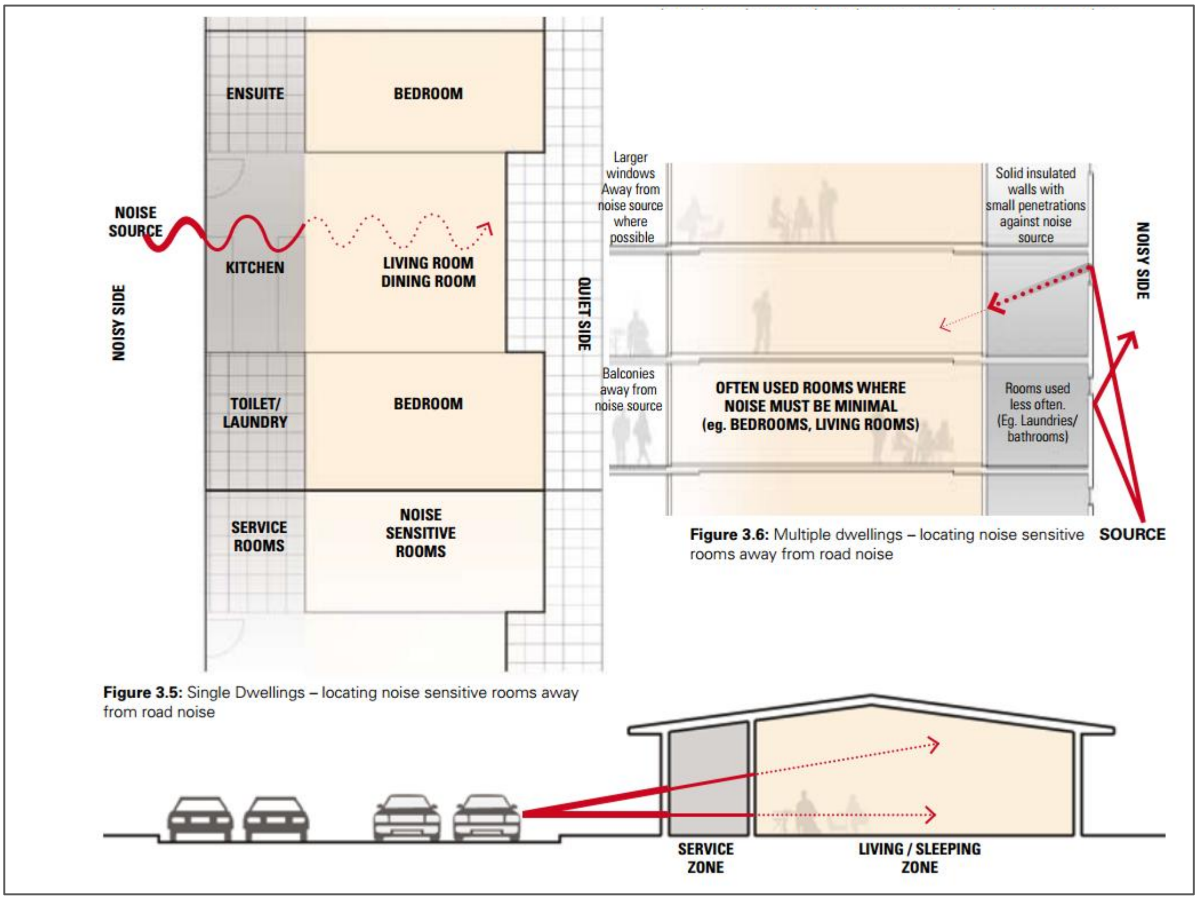
The requirements for facade design and natural ventilation should be reviewed as the project progresses. Where natural ventilation is deemed as being required, the design solution will require careful consideration of the high road traffic noise levels in the area.

5.5.3 Internal Layout of Buildings

Where residential buildings are located close to sources of road noise, the layout of the buildings can be optimised to minimise road traffic noise intrusion into sensitive areas. Buildings can be constructed so that noise insensitive areas such as kitchens, storage areas and laundries are located closer to the noise source, with habitable spaces being positioned away from the most noise affected facades. Noise levels in habitable spaces protected by less noise sensitive uses would be expected to comply with the appropriate internal noise criteria in most cases.

An example of how residential buildings can be designed to shield sensitive sleeping and living areas is shown in **Figure 9**.

Figure 9 Examples of Design Orientation and Room Layout



Note: Taken from DP&I *Development near Rail Corridors and Busy Roads – Interim Guideline*.

5.5.4 Operational (Industrial) Noise Recommendations

Noise emissions from mechanical plant at future non-residential uses in the Precinct would be required to be assessed against the noise goals in **Table 3**, noting that the criteria relate to the total noise from the cumulative impact of all industrial sources in the area, including existing sources of industrial noise at Cherrybrook Station.

At this stage of the development the non-residential uses of the Precinct are unknown but would likely consist of small scale retail, restaurants/cafes and community facilities. Noise impacts may be apparent at receivers situated nearby where these facilities have mechanical plant.

It is recommended that a detailed acoustic assessment of the potential industrial noise impacts is completed once the various non-residential uses are finalised. The following strategies are recommended where exceedances are predicted:

- Spatial separation between noisy activities and noise sensitive areas through locating less noise sensitive uses in high noise areas.
- Taking advantage of any site features that can be used to screen noise impacts when planning land use in an area.
- Using intervening structures such as less noise sensitive multi-storey buildings to act as barriers. Buildings used as barriers should incorporate noise mitigation principles into their building design to ensure appropriate internal noise conditions.
- Locating mechanical plant inside plant rooms or in enclosures with appropriate acoustic treatment.

Noise impacts from industrial/commercial noise sources within the Precinct would be assessed individually in the DA stage of the project.

6 Conclusion

SLR Consulting Australia Pty Ltd (SLR) was engaged to perform a noise assessment to support the precinct planning process for the redevelopment of Cherrybrook Precinct.

The impact of the future road traffic noise on the development varies across the site and various building facades. The most exposed facades which face Castle Hill Road or Bradfield Parade are predicted to be subject to relatively high road traffic noise levels and mitigation strategies have been recommended, including upgrading facade elements and designing building layouts to place less noise sensitive usages near to source of road traffic noise. The required noise mitigation for each building would be further assessed during the next stages of the project.

The potential impacts from the operation of Metro North West have been assessed. Compliance with the ground-borne noise criteria is predicted for most of the proposed buildings, however, a potential marginal exceedance has been identified for one building which is located immediately above the alignment in the south-eastern corner of the site. This exceedance would require further investigation during detailed design and may require building isolation to reduce train vibration transmission through the structure.

APPENDIX A

Acoustic Terminology

1. Sound Level or Noise Level

The terms ‘sound’ and ‘noise’ are almost interchangeable, except that ‘noise’ often refers to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure. The human ear responds to changes in sound pressure over a very wide range with the loudest sound pressure to which the human ear can respond being 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 LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2 x 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. 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

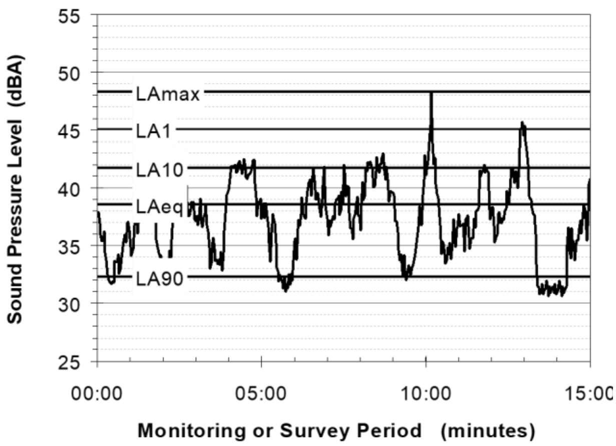
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure is similar to the effect of 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 LAN, where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time, LA10 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:

LA1 The noise level exceeded for 1% of the 15 minute interval.

LA10 The noise level exceeded for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

LA90 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.

LAeq 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.

5. Frequency Analysis

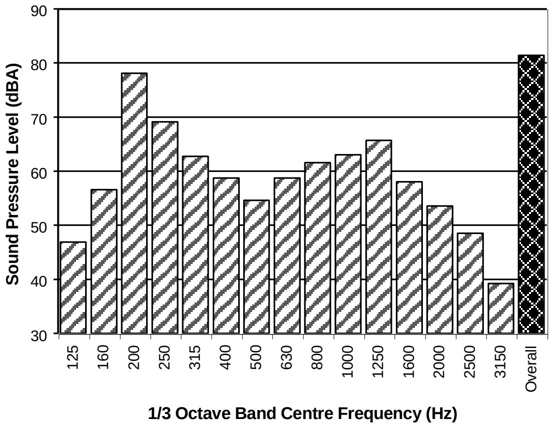
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

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 (three 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.



6. Annoying Noise (Special Audible Characteristics)

A louder noise will generally be more annoying to nearby receivers than a quieter one. However, noise is often also found to be more annoying and result in larger impacts where the following characteristics are apparent:

- **Tonality** - tonal noise contains one or more prominent tones (ie differences in distinct frequency components between adjoining octave or 1/3 octave bands), and is normally regarded as more annoying than 'broad band' noise.
- **Impulsiveness** - an impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.
- **Intermittency** - intermittent noise varies in level with the change in level being clearly audible. An example would include mechanical plant cycling on and off.
- **Low Frequency Noise** - low frequency noise contains significant energy in the lower frequency bands, which are typically taken to be in the 10 to 160 Hz region.

7. 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 (ie vertical, longitudinal 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/Vo), where Vo is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used.

8. Human Perception of Vibration

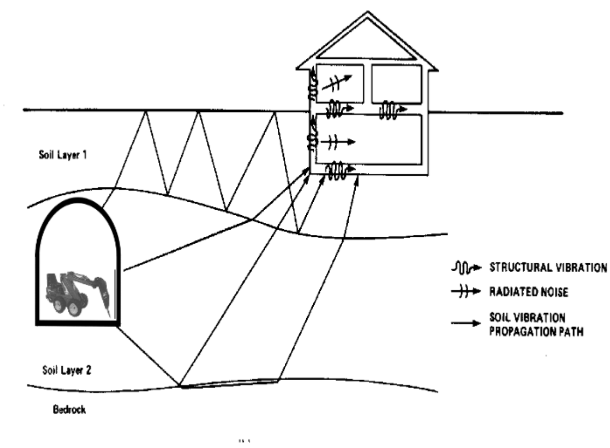
People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience 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.

9. 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

Unattended Noise Monitoring Data

Noise Monitoring Location	L.01
Noise Monitoring Address	**Inala School, Cherrybrook**

Logger Device Type: Svantek 957, Logger Serial No: 20674

Sound Level Meter Device Type: Brüel and Kjær 2260, Sound Level Meter Serial No: 2414605

Ambient noise logger deployed beside the front fence of the Inala School adjacent to Castle Hill Road, Cherrybrook.

Attended noise measurements indicate that the ambient noise environment at this location is dominated by road traffic noise from Castle Hill Road as well as other distant roads.

Recorded Noise Levels: (LAmax):

04/05/2016: Light-vehicle traffic Castle Hill Road: 50-76 dBA,

Heavy-vehicle traffic Castle Hill Road: 74-83 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – NPfI Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	LAeq	L10	L1
Daytime	55	71	75	79
Evening	51	70	73	76
Night-time	36	67	68	75

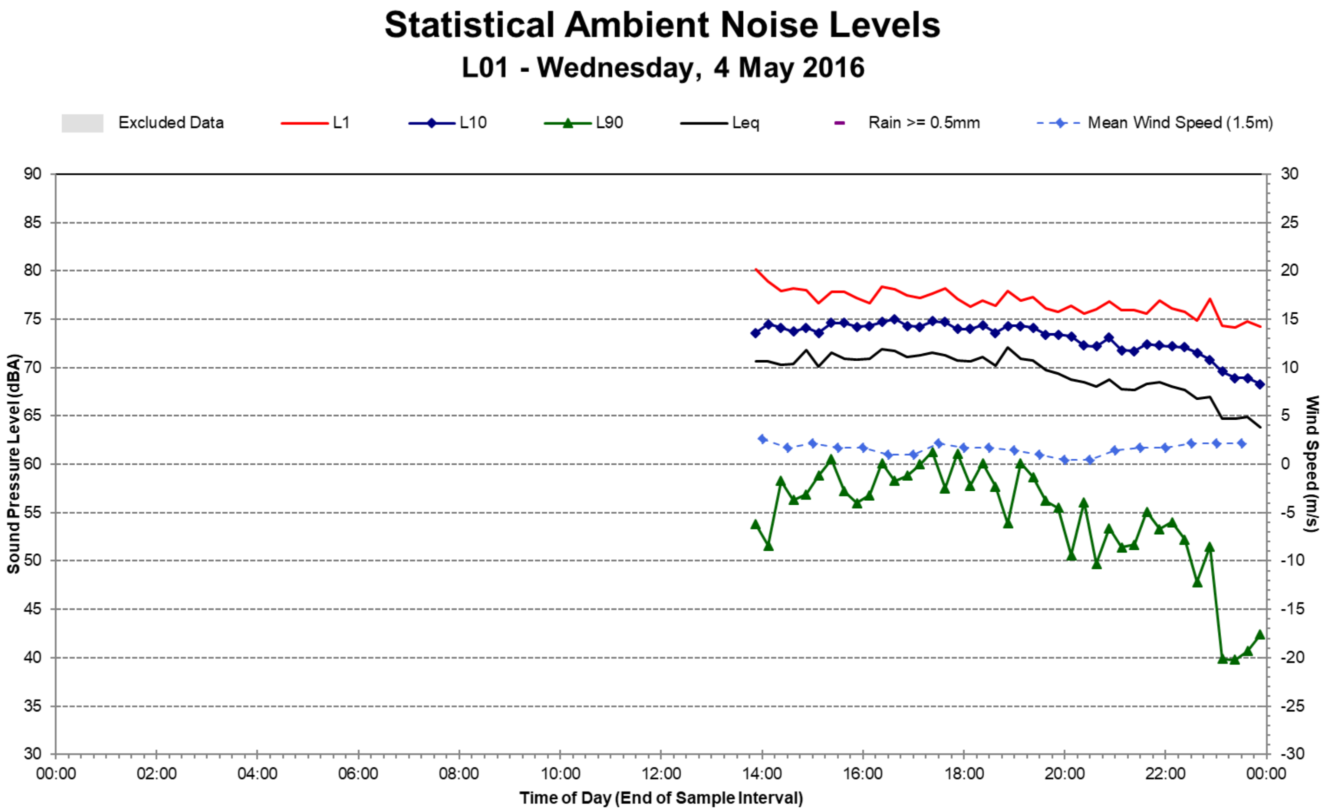
Ambient Noise Logging Results – RNP Defined Time Periods

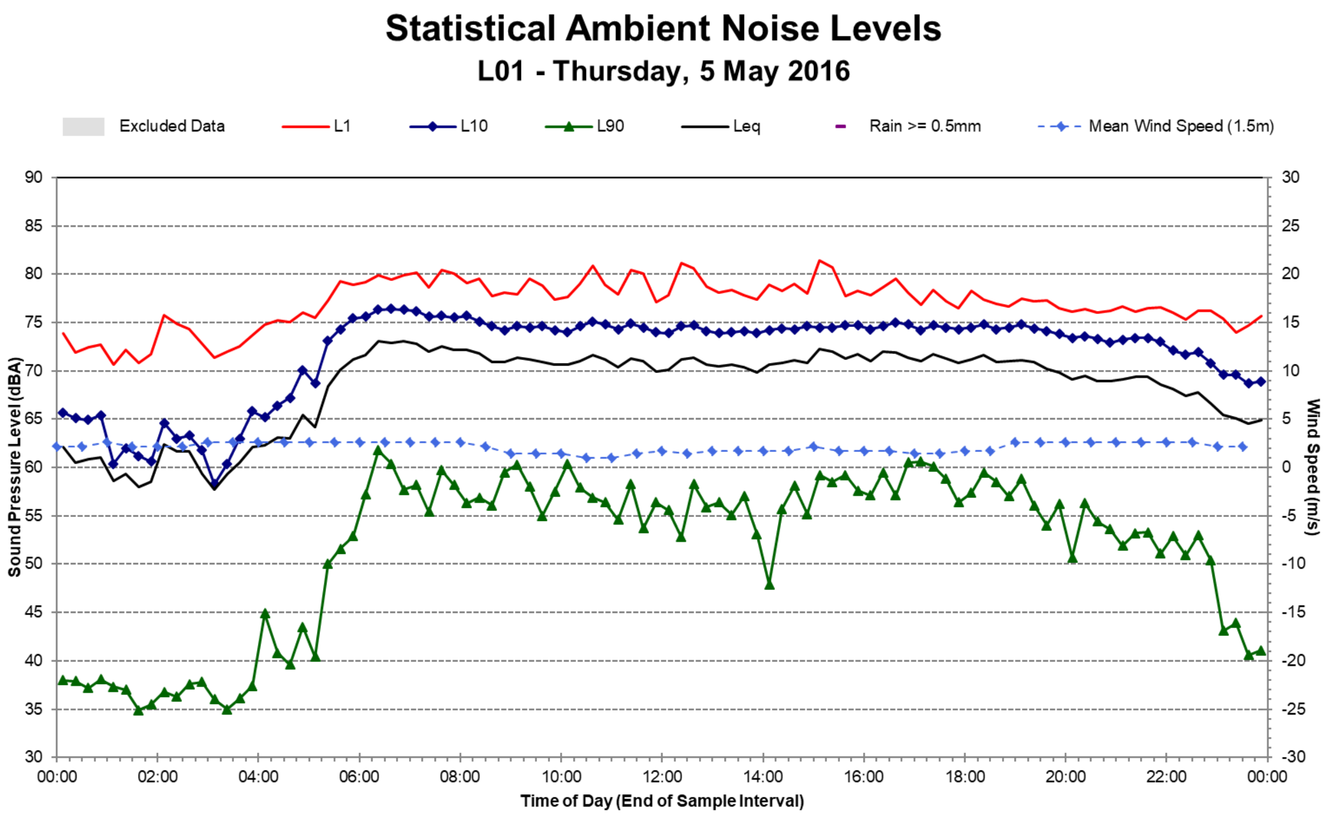
Monitoring Period	Noise Level (dBA)	
	LAeq(period)	LAeq(1hour)
Daytime (7am-10pm)	71	72
Night-time (10pm-7am)	67	73

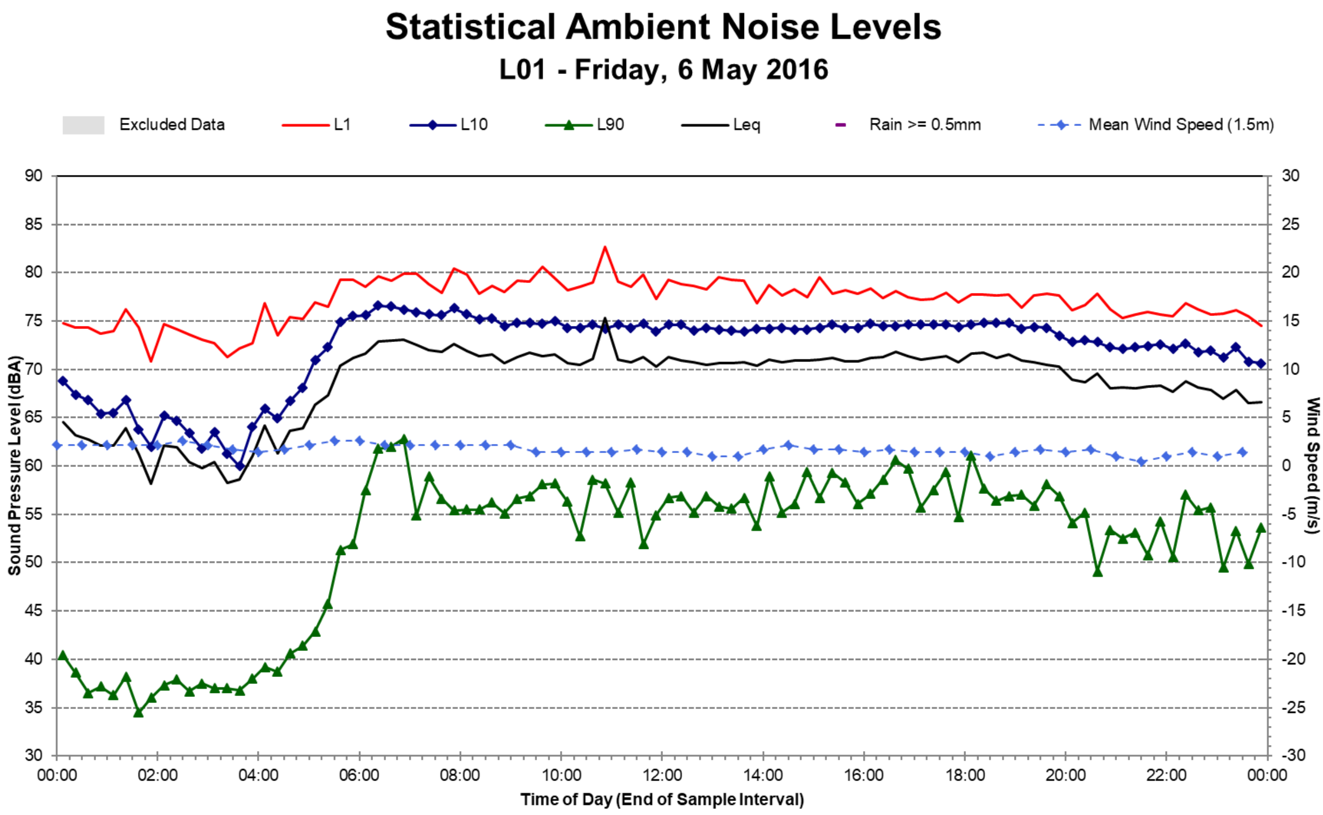
Attended Noise Measurement Results

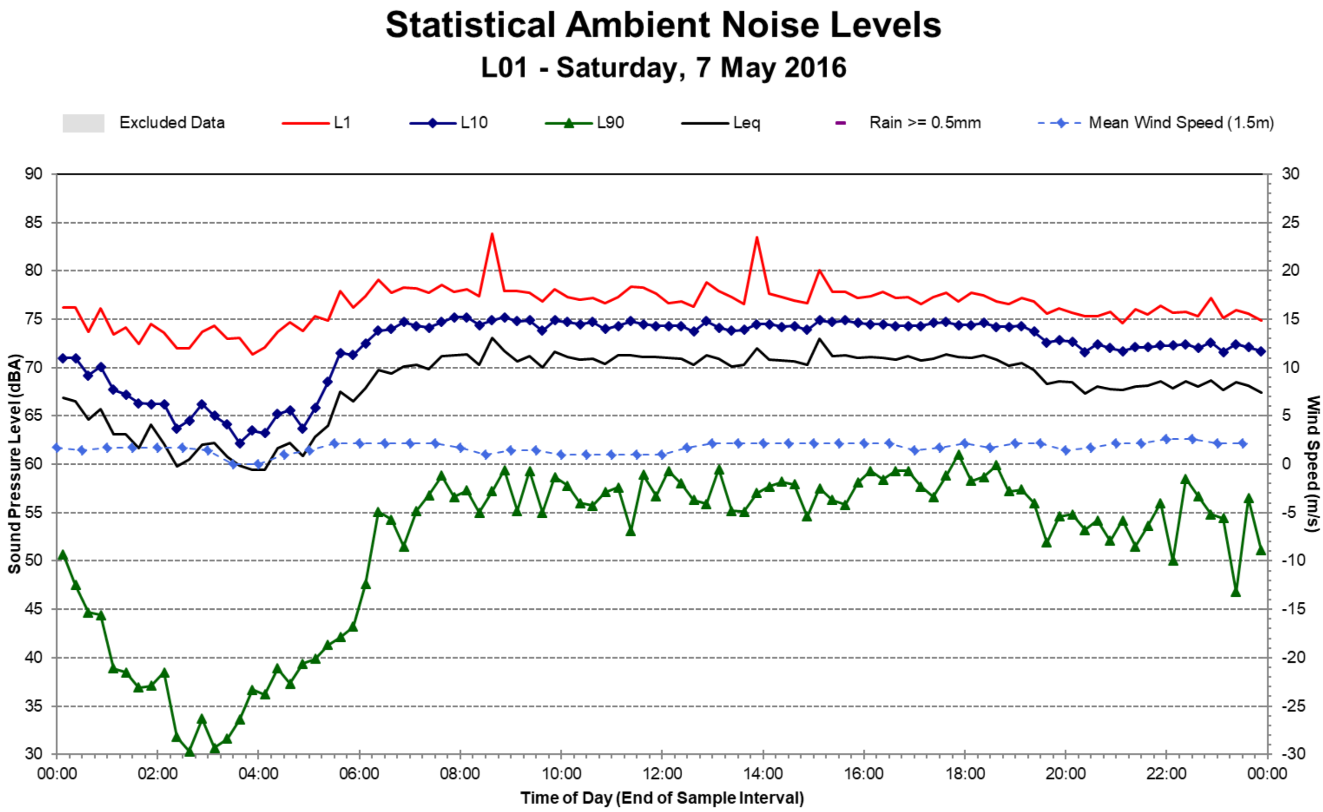
Date	Start Time	Measured Noise Level (dBA)		
		LA90	LAeq	LAmax
04/05/2016	13:47	50	71	83

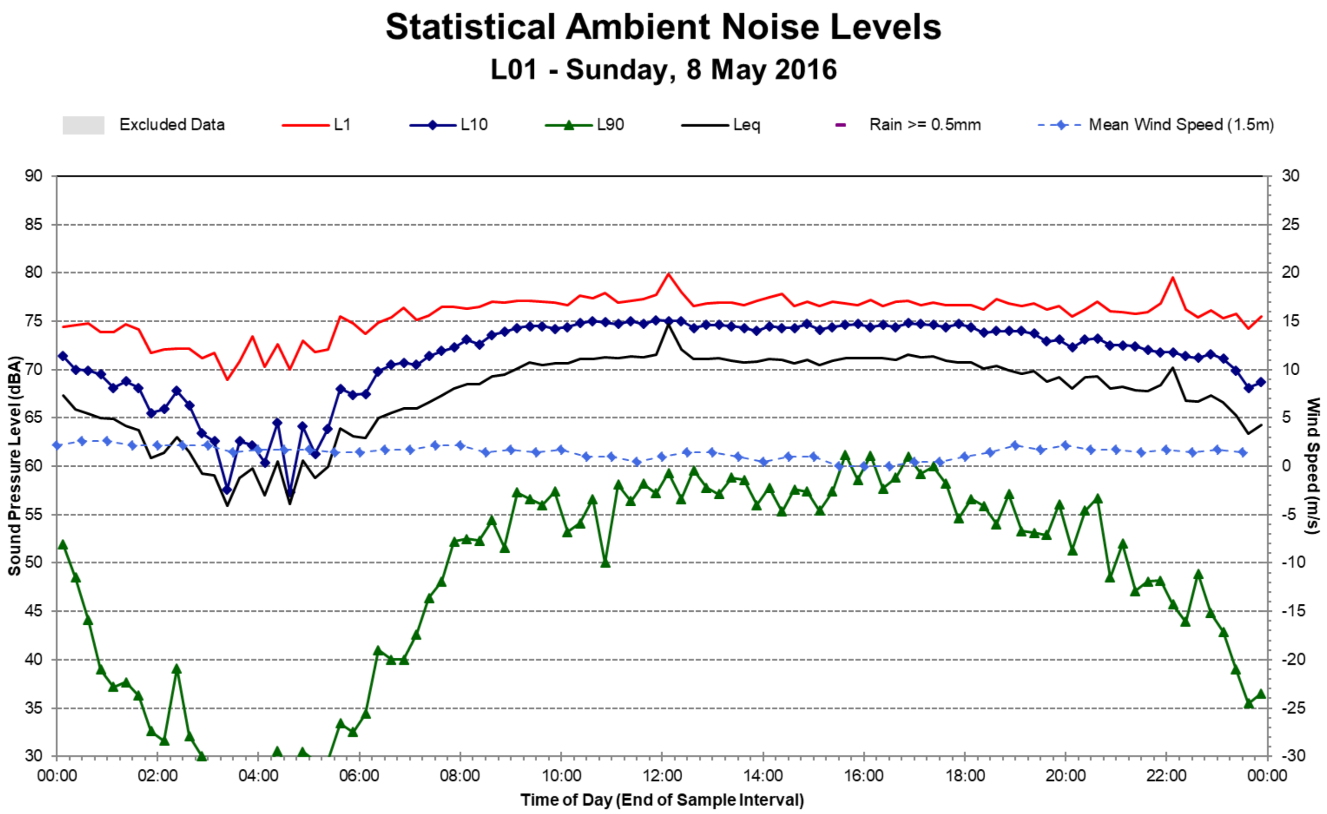
Photo of Noise Monitoring Location

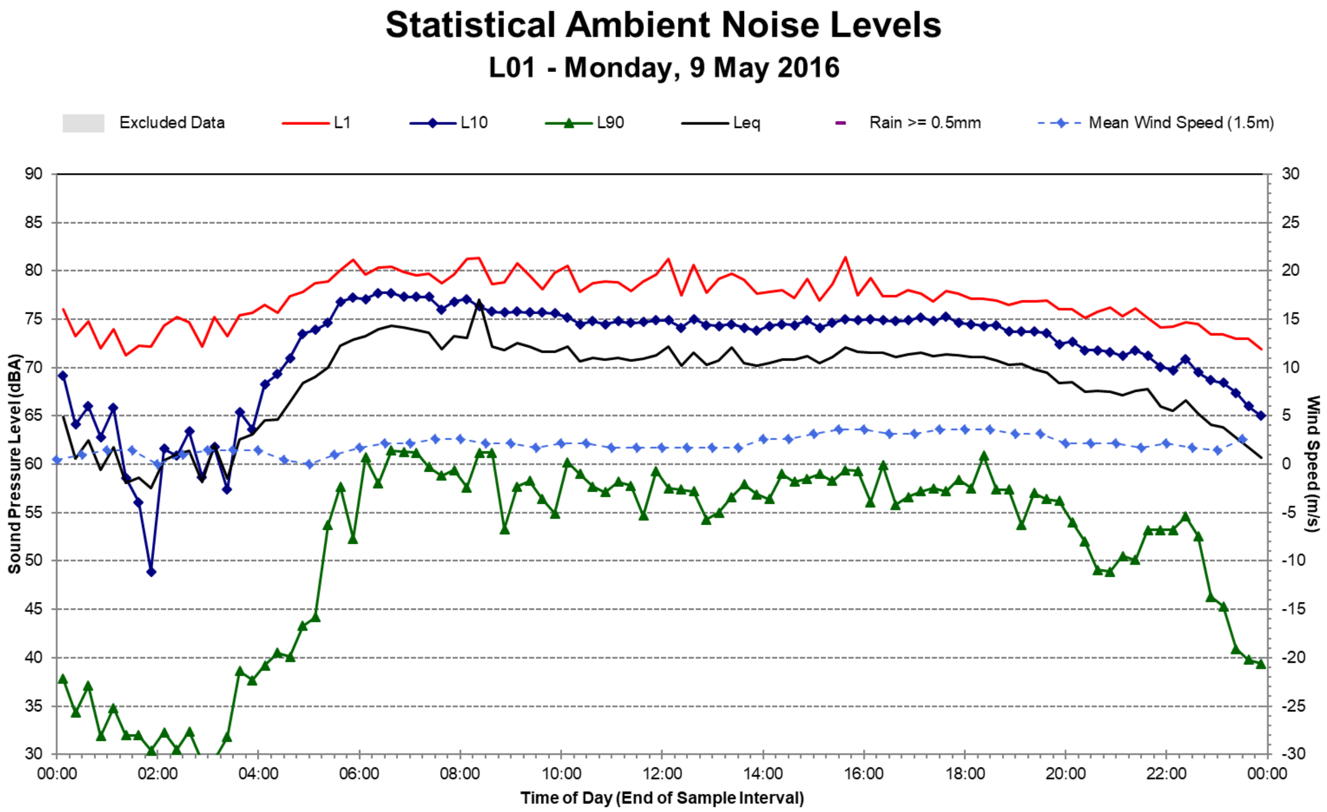

Statistical Ambient Noise Levels
L01 - Wednesday, 4 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
90
85
80
75
70
65
60
55
50
45
40
35
30
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00

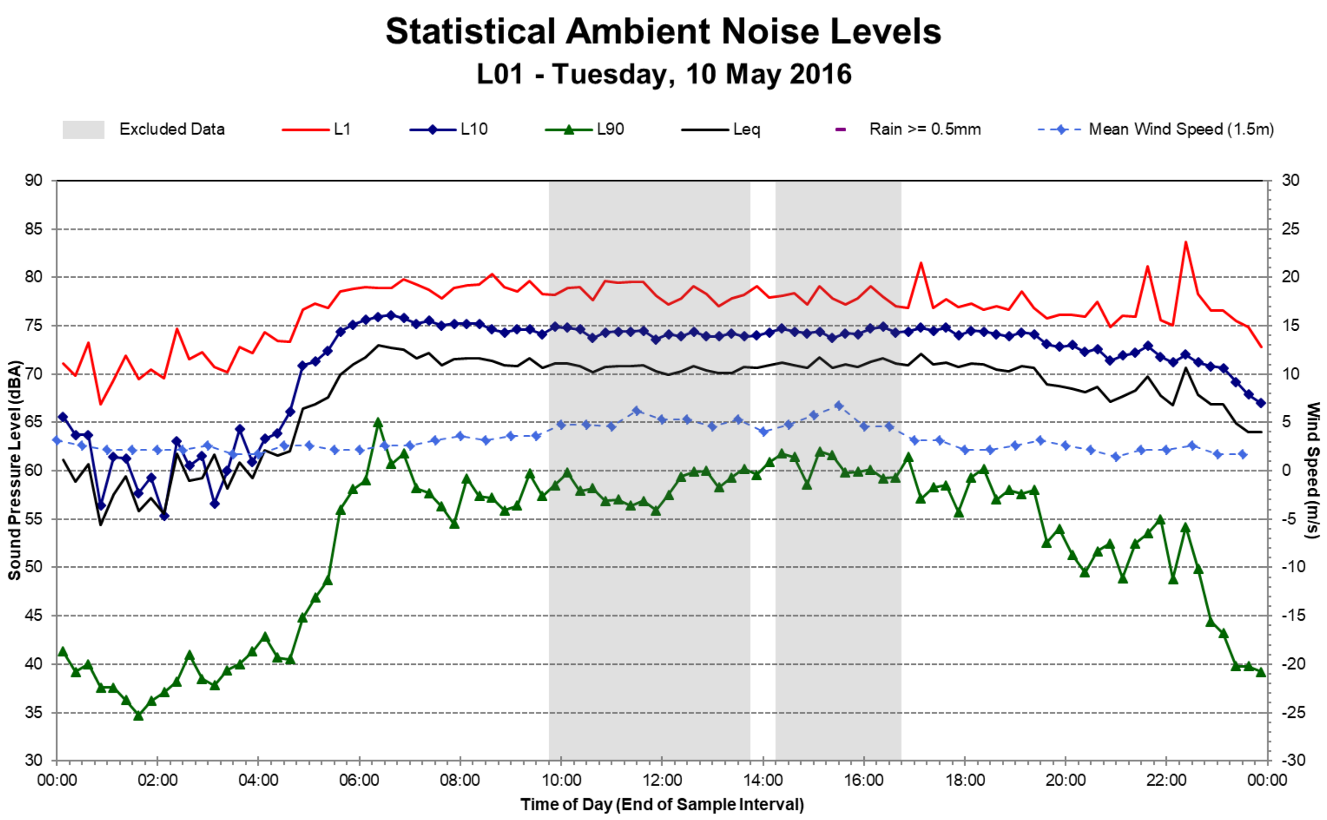

Statistical Ambient Noise Levels
L01 - Thursday, 5 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
90
85
80
75
70
65
60
55
50
45
40
35
30
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00


Statistical Ambient Noise Levels
L01 - Friday, 6 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

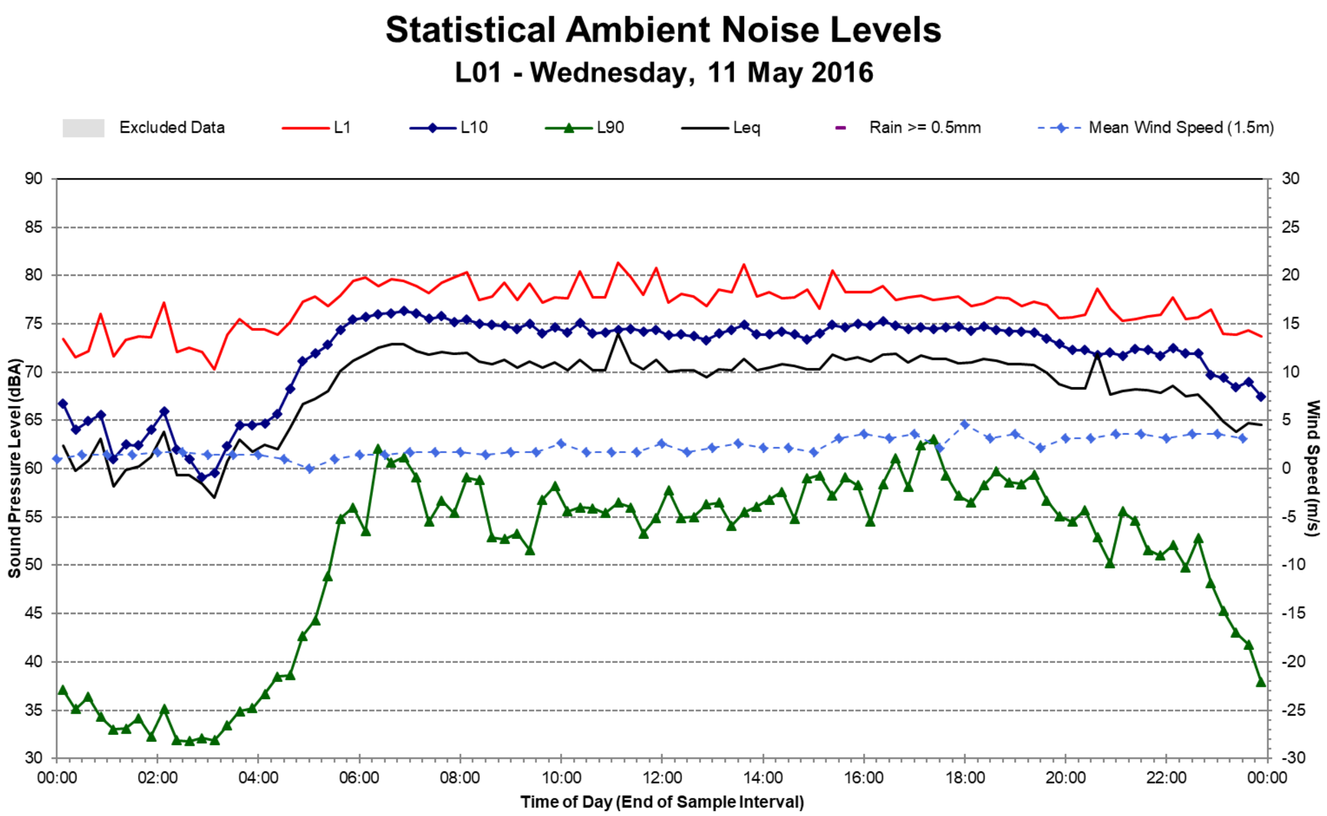

Statistical Ambient Noise Levels
L01 - Saturday, 7 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
L01 - Sunday, 8 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00

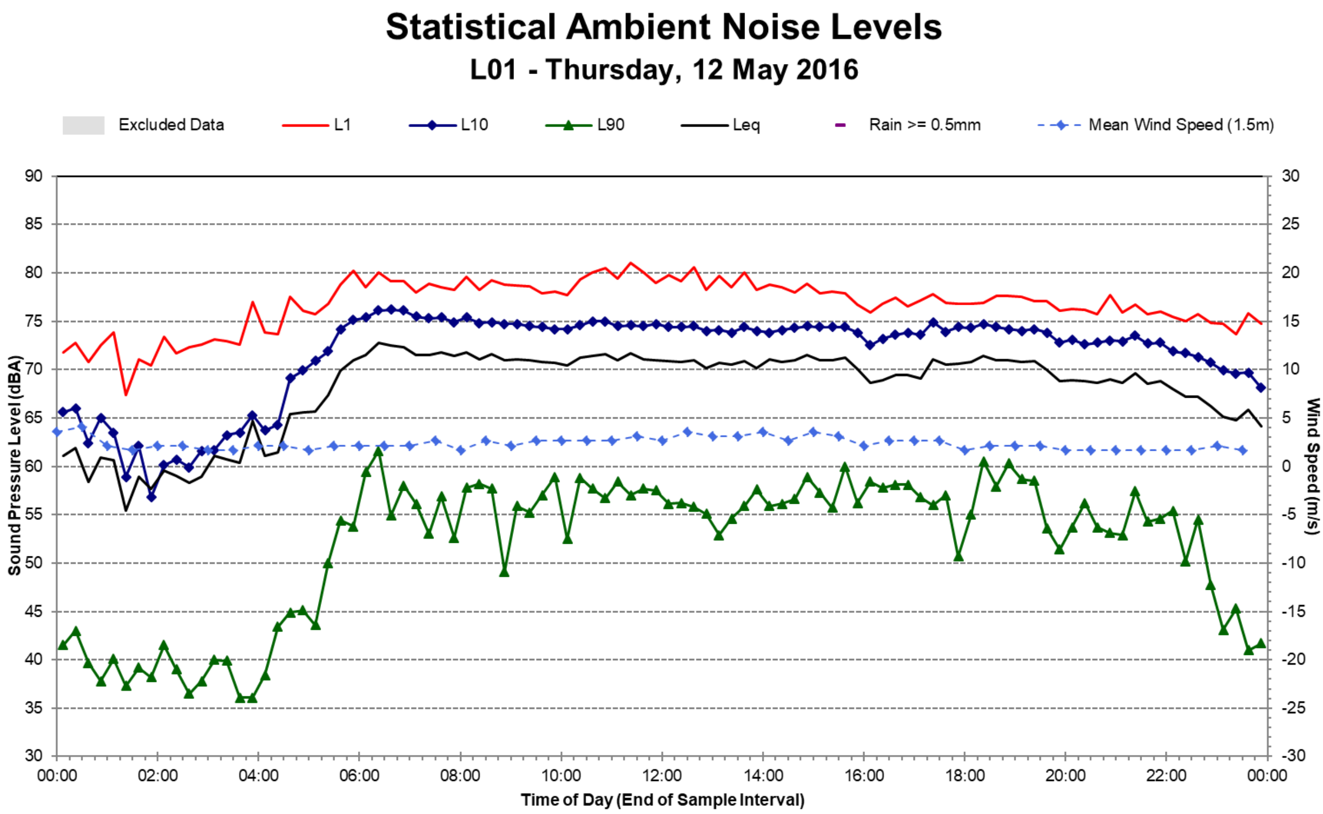

Statistical Ambient Noise Levels
L01 - Monday, 9 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00



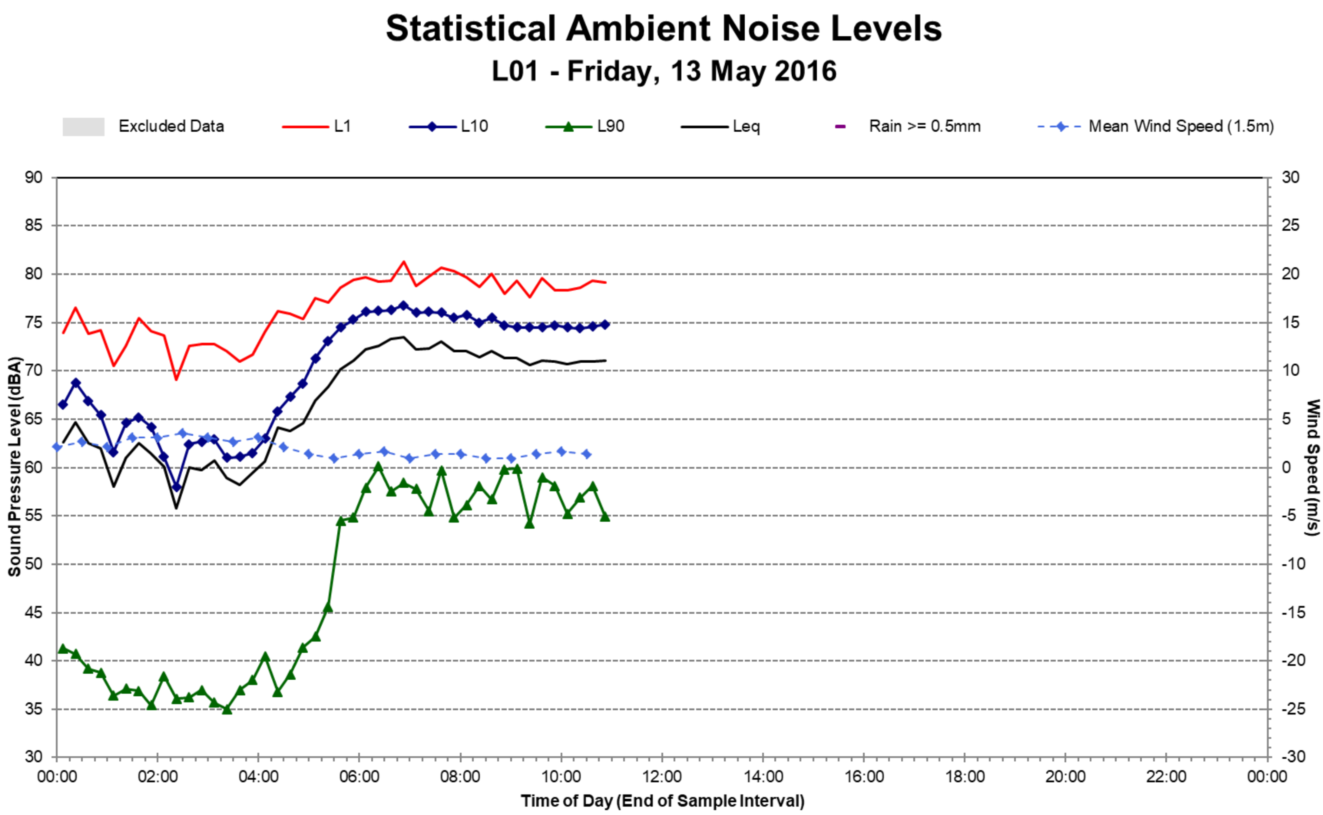
Statistical Ambient Noise Levels
L01 - Tuesday, 10 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



Statistical Ambient Noise Levels
L01 - Wednesday, 11 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



Statistical Ambient Noise Levels
L01 - Thursday, 12 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



Statistical Ambient Noise Levels
L01 - Friday, 13 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

Noise Monitoring Location	L.02
Noise Monitoring Address	**25 Glenhope Road, Cherrybrook**

Logger Device Type: Svantek 957, Logger Serial No: 20665

Sound Level Meter Device Type: Brüel and Kjær 2260, Sound Level Meter Serial No: 2414605

Ambient noise logger deployed in the front garden of residential address 25 Glenhope Road, Cherrybrook.

Attended noise measurements indicate that the ambient noise environment at this location is dominated by road traffic noise from Glenhope Road as well as other distant roads. Aircraft passby noise also heard at this location.

Recorded Noise Levels: (LAmax):

04/05/2016: Light-vehicle traffic Glenhope Road: 45-75 dBA, Aircraft: 55-64 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – NPfI Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	LAeq	L10	L1
Daytime	36	58	62	70
Evening	37	56	57	69
Night-time	30	51	41	59

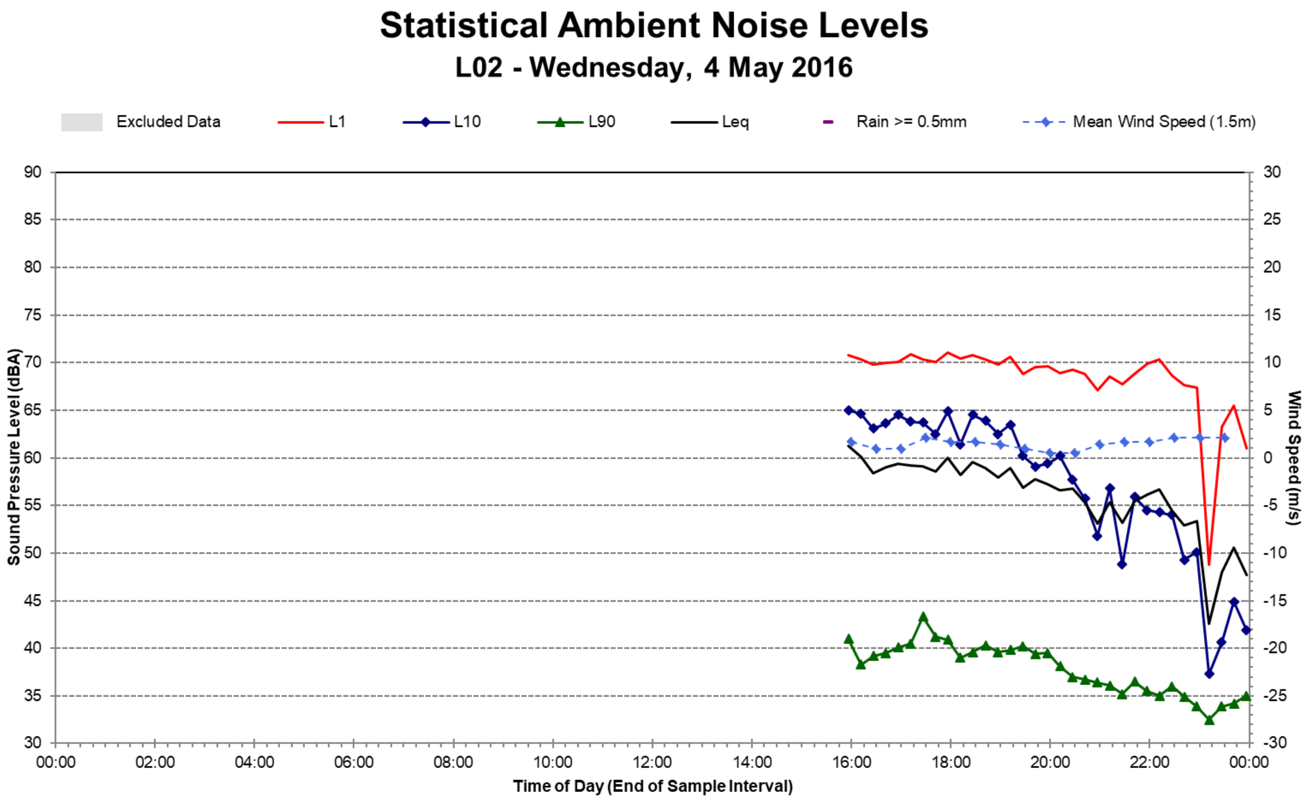
Ambient Noise Logging Results – RNP Defined Time Periods

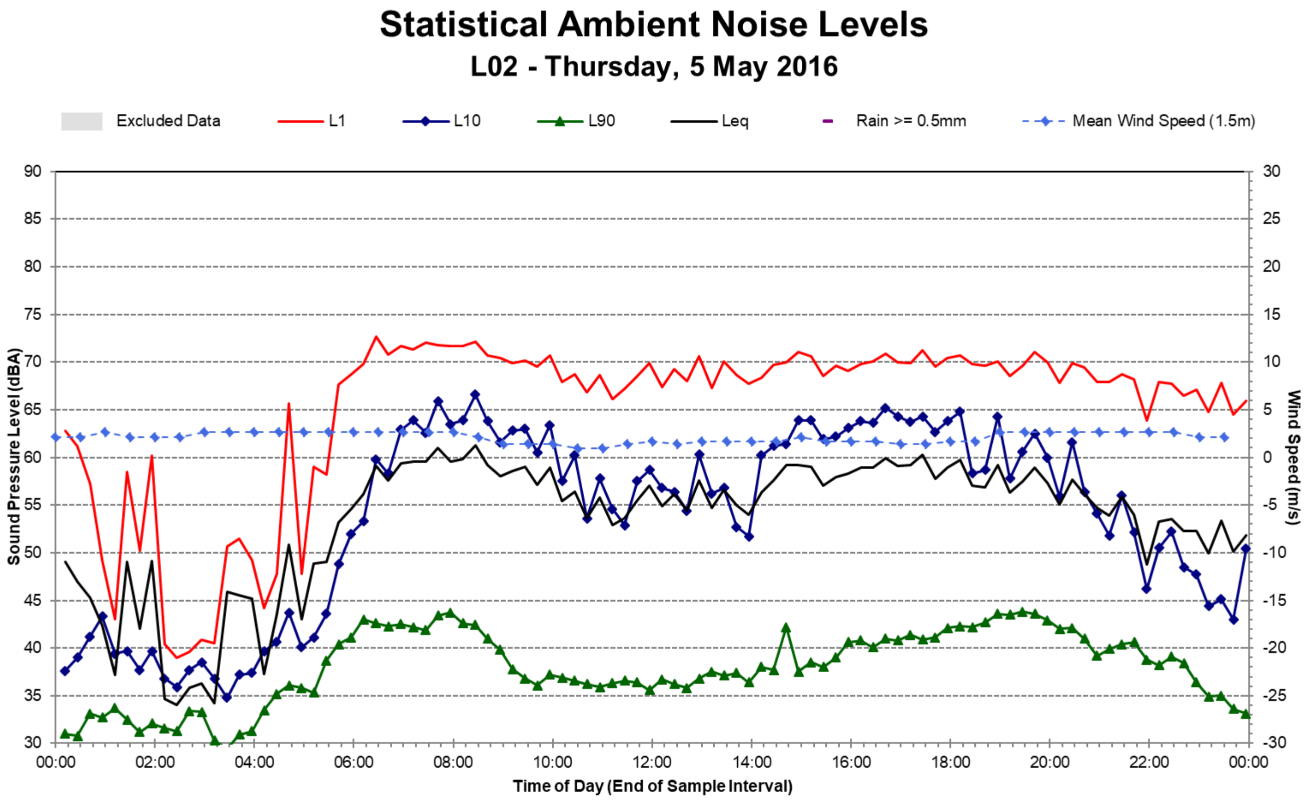
Monitoring Period	Noise Level (dBA)	
	LAeq(period)	LAeq(1hour)
Daytime (7am-10pm)	58	60
Night-time (10pm-7am)	51	59

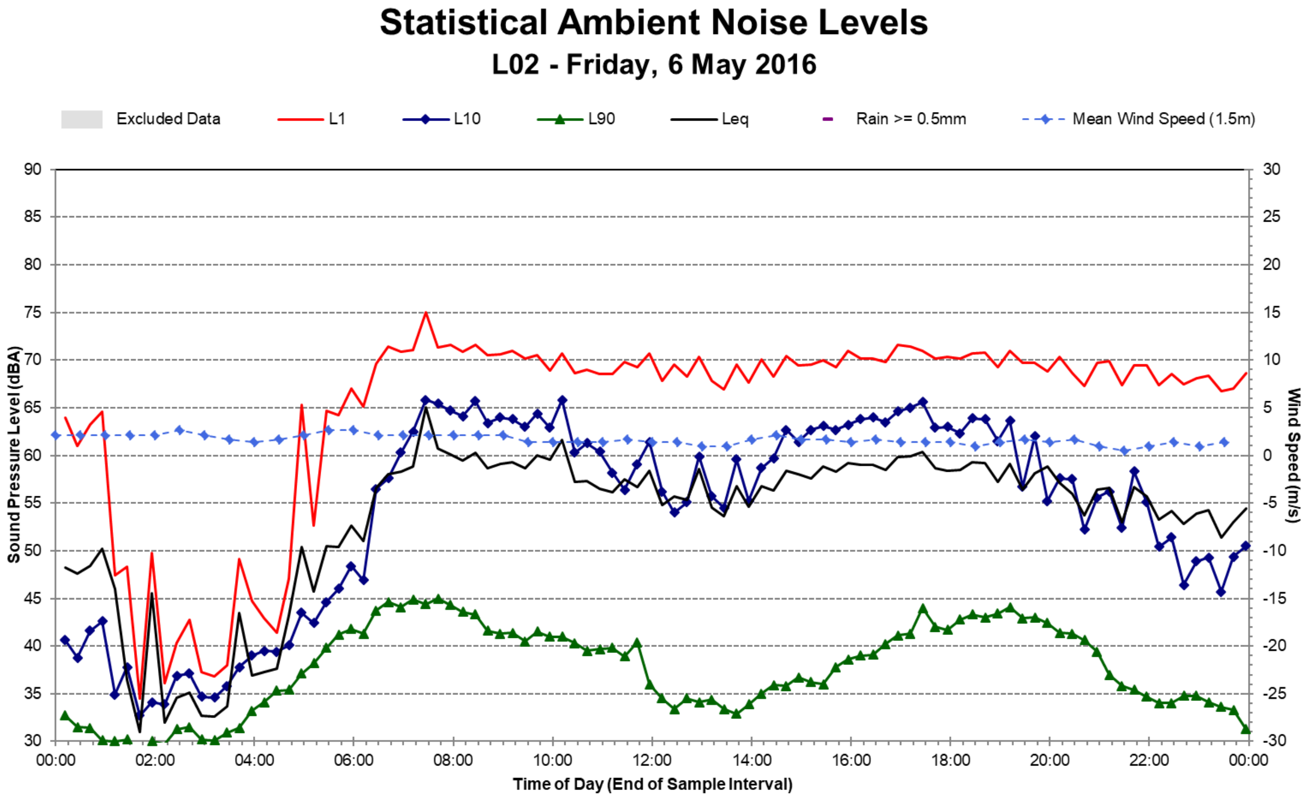
Attended Noise Measurement Results

Date	Start Time	Measured Noise Level (dBA)		
		LA90	LAeq	LAmax
04/05/2016	15:51	40	60	75

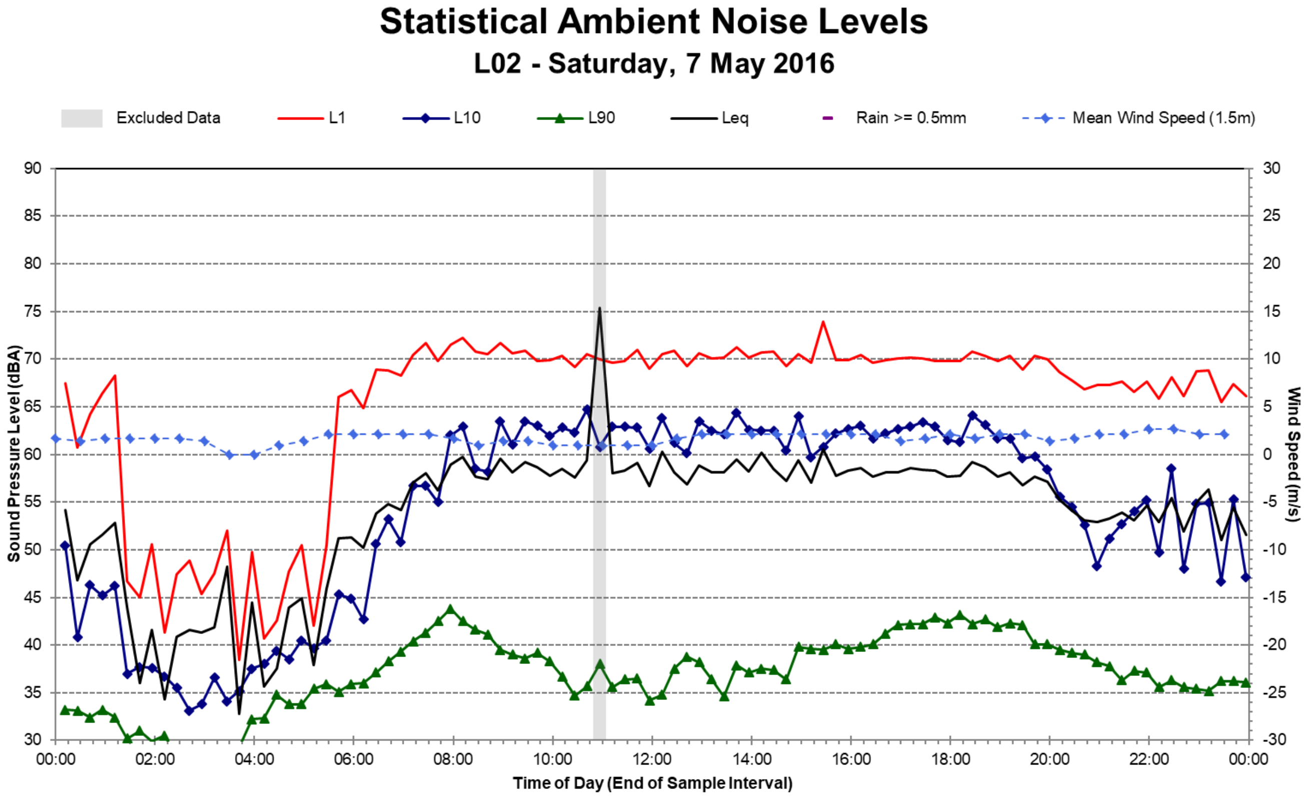
Photo of Noise Monitoring Location


Statistical Ambient Noise Levels
L02 - Wednesday, 4 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

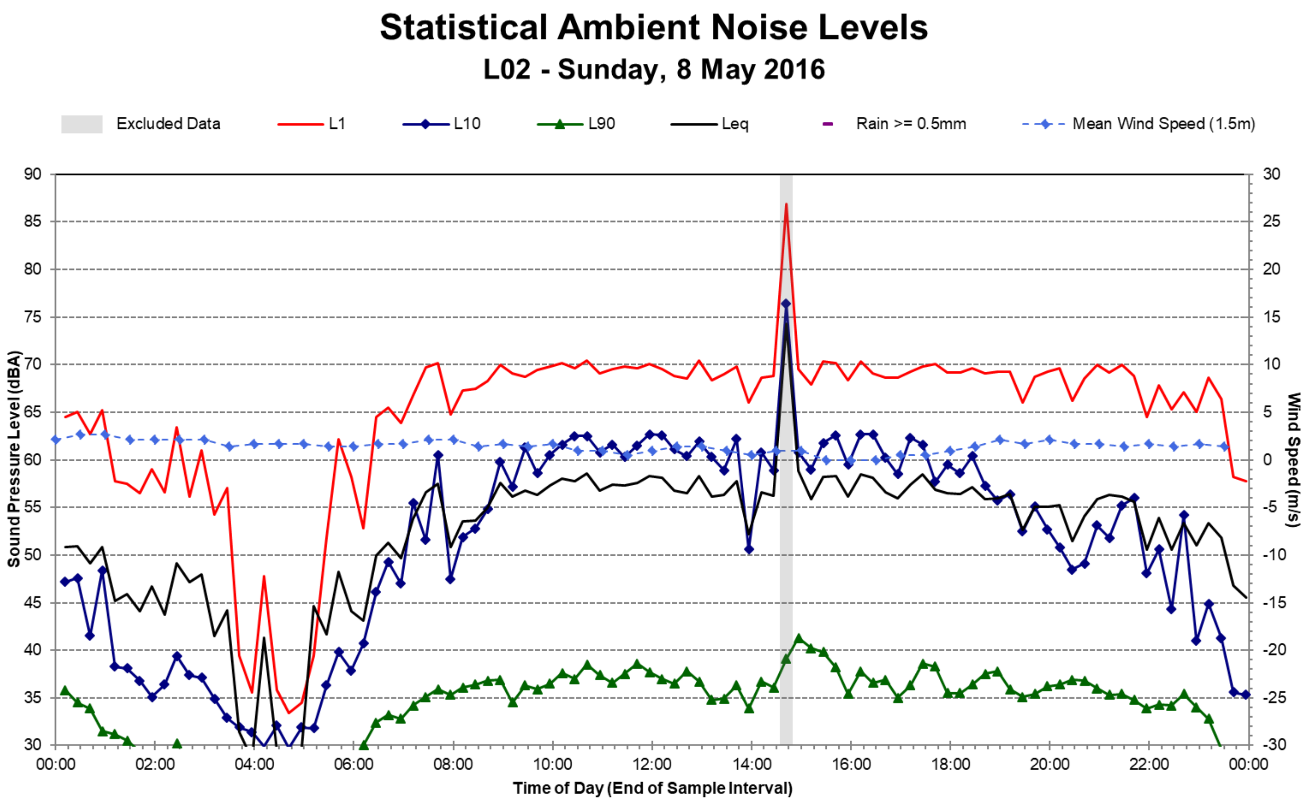

Statistical Ambient Noise Levels
L02 - Thursday, 5 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



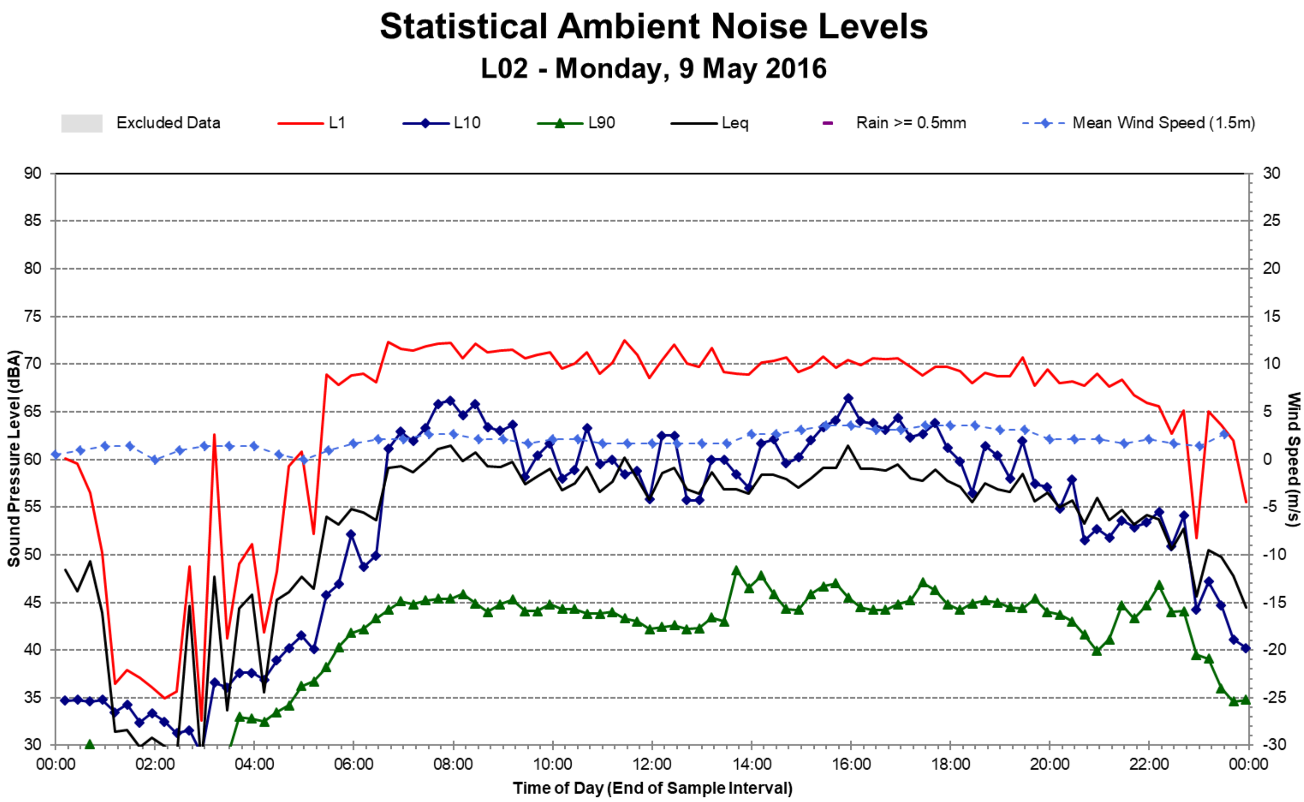
Statistical Ambient Noise Levels
L02 - Friday, 6 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



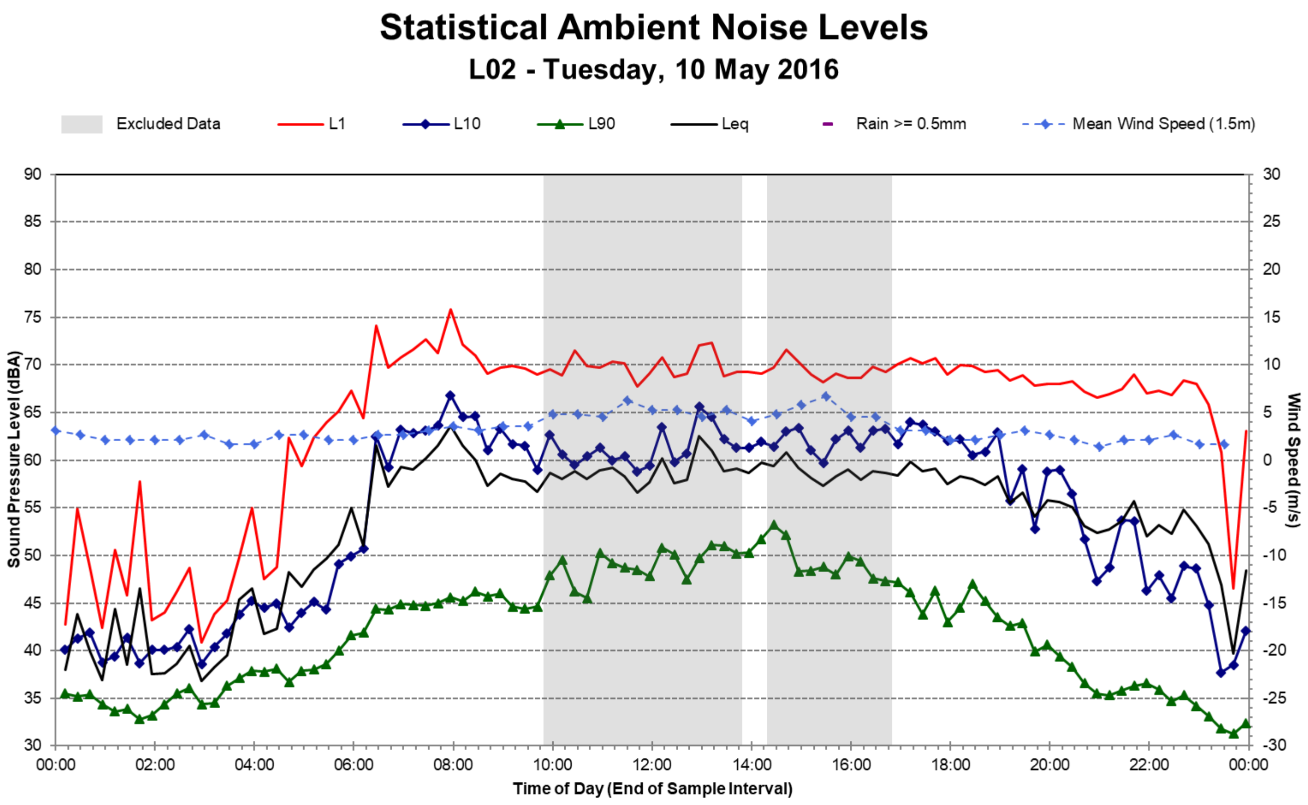
Statistical Ambient Noise Levels
L02 - Saturday, 7 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

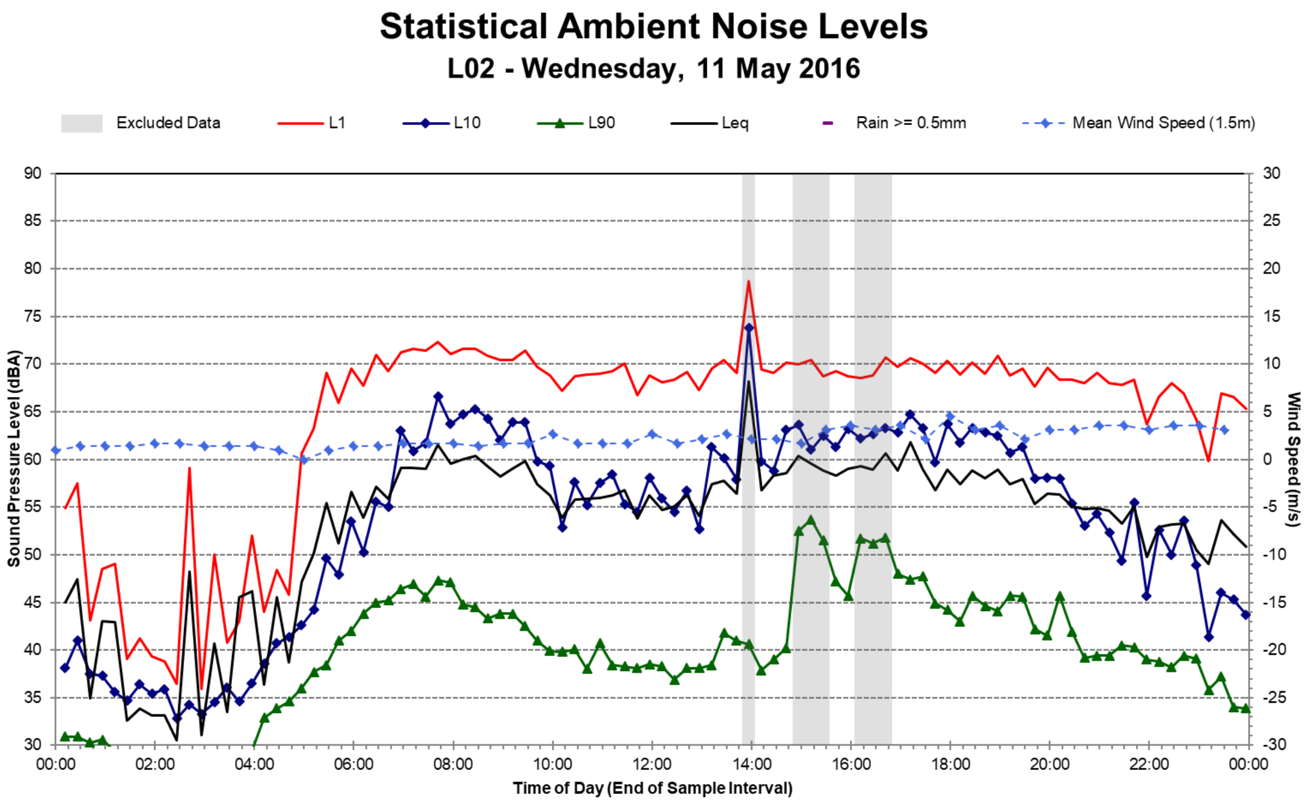


Statistical Ambient Noise Levels
L02 - Sunday, 8 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



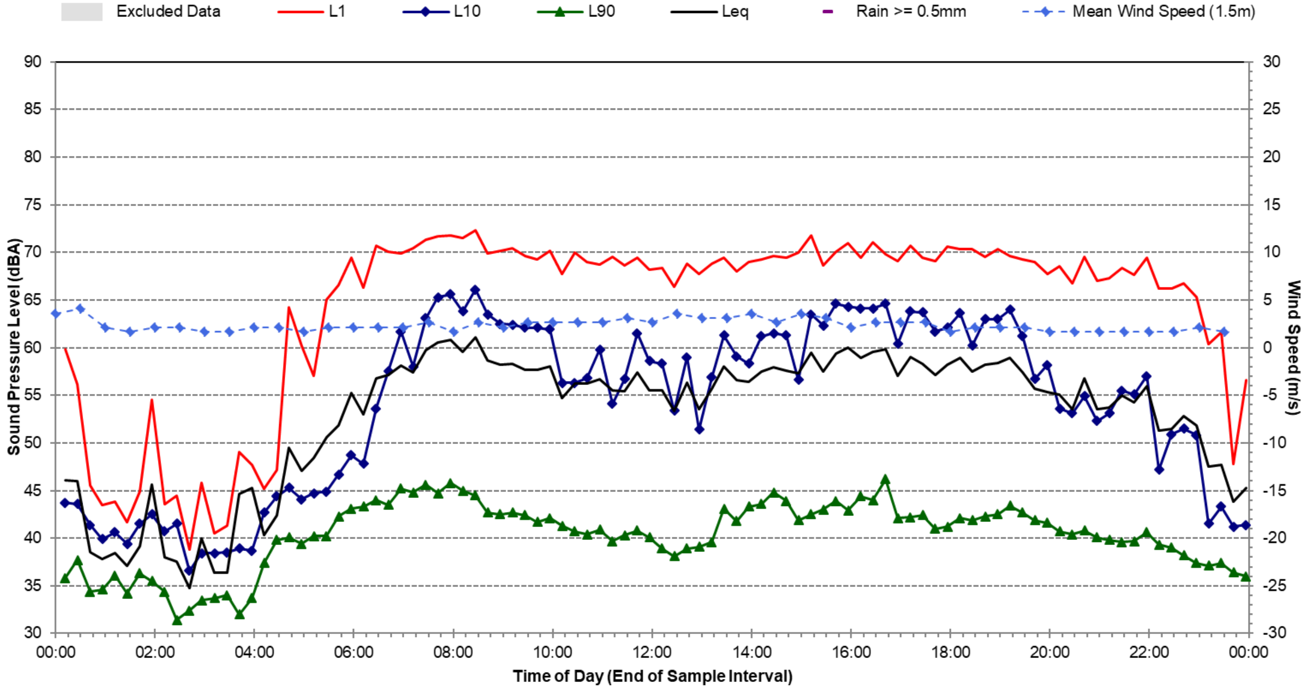
Statistical Ambient Noise Levels
L02 - Monday, 9 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
L02 - Tuesday, 10 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
L02 - Wednesday, 11 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

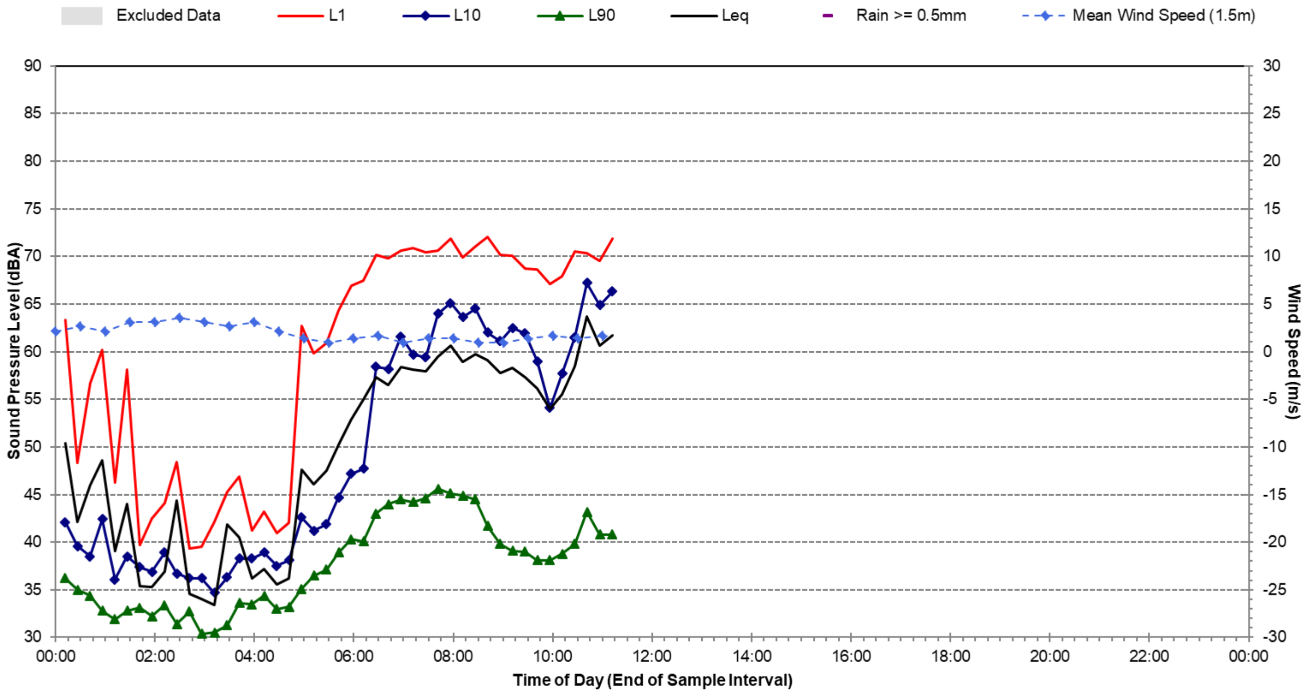
Statistical Ambient Noise Levels

L02 - Thursday, 12 May 2016



Statistical Ambient Noise Levels

L02 - Friday, 13 May 2016



Noise Monitoring Location	L.03
Noise Monitoring Address	**7 Robert Road, Cherrybrook**

Logger Device Type: Svantek 957, Logger Serial No: 20675

Sound Level Meter Device Type: Brüel and Kjær 2260, Sound Level Meter Serial No: 2414605

Ambient noise logger deployed in the front garden of residential address 7 Robert Road, Cherrybrook.

Attended noise measurements indicate that the ambient noise environment at this location is dominated by road traffic noise from Robert Road as well as other distant roads such as Castle Hill Road. Aircraft noise and noise from the construction of Cherrybrook Station is also heard at this location.

Recorded Noise Levels: (LAmax):

04/05/2016: Light-vehicle traffic Robert Road: 52-73 dBA, Light-vehicle traffic Castle Hill Road: 40-46 dBA,

Heavy-vehicle traffic Castle Hill Road: 47-54 dBA, Aircraft: 52-64 dBA,

Construction (Cherrybrook Station): 39-41 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – NPfI Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	LAeq	L10	L1
Daytime	37	55	54	68
Evening	39	52	50	66
Night-time	31	49	41	50

Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	Noise Level (dBA)	
	LAeq(period)	LAeq(1hour)
Daytime (7am-10pm)	54	56
Night-time (10pm-7am)	50	56

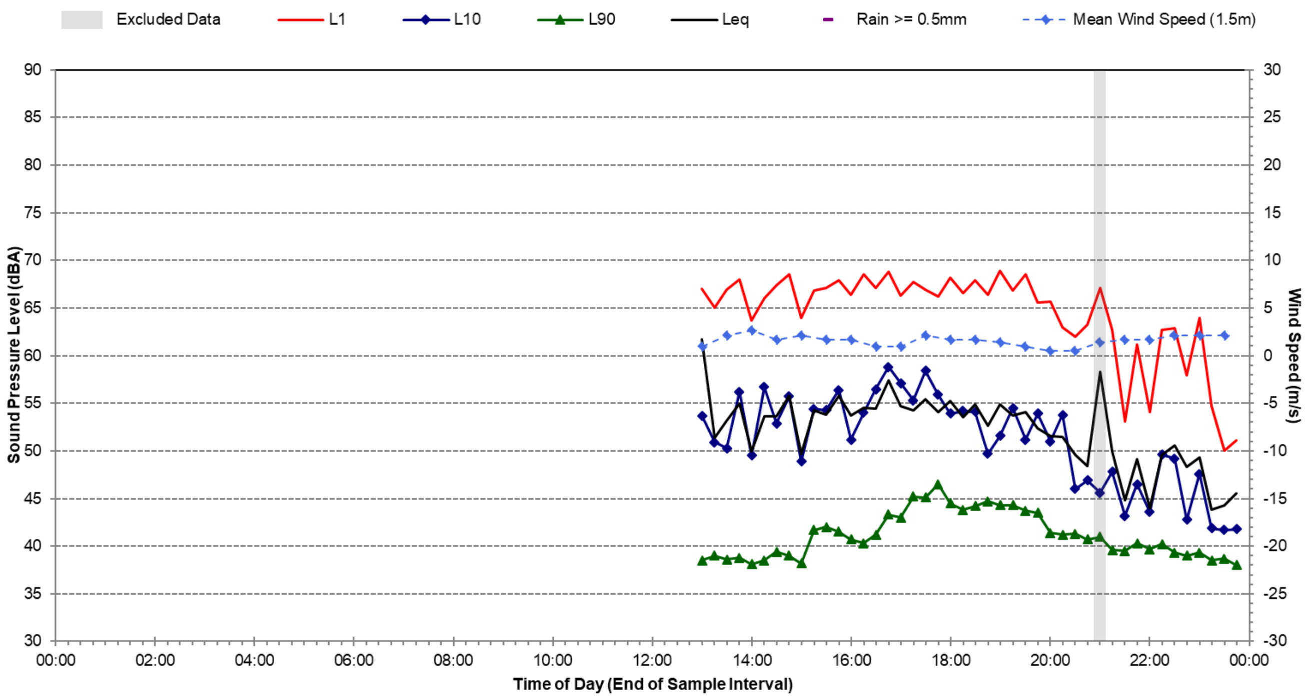
Attended Noise Measurement Results

Date	Start Time	Measured Noise Level (dBA)		
		LA90	LAeq	LAmax
04/05/2016	12:58	40	52	73

Photo of Noise Monitoring Location

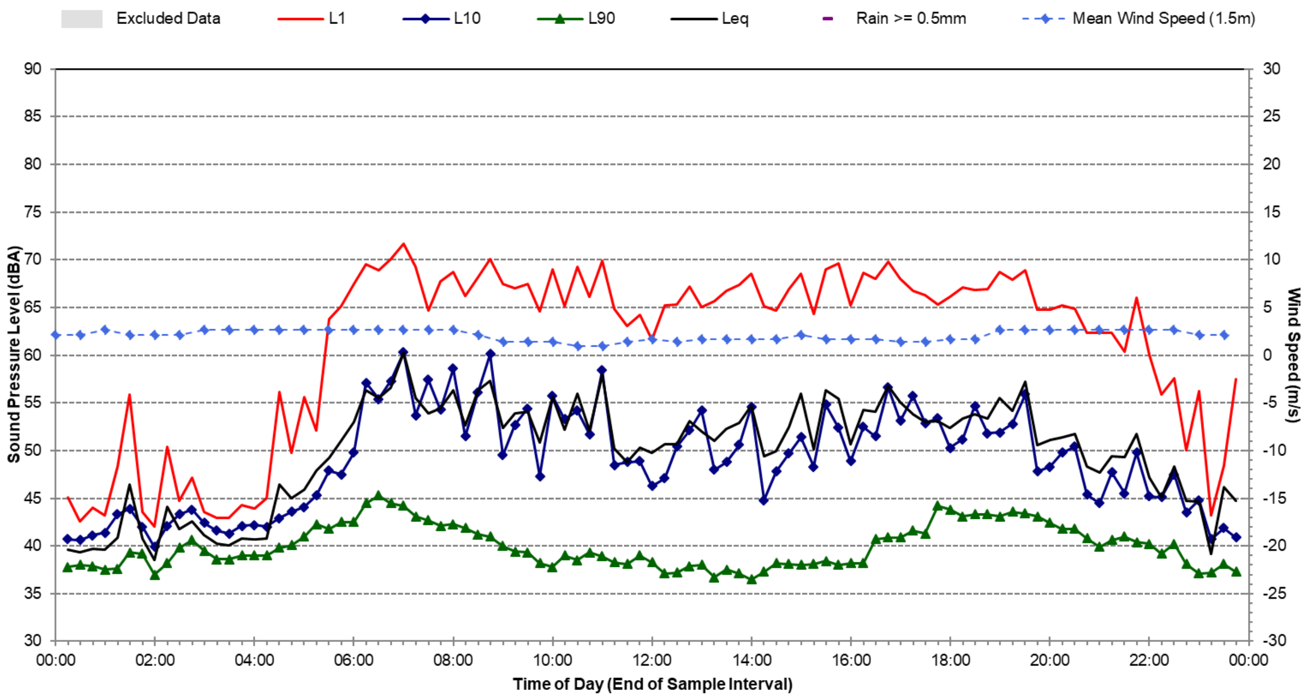
Statistical Ambient Noise Levels

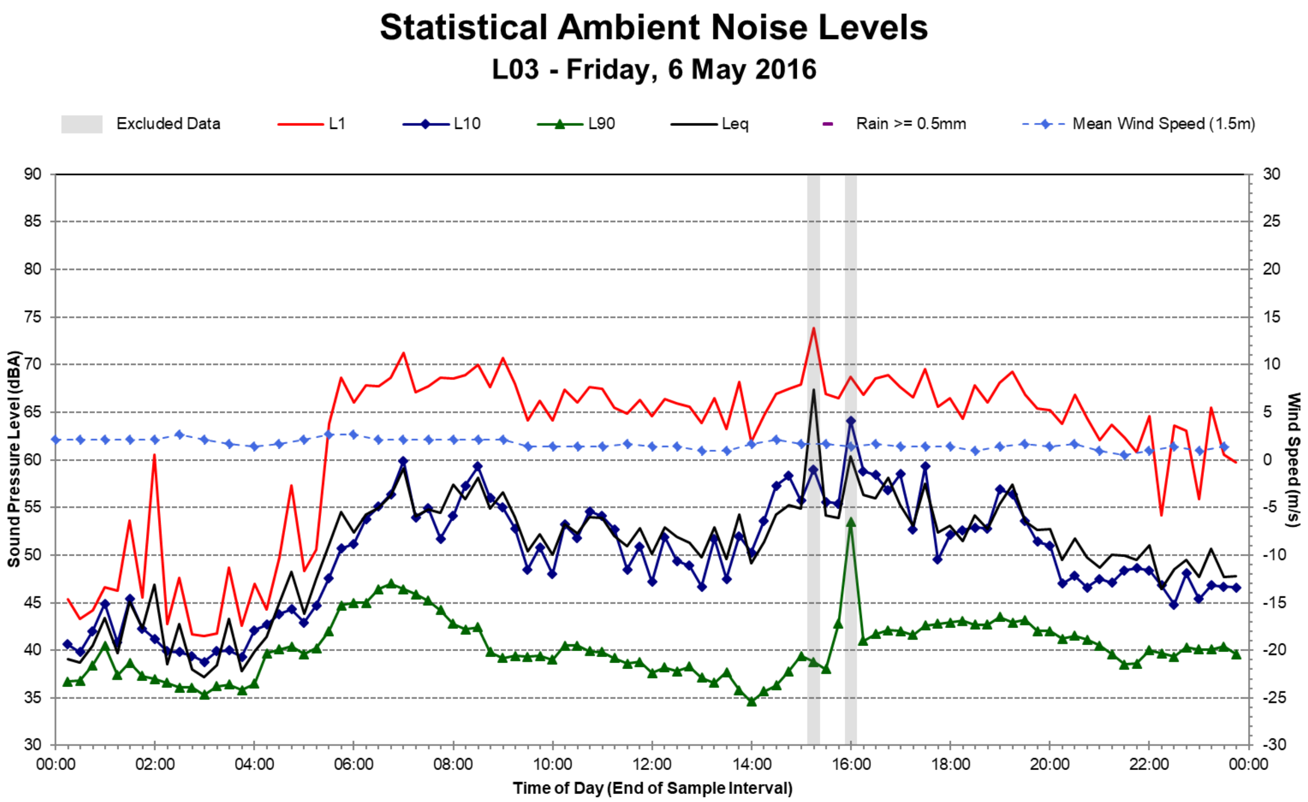
L03 - Wednesday, 4 May 2016



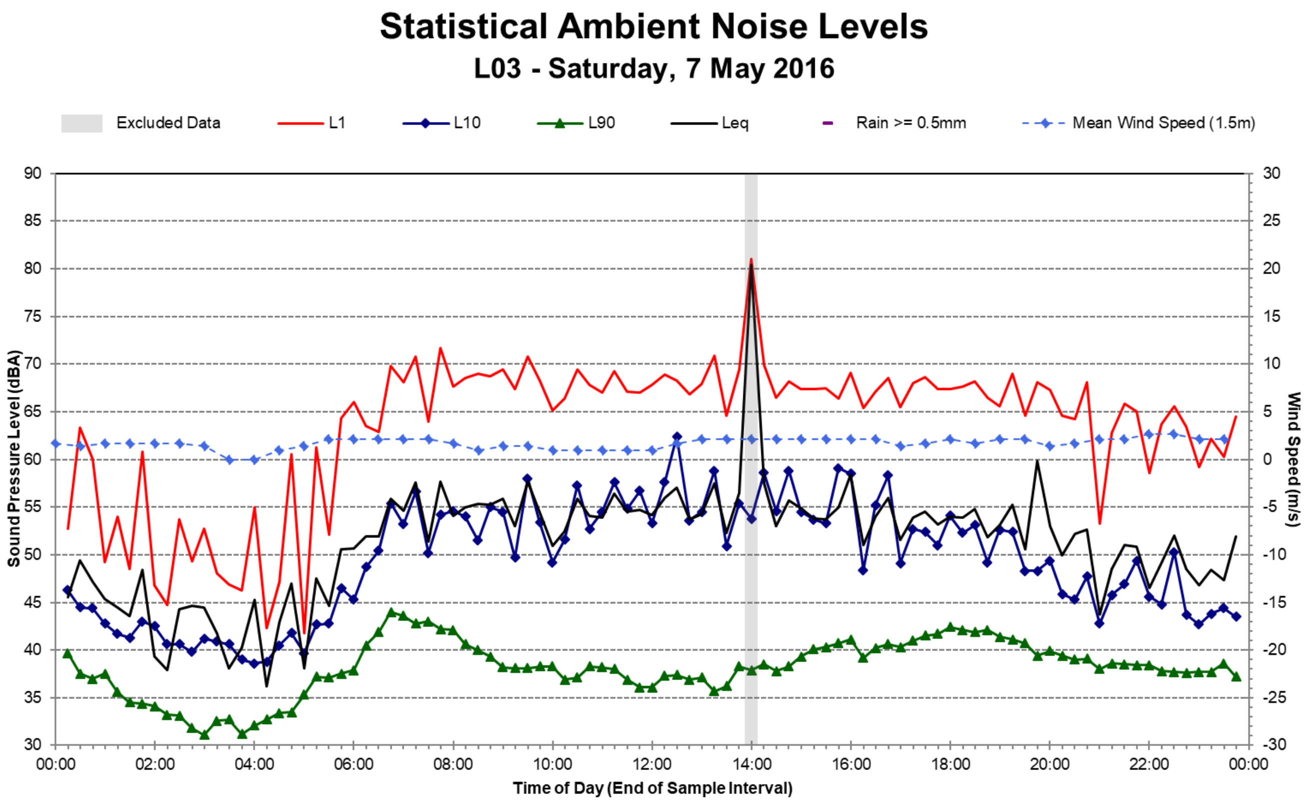
Statistical Ambient Noise Levels

L03 - Thursday, 5 May 2016

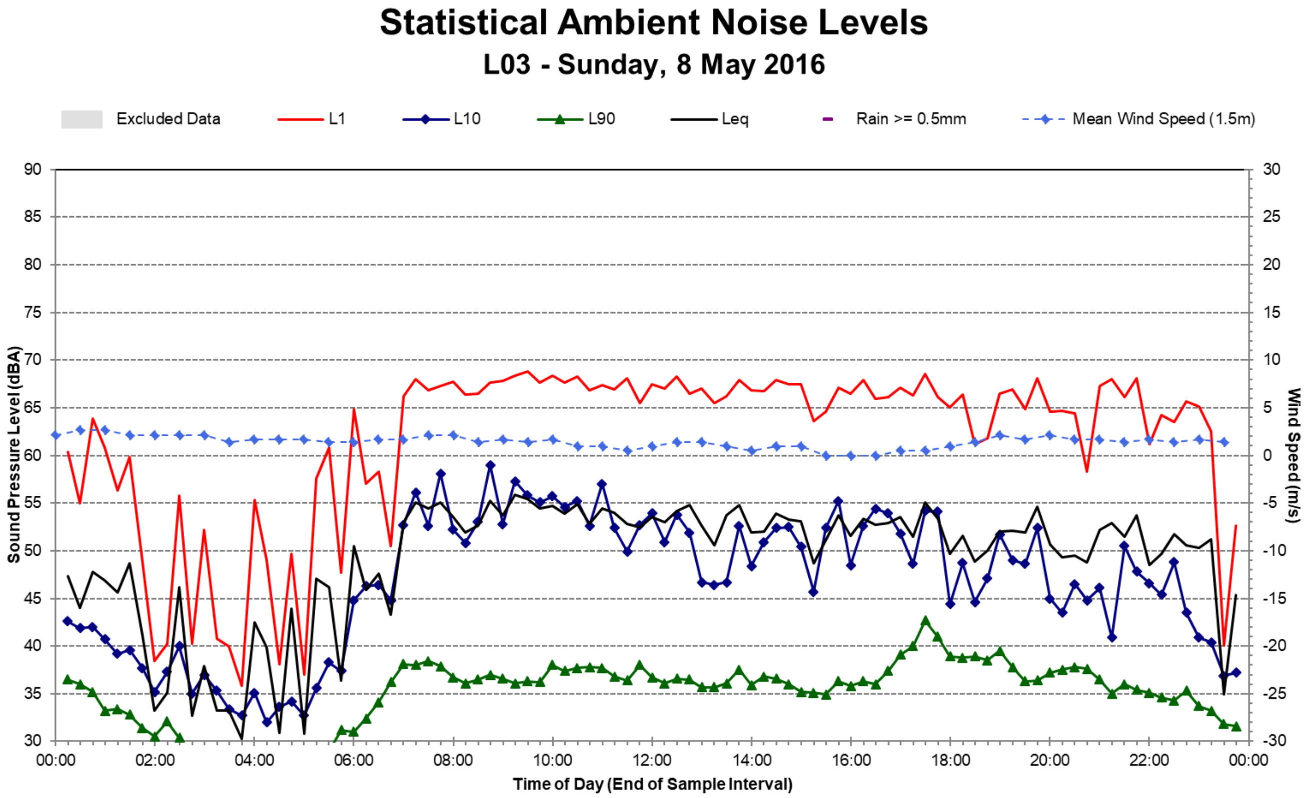


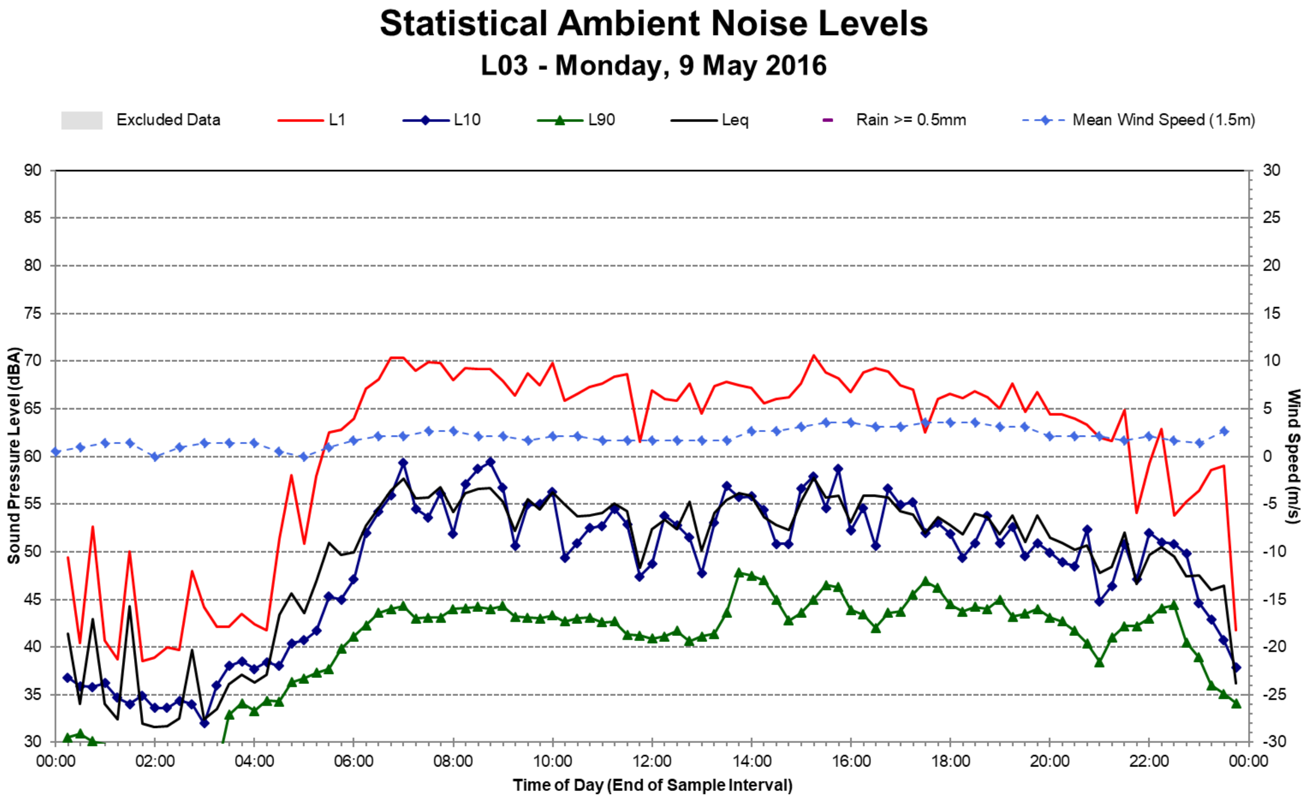


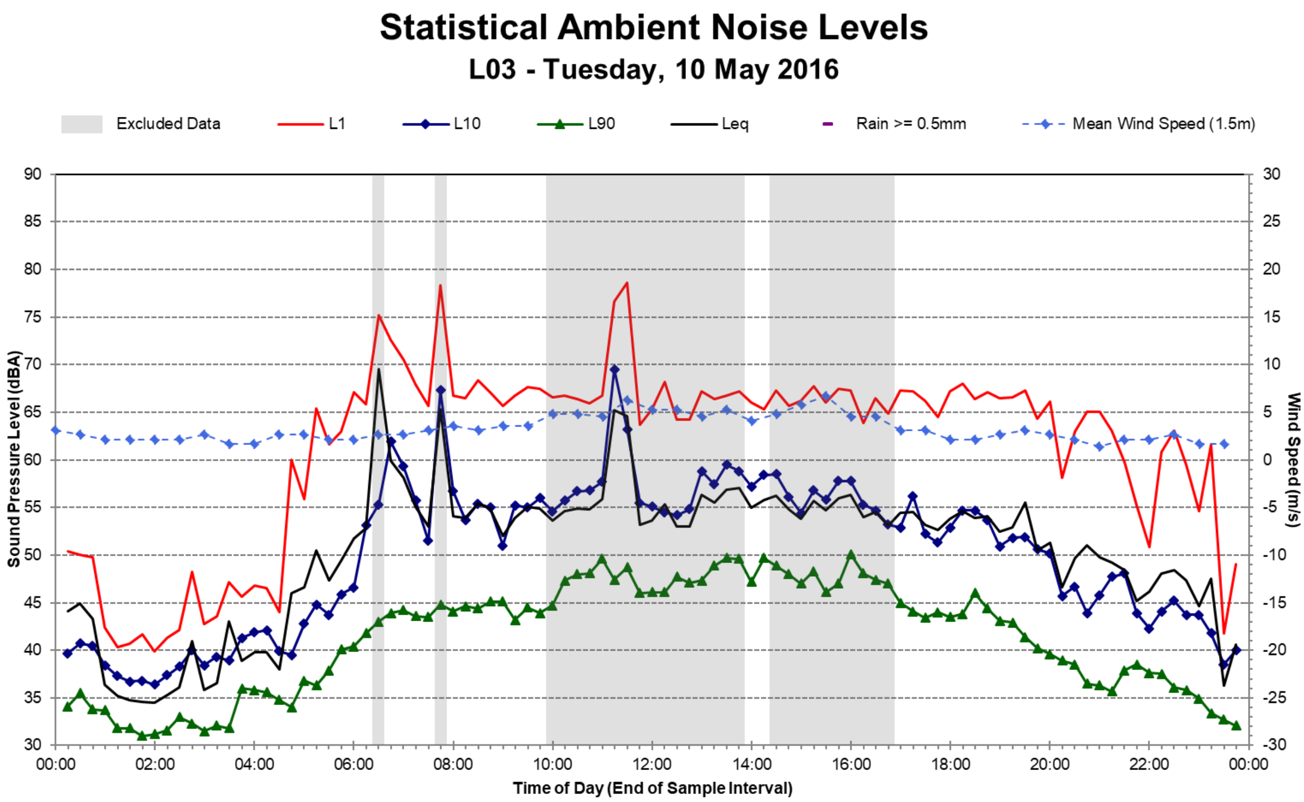
Statistical Ambient Noise Levels
L03 - Friday, 6 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

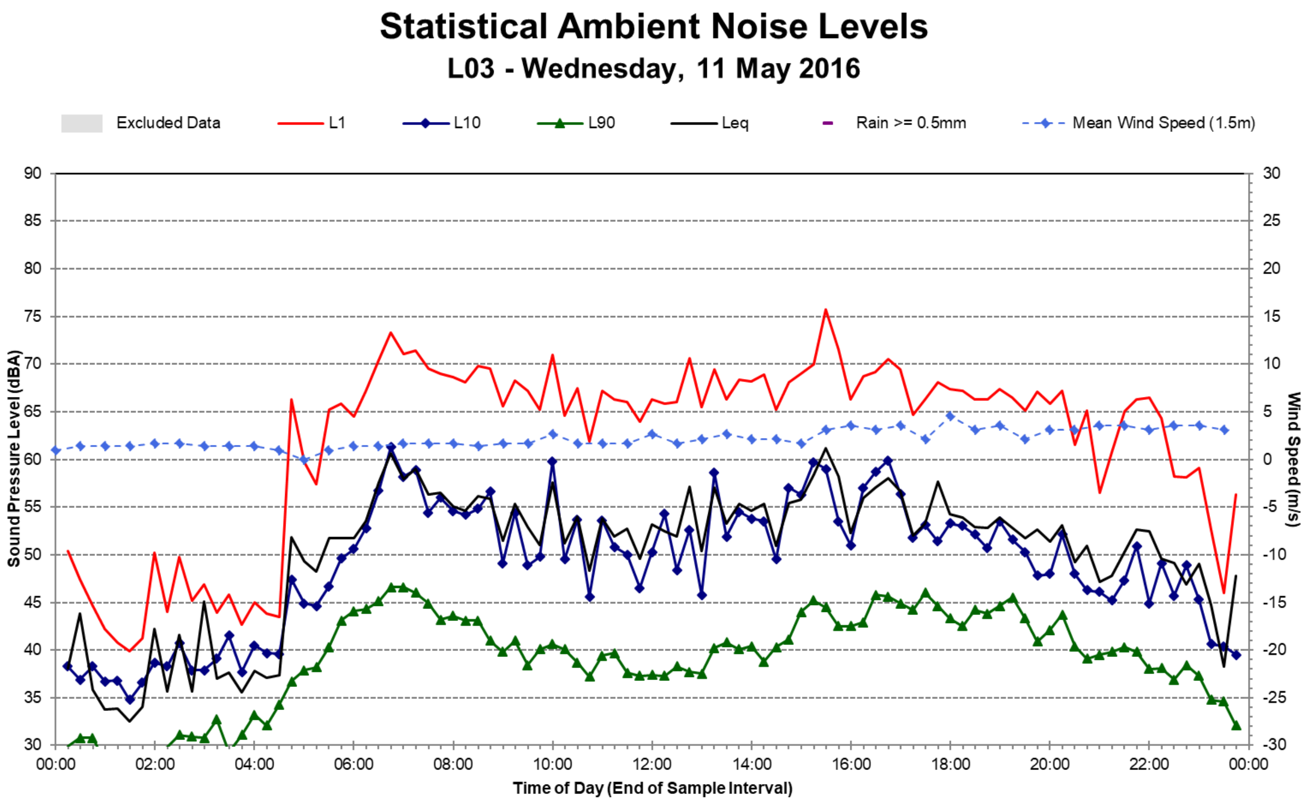


Statistical Ambient Noise Levels
L03 - Saturday, 7 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
L03 - Sunday, 8 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
90
85
80
75
70
65
60
55
50
45
40
35
30
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00

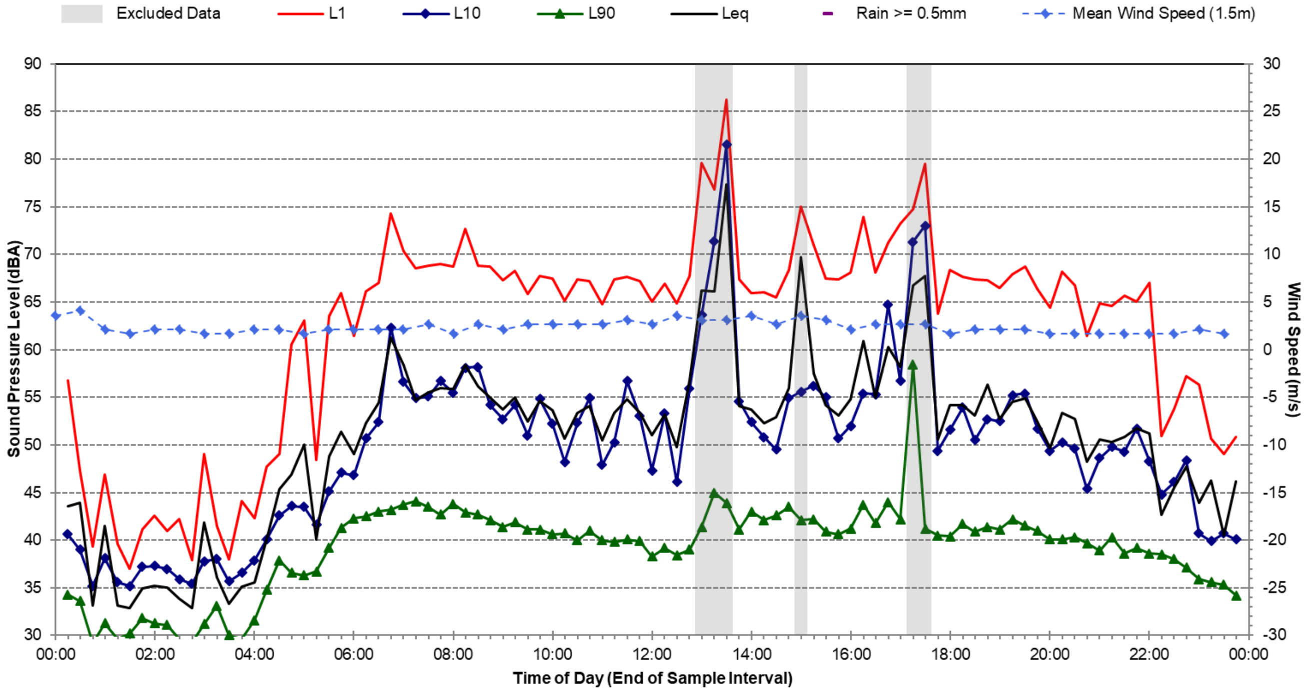

Statistical Ambient Noise Levels
L03 - Monday, 9 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
90
85
80
75
70
65
60
55
50
45
40
35
30
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00


Statistical Ambient Noise Levels
L03 - Tuesday, 10 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
L03 - Wednesday, 11 May 2016
Excluded Data
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

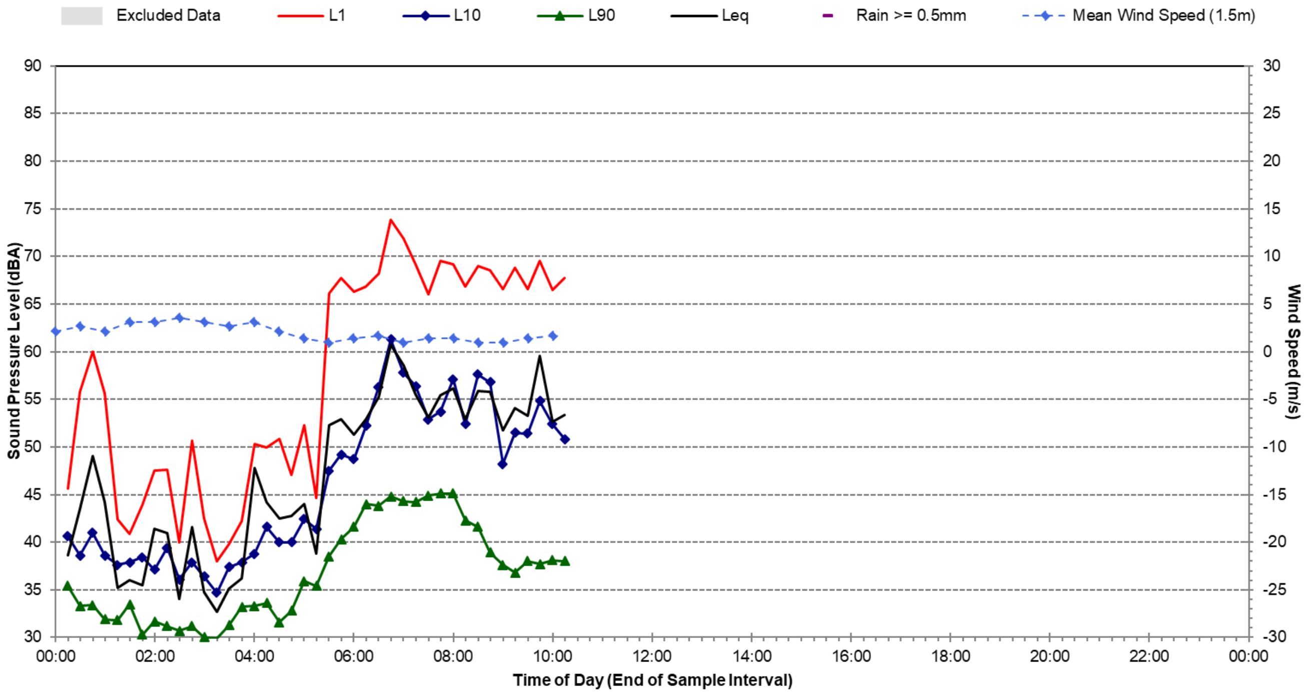
Statistical Ambient Noise Levels

L03 - Thursday, 12 May 2016



Statistical Ambient Noise Levels

L03 - Friday, 13 May 2016



ASIA PACIFIC OFFICES

BRISBANE
Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
F: +61 8 9370 0101

GOLD COAST
Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Level 11, 176 Wellington Parade
East Melbourne VIC 3002
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
Tenancy 202 Submarine School
Sub Base Platypus
120 High Street
North Sydney NSW 2060
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
12 Cannan Street
South Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 404 939 922

AUCKLAND
68 Beach Road
Auckland 1010
New Zealand
T: 0800 757 695

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628